GENETIC RESOURCES UNIT

Annual Report for 1990

ICARDA

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International Center for Agricultural Research in the Dry Areas
P.O. Box 5466, Aleppo, Syria

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1. GENETIC RESOURCES ACTIVITIES

1.1. Introduction

Germplasm exploration, preservation and utilization have been drawing attention of the international community in the last two decades. The growing interest in genebanks shown by national authorities throughout the world was reflected in the inauguration of the FAO Commission on Plant Genetic Resources in 1985. At its 1988 annual meeting the CGIAR (Consultative Group on International Agricultural Research) adopted a policy statement on plant genetic resources. Subsequently, ICARDA developed its position paper on genetic resources availability, which was approved by the Program Committee Meeting in October 1989.

The objectives and strategic guidelines of the Board of Trustees have been clearly formulated in the ICARDA's Medium-term plan 1990-1994:

The main objective of the Genetic Resources Unit is to explore, safeguard and enhance the utilization of diverse germplasm collections of crops for which ICARDA has either a global or regional responsibility. The WANA (West Asia and North Africa) region includes the primary centers of diversity of its mandated crops - wheat, barley, chickpea, lentil, faba bean and a number of forage species. The genetic resources originating from the region have a global importance for crop improvement and related research as well as for providing basic material for the development of improved germplasm adapted to the farming systems in the region.

According to its Medium-term plan ICARDA is extending its activities into the lower rainfall areas and marginal lands and also to the highlands. In these environments new germplasm tolerant to abiotic stresses is needed but resistance to diseases and pests remains equally important.

The modern high-yielding varieties have proved to be mostly unadapted to the low-input farming systems of the rainfed agriculture in West Asia and North Africa. Consequently, new types of germplasm have to be developed with extensive use of locally adapted landraces, primitive forms and wild relatives. This indigenous gene pool has accumulated a number of genes for tolerance to environmental stresses during millennia of its existence in the region, where agriculture based on ICARDA mandated crops (barley, wheat and food legumes) originated some 10000 years ago.

Therefore, collecting of the adapted germplasm in unexplored or under explored regions of WANA or related environments continued to receive high priority in 1990 (Table 1). The total of 1620 new entries indicates a considerable exploration of indigenous germplasm adapted to WANA's agroecological conditions. These resources will be multiplied, characterized, evaluated and preserved for their use in crop improvement programs.

In addition to the germplasm collected during GRU/ICARDA collecting missions, 3889 cereal, 234 food legume and 264 forage germplasm accessions were received from other institutions in 1989/90 (Table 1).

The total number of new accessions, collected or obtained from other sources, was 6007, i.e. an almost 7% increase in GRU holdings. On the other hand GRU/ICARDA provided 11622 samples to breeders at ICARDA, to NARSs and other bona fide users worldwide.

Germplasm multiplication and characterization and/or preliminary evaluation remained main activities of the unit, similar to previous years (Table 2).

Table 1. Germplasm collected or received in 1989/90.

Crop groups	Collected by GRU	Received from other institutes	New acquisitions (total)
Barley	43	2224	2267
Wild barley	19	6	25
Durum wheat	26	1381	1407
Bread wheat	14	157	171
Wheat wild species	257	121	378
Cereals-subtotal	359	3889	4248
Chickpea	3	80	83
Wild Cicer spp.	2	-	2
Lentil	130	127	257
Wild Lens spp.	12	-	12
Faba bean	9	27	36
Food legumes-subtotal	156	234	390
Medicago spp.	276	58	334
Vicia spp.	68	112	180
Lathyrus spp.	33	57	90
Pisum spp.	22	10	32
Trifolium spp.	363	2	365
Other forage crops	343	25	368
Forage species-subtotal	1105	264	1369
Grand total	**1620**	**4387**	**6007**

In the evaluation experiments stress tolerant germplasm was found among wild relatives and landraces of cultivated species. Seed samples of this germplasm were provided to breeders and scientists in ICARDA's commodity programs, as well as to the national research programs in WANA for in-depth evaluation and enhancement.

In 1990, the transfer of active collections from the

Table 2. Germplasm multiplication, characterization and evaluation in 1989/90.

Crop groups	Multiplied (No. of acc.)	Characterized or/and evaluated (No. of acc.)	(No. of traits)
Barley	747	3976	7-16
Wild barley	-	287	11
Durum wheat	-	1571	6-16
Bread wheat	147	541	6-16
Wheat wild species	221	454	16
Cereals-subtotal	1115	6829	-
Chickpea	671	1654	15
Wild *Cicer* spp.	226	10	2
Lentil	925	112	13
Wild *Lens* spp.	290	178	3
Faba bean	204	38	3
Food legumes-subtotal	2316	1992	-
Medicago spp.	820	397	5-13
Vicia spp.	606	329	5
Lathyrus spp.	545	135	5
Pisum spp.	701	51	5
Other forage legumes	-	604	5
Forage legumes-subtotal	2672	1516	5-13
Grand total	**6103**	**10337**	-

old to the new medium-term store has been completed.

Since July 1990, when deposition of germplasm into the base collection started, 18396 seed samples, including 6132 accessions, were transferred to the long-term storage.

Table 3. Status of ICARDA collections by origin (October 1990).

Crop	Number of accessions originated from						
	W A N A		Other countries		Unknown		Total
	No. of acc.	(%)	No. of acc.	(%)	No. of acc.	(%)	No. of acc.
Barley	6113	32.7	11944	64.0	614	3.3	18671
Hordeum spontaneum	375	28.4	65	4.9	880	66.7	1320
Durum wheat	7463	41.4	9725	53.9	845	4.7	18033
Bread wheat	4336	64.6	1342	20.0	1033	15.4	6711
Triticum boeoticum	96	82.0	14	12.0	7	6.0	117
Triticum dicoccoides	870	92.1	24	2.5	51	5.4	945
other Triticum spp.	134	46.7	48	16.7	105	36.6	287
Aegilops spp.	1457	79.8	342	18.7	27	1.5	1826
Cereals-subtotal	20844	43.5	23504	49.1	3562	7.4	47910
Chickpea	6301	77.2	1569	19.2	294	3.6	8164
Wild Cicer spp.	233	99.2	1	0.4	1	0.4	235
Lentil	3824	55.8	2869	41.9	157	2.3	6850
Wild Lens spp.	260	81.8	48	15.1	10	3.1	318
Faba bean	1741	49.3	1244	35.3	543	15.4	3528
Food legumes-subtotal	12359	64.7	5731	30.0	1005	5.3	19095
Medicago spp.	4348	88.0	326	6.6	265	5.4	4939
Vicia spp.	1889	44.3	908	21.3	1470	34.4	4267
Pisum spp.	451	13.3	1788	52.6	1161	34.1	3400
Lathyrus spp.	1086	82.6	222	16.9	7	0.5	1315
Trifolium spp.	1928	93.1	65	3.3	70	3.6	1963
Other forages	2652	33.1	5061	63.2	293	3.7	8006
Forage-subtotal	12254	51.3	8370	35.0	3266	13.7	23890
Grand total	**45457**	**50.0**	**37605**	**41.4**	**7833**	**8.6**	**90895**

Seed viability was monitored in 4369 germination tests, with 89% of the accessions showing good germination (see under 1.7.2.).

The current status of the GRU/ICARDA active collections is presented in Table 3. In comparison with the last year (October 1989) the total germplasm holdings increased by 6007 accessions 6.8%, mainly due to increments in cereal germplasm - 3889 accessions.

The germplasm information system provides collection, passport and characterization data on request to the users. Information on new accessions was entered into the GRU database, as well as additional data on older accessions.

Two ecogeographical databases, one for wild wheat relatives and one for Mediterranean annual forage and pasture legumes, respectively, were developed in joint IBPGR/ICARDA projects. After termination of these projects responsibility for the databases has been transferred to GRU/ICARDA.

Training of national program staff, partially carried out in collaboration with IBPGR, was an important component of GRU activities in 1990.

Group training courses on genetic resources management and on the use of electrophoresis were organized in Amman, Jordan and ICARDA Headquarters in Tel Hadya, Syria, respectively, with a total of 21 participants. In addition, individual training was provided to eight persons from WANA countries.

High priority was given to the collaboration with NARSs especially in germplasm collecting and training activities.

Two laboratories are attached to the GRU: (i) the Seed Health Laboratory, which safeguards seed movement at ICARDA by minimizing the risk of spreading pests and pathogens during seed distribution and exchange. The total number of outgoing shipments decreased by 13% and the number of incoming consignments increased by 16% compared to the previous period. (ii) The Virology Laboratory carries out research on important viruses of cereals and food legumes and its work concentrates on screening for virus disease resistance, yield loss evaluation in response to infection with selected viruses and testing for seed borne viruses. During the past season some basic studies on selected viruses were also carried out. The research component substantially increased in the 1989/90 season in both the Seed Health and Virology labs. ***J. Valkoun***

1.2. New germplasm collected or introduced in 1989/90

1.2.1. Barley collection mission in Syria

As part of an ongoing activity paired samples of barley landraces and the wild progenitor H. spontaneum were collected. Four sites were identified in 1988 and 1989 for their combined occurrence and a third collecting mission to these sites was conducted in May 1990. They include the Palmyra area and the Lattakia province. This enables the study on the genetic composition of the landraces and the extent of gene flow between the wild and cultivated types in their natural habitat. This year less success was achieved compared with previous years, due to the severe drought, which persists now for several years in the area. A total of 218 single head samples was collected of both wild and cultivated barley, which will be planted in the isolation area for preliminary characterization. ***B. Humeid and M. Hamran***

1.2.2. Barley collection mission in Algeria

The strategy of the Genetic Resources Unit at ICARDA is to collect in countries where a rich accumulation of useful alleles and a high frequency of such alleles can be expected. Such a collection can supply accessions with several desired traits in different genetic background.

Table 4. Germplasm samples collected in Algeria in 1990.

	Number of samples collected	
	Bulk	**Single head**
barley	23	247
durum wheat	6	61
bread wheat	8	-
Aegilops ventricosa	3	-
Aegilops ovata	5	-
Aegilops triuncialis	1	-
pea	5	-
chickpea	3	-
lentil	6	-
faba bean	8	-
Total	**68**	**308**

Based on this the second expedition in Algeria aimed to collect landraces of cereals, food and forage legumes, which are still cultivated on small farms in areas between Atlas Tellien in the northwest of the country and Atlas Saharien in the southwest. In addition some wild relatives of these crops were also collected. During the mission 68 populations and 308 single spike samples were collected (Table 4), including nine samples of three _Aegilops_ species: _Ae_. _ventricosa_, _Ae_. _ovata_ and _Ae_. _triuncialis_. These wild species were collected from the Tellien Atlas; locations varied in altitude from 700 m to 1185 m a.s.l. _Aegilops ovata_ was found dominant in a wide range of altitudes, and showed overall earlier maturity than _Ae_. _ventricosa_ and _Ae_. _triuncialis_, even at high altitudes.

The entire collection will be planted in the isolation area for multiplication and preliminary characterization.
B. Humeid and M. Hamran

1.2.3. Collection of wild relatives of wheat

In the framework of the special project "Collection and characterization of germplasm of the wild relatives of wheat" collection trips have been made to Tunisia, Libya, Morocco, the USSR and Bulgaria. These were joint missions with the respective national programs: the Institut National de l'Agriculture de Tunisie (INAT), joined by the *Ecole Superieure d'Agriculture du Kef* (ESAK) at Tunis and Le Kef, Tunisia, the Agricultural Research Center, Tripoli and El Fatayeh, Libya, the Institut National de Recherche Agronomique (INRA), Settat, Morocco, and the N.I. Vavilov All-Union Institute *of Plant Industry (VIR), Leningrad* and Derbent (Daghestan), USSR. The mission in Bulgaria followed an invitation from the Institute of Introduction and Plant Genetic Resources "K. Malkov" at Sadovo, Bulgaria, and was a follow-up of a similar expedition in 1989. Priority was given to the species of Aegilops and the wild species of Triticum while recording pertinent environmental data.

From 21-28 May, 1990, a collection mission was held in Tunisia and Libya. In Tunisia 21 collections were made, representing three species of Aegilops as well as some six-rowed barley landraces and annual species of Medicago. Aegilops ovata was the only species which was frequently encountered. Ae. ventricosa was, contrary to 1989 results from neighboring Algeria, rare and apparently maturing later than at the time of expedition. Immature Hordeum bulbosum was found once.

In Libya the coastal area between Benghasi and Tolbruq was visited following earlier reports by Dr. A. Kamel on the presence of wild wheat relatives. Limited to a few days only a surprising 34 accessions were collected. Ae. ventricosa and Ae. ovata were equally well represented. On the lighter and sandy soils in the far eastern part of the country Ae. kotschyi was also found, a continuation westward of its distribution in coastal Egypt. An important result was the presence of seven large populations of Hordeum spontaneum, the barley wild relative that is used in breeding programs. Similar to Ae. kotschyi these findings represent an extension of the distribution area, and warrant a closer survey of the furthermost parts of eastern Libya in the future. In addition a few landraces of durum wheat and six-rowed barley were collected. Since landraces have become almost extinct in Libya a contribution could thus be made to the much-needed conservation of this material.

From 4-18 June, 1990 a collection mission was held in the central and northern parts of Morocco. The result was 73 accessions, representing four species of Aegilops, with, in addition, landrace material of durum and bread wheat, six-rowed barley and lentil. Distribution of Aegilops was similar as in Tunisia with Ae. ovata most ubiquitous. Ae. triaristata, a rare species in Morocco, was found three times. Most notably was the virtual absence of Ae. ventricosa, a species reported extensively with germplasm and herbarium material from all North-African countries and from Spain.

In the frame work of the ICARDA-VASHKNIL agreement the USSR was visited in the period of 23 June to 6 July. During field trips in the vicinity of Derbent, Daghestan, and at the research station of the Vavilov Institute, located a few kilometers south of Derbent near the

Table 5. Natural and artificial hybrids and amphidiploids of *Aegilops* and *Triticum* species, collected during missions and at the VIR station, Derbent, Daghestan, USSR.

Natural hybrids	Remarks
Ae. columnaris x *Ae. triuncialis*	VIR Station
Ae. cylindrica x *Ae. triuncialis*	VIR Station
Ae. triaristata x *Ae. triuncialis**	collection mission
Ae. triuncialis x *Ae. biuncialis**	collection mission
Ae. triuncialis x *Ae. cylindrica*	collection mission (*) & VIR Station
Ae. cylindrica x *T. aestivum*	VIR Station
Ae. cylindrica x *T. aestivum*	VIR Station
T. boeoticum x *T. timopheevii**	VIR station
(*T. dicoccum* x *Ae. biuncialis*) x *T. aestivum*	VIR Station
(*T. dicoccum* x *Ae. biuncialis*) x *T. compactum*	VIR Station
(*T. dicoccum* x *Ae. speltoides*) x *T. aestivum*	VIR Station
(*T. timopheevii* x *T. persicum*) x *T. aestivum*	VIR Station
(*T. turgidum* x *Ae. biuncialis*) x Triticale	VIR Station; several forms
Artificial hybrids or amphidiploids	**Remarks**
Ae. squarrosa x *Ae. squarrosa*	autotetraploid; 2n = 28
Ae. squarrosa x *T. urartu*	amphidiploid; 2n = 28
T. boeoticum x *T. boeoticum*	artificial 4n autotetraploid; 2n = 28
T. dicoccum x *Ae. biuncialis*	amphidiploid
T. karamyschevii x *Ae. triuncialis*	amphidiploid
T. timopheevii x *T. persicum*	amphidiphoid; 2n = 56; known as *T. fungicidum*
T. timopheevii x *Ae. squarrosa*	amphidiploid; 2n = 42; known as *T. kiharae*
T. turgidum x *Ae. biuncialis*	amphidiploid; 2n = 56; several forms

* : male parent unknown

Caspian sea, 70 collections were made. This total comprised the following categories: (1) species collected during the collection missions (20), **(2)** (sub-) species collected at the VIR station (20), **(3)** natural hybrids of Aegilops species, found on the collections trips (3), and **(4)** research material collected at the VIR station, consisting of natural hybrids and artificial amphidiploids of various Aegilops and Triticum species (27).

The total, resulting from the collection missions breaks down as follows: Aegilops biuncialis (3), Ae. cylindrica (4), Ae. squarrosa (3), Ae. triaristata (3), Ae. triuncialis (3), Hordeum bulbosum (bulbs collected from 2 populations), and H. spontaneum (2). Natural hybrids of three different combinations of Aegilops species were also found (Table 5). All the Aegilops species reported from Daghestan were found, but most conspicuous was the size of several populations of Ae. biuncialis, estimated sometimes as more than 100 square meters. This is surprising since this species is in Daghestan at the margin of its distribution area.

At the VIR station samples were taken from rare (sub-) species of Aegilops and Triticum in order to enhance the ICARDA collection: Aegilops juvenalis (1), Ae. peregrina ssp. cylindrostachys (1), Ae. triuncialis ssp. persica (1), Ae. uniaristata (1), Triticum timopheevii ssp. araraticum (4), T. monococcum ssp. boeoticum (5), T. isphahanicum (1), T. jakubzineri (1), T. timopheevii (1), T. urartu (4). Comparison of the Triticum urartu material, which originates from Lebanon, Turkey and from the Armenian Republic in the Soviet Union, will enable whether similar material that was recently collected from Syria indeed belongs to the same species. If so, T. urartu will be for the first time reported from Syria.

Natural and artificial hybridization among Aegilops species and within the Aegilops-Triticum complex underlines the close genetic and evolutionary linkage of the species involved. All natural hybrids are normally sterile but rarely some seeds may be present. An extensive collection of these hybrids could be made, both in natural habitats and on the fields of the experimental station. In the latter case hybrids can be more or less intentionally induced by replanting plots in the second year with different species of Aegilops due to the presence of Triticum species in the vicinity of the test plots in the first year. The VIR station in Daghestan has been conducting research on wide hybridization and artificial amphidiploidization of Aegilops and Triticum for a long time and as a result an extensive collection of these hybrids and amphidiploids could be made (Table 5). This collection can be divided into several categories: (1) natural hybrids between Aegilops species and of Aegilops x Triticum species, (2) natural hybrids among Triticum species and between amphidiploids and Triticum species, and (3) artificial hybrids and amphidiploids. Whereas in a natural habitat the male parent cannot be established it can generally be assumed that the species of a second year's plot serves as the male parent of any hybrid, found in that plot. Hence the notation in Table 5 is "female parent x male parent"; when amphidiploids are involved the notation is "amphidiploid x male parent". Several artificial amphidiploids have been given a species status, mainly within the elaborate taxonomy of Triticum used by Russian authors.

The collection mission in Bulgaria was held immediately after visiting the USSR. The Genetic Resources Unit of ICARDA participated for the second year in a survey of Bulgaria for wild wheat relatives, carried out by IIPGR at Sadovo. During 8-19 July the mainly

Table 6. New accessions of *Aegilops* and wild *Triticum* resulting from 1990 collection missions.

Aegilops/Triticum

Species	Algeria*	Bulgaria	Libya	Morocco	Syria**	Tunisia	USSR	Total
A. biuncialis	-	20	-	-	4	1	3	28
caudata	-	2	-	-	-	-	-	2
columnaris	-	-	-	-	1	-	-	1
crassa	-	-	-	-	1	-	-	1
cylindrica	-	13	-	-	-	-	4	17
juvenalis	-	-	-	-	-	-	1	1
kotschyi	-	-	1	-	-	-	-	1
ovata	5	5	11	37	7	8	-	73
peregrina peregrina	-	-	-	-	17	-	-	17
peregrina cylindros.	-	-	-	-	-	-	1	1
speltoides ligustica	-	1	-	-	2	-	-	3
speltoides speltoides	-	-	-	-	2	-	-	2
squarrosa	-	-	-	-	-	-	3	3
triaristata	-	10	-	2	1	-	3	16
triuncialis triuncialis	1	20	-	17	17	-	3	57
triuncialis persica	-	-	-	-	-	-	1	1
umbellulata	-	-	-	-	1	-	-	1
uniaristata	-	-	-	-	-	-	1	1
vavilovii	-	-	-	-	2	-	-	2
ventricosa	3	-	8	1	-	-	-	12
T. monococcum boeoticum	-	4	-	-	-	-	5	9
timopheevii araraticum	-	-	-	-	-	-	4	4
urartu	-	-	-	-	-	-	4	4
Grand total								**257**

* : from a mission of B. Humeid and M. Hamran.
** : from missions of J. Valkoun, A.B. Damania, B. Humeid and M. Hamran.

mountainous regions in the south and west of the country were visited. During the field trip 81 collections were made, breaking down as follows: Aegilops biuncialis (20), Ae. caudata (2), Ae. cylindrica (13), Ae. ovata (5), Ae. speltoides var. ligustica (1), Ae. triaristata (10), Ae. triuncialis (20), Triticum monococcum ssp. boeoticum (4), and Vicia pisiformis (1). In addition, the following natural hybrids among Aegilops species were found: Ae. biuncialis x cylindrica (1), Ae. cylindrica x triuncialis (1), and Ae. triaristata x triuncialis (3). Although the notation of hybrids is usually "female parent x male parent" it is impossible to establish in the field what the female and the male parent is. The mentioned combinations, therefore, can also be cited the other way around. All hybrids were sterile. Contrary to the result of the 1989 mission in southeastern and eastern Bulgaria a predominance of Ae. cylindrica was not found. Ae. biuncialis and triuncialis were the most widely present species and in the southwest corner of the country Ae. cylindrica was completely absent. A one-day trip to the Svilengrad area near the Turkish border yielded all the known Bulgarian species as well as Triticum boeoticum. Most conspicuous was the presence of a large population of Ae. speltoides var. ligustica. Not only is this rare species in Bulgaria but the population consisted only of the variety ligustica, whereas a mixed growth, together with the variety speltoides, has consistently been found in Turkey and Syria. Also the size of the population, estimated at more than 100 square meters, is remarkable as the species is here at the margin of its distribution area.

A visit to the experimental fields of IIPGR yielded eight collections of natural hybrids among Aegilops species: biuncialis x triuncialis, ovata x triuncialis,

Table 7. Number of accessions and frequency distribution of Aegilops germplasm at ICARDA.

Species	accessions	percentage
triuncialis	363	19.87
ovata	311	17.03
biuncialis	191	10.46
squarrosa	156	8.54
cylindrica	130	7.11
peregrina	127	6.95
triaristata	104	5.69
speltoides	79	4.32
umbellulata	56	3.06
vavilovii	48	2.62
columnaris	48	2.62
kotschyi	41	2.24
ventricosa	40	2.19
caudata	33	1.80
searsii	30	1.64
bicornis	17	0.93
mutica	17	0.93
crassa	16	0.87
uniaristata	6	0.32
longissima	5	0.27
comosa	4	0.21
juvenalis	2	0.10
sharonensis	2	0.10
Total	**1826**	**100.00**

ovata x columnaris/triuncialis, triaristata x biuncialis, triaristata x cylindrica, triaristata x triuncialis, and in addition the hybrid Ae. columnaris x Triticum durum. All hybrids were sterile. This collection represents a valuable addition to the natural hybrids found in the experimental station of the Vavilov Institute at Derbent, USSR. Contrary to the hybrids found during the collection mission the female parent could be identified in the material at the IIPGR station and the above notation is "female parent x male parent".

Table 6 shows the newly acquired accessions by country and species.

The total of Aegilops accessions in ICARDA's genebank increased from 1441 at the end of 1989 to 1826. The current holdings in percentage and number is presented in Table 7. ***M. van Slageren***

1.2.4. USSR/ICARDA collecting mission in Syria

During the last week in June, 1990, a collecting mission to the northeastern part of Syria was organized. In addition to Genetic Resources Unit staff Dr. A.A. Filatenko and Dr. Z. Khalikulov from the USSR and Mr. K. Obari from the Agricultural Research Center, Douma, Syria also participated. In all 61 samples were collected: 40 Aegilops spp., 6 Triticum durum, 6 Lens culinaris, 2 Hordeum spontaneum, 2 Hordeum vulgare, 1 T. aestivum, 3 Allium spp., and 1 Citrullus vulgaris. Attempts were made, with mixed success, to trace the villages mentioned by Vavilov in reports of his travels in the same areas during the 1920s. In their report the team concluded that a considerable variability in wild relatives of cereals exists in the area, but our mission showed that landraces of cereals have largely disappeared and those of other crops are about to follow suit. It may as yet not be too late to collect this germplasm.

The mission continued collection in the coastal region covering Tartous and Lattakia provinces during the first week in July. During the mission 37 Aegilops spp. were sampled: 17 Ae. peregrina, 8 Ae. triuncialis, 7 Ae. ovata, 3 Ae. biuncialis, 1 Ae. columnaris, and 1 Ae. speltoides. In addition, 7 samples of cultivated cereals and 6 populations of forage legumes were collected. Wild Triticum spp. were not encountered during this mission.
A.B. Damania and J. Valkoun

1.2.5. Barley and wheat collection mission to Tibet Autonomous Region of China

A joint exploration mission to Tibet was carried out in collaboration with the University of Saskatchewan, Saskatoon, Canada, the Plant Genetic Resources Center of Canada, Ottawa, CIMMYT, Mexico, and the Chinese Academy of Agricultural Sciences, Beijing, China. Five districts were covered: Lhasa, Dongyai, Nedong, Gyantse, and Shigatse. In total 54 population samples were collected. These were mostly 6-rowed naked barley and hexaploid wheats. The morphological variability in the barley fields was high. For example, spike and seed color ranged from yellow to purple and black. Awns were hooded, semi-hooded, and long or short. Barley was mostly of the spring type, sown in early April, and harvested between mid August and the end of September, depending on the altitude.

The most common diseases of barley encountered were covered smut (Ustilago hordei), loose smut (Ustilago nuda), yellow rust (Puccinia striiformis), and stem rust (Puccinia graminis f. sp. hordei). The percentage of affected plants for smuts ranged from 0.5-1.0 %. The farmers considered this to be an acceptable loss.

The collected material, (35 barley, 18 wheat and 1 faba bean), was left in Beijing, to be multiplied after different morphotypes had been sorted out. The morphotypes consisted of 91 barley and 160 wheat samples. Although more samples of barleys were collected, the morphological variation for single spikes within populations of landraces was greater in the wheats. When a bulk seed sample was taken from the threshing floor or a farmer's store such a differentiation based on spike morphology could not be carried out. Next year when sufficient seed becomes available sub-samples will be sent to ICARDA where further classification of spikes from the bulk samples will be carried out. In addition, electrophoresis will be performed on storage proteins of single seeds to study genetical relationships between the different morphotypes. ***J. Valkoun and A.B. Damania***

1.2.6. Ecogeographic survey and collection of native pasture and forage legumes in Jordan

The second mission of the ecogeographic survey and collection of native pasture and forage legumes in Jordan, which started last year, was undertaken jointly with NCARTT in Jordan. Its aim was to continue exploring native pasture and forage legumes in the northern and central areas of Jordan, since these regions were not visited last year. The survey was undertaken in two missions (2-17 May and 12-28 June 1990). During the first mission, herbarium voucher specimens and nodules with rhizobia were collected from 30 sites. In total 588 specimens representing 19 genera were collected (Table 8).

During the second mission, 52 sites were visited and seeds and soil samples were collected. In total 1089 seed samples from 20 genera were collected (Table 8). At every site a soil sample was collected for chemical analysis, physical properties and rhizobia isolation.

The average annual rainfall in the collection sites varied from 150 mm in the east (Zarqa province) to 650 mm near Ajloun (Irbid province). The collection sites also represented a wide range of elevation, varying from 200 m below sea level at Al Adasiyeh in the northwest to 1125 m in the Ajloun region.

Annual Medicago, Trifolium, Astragalus, and Trigonella were the most common pasture and forage species in the surveyed areas. Vicia, Lathyrus and Pisum were also

Table 8. Summary of herbarium specimens and germplasm samples collected in Jordan.

Genera	Number of herbarium specimens	Number of germplasm samples
Trifolium	168	363
Medicago	136	267
Astragalus	20	72
Trigonella	34	70
Vicia	51	66
Onobrychis	30	45
Hippocrepis	14	34
Lathyrus	30	33
Hymenocarpus	17	29
Coronilla	10	24
Scorpiurus	2	22
Pisum	5	17
Ononis	16	15
Lens	9	11
Lotus	12	8
Ornithopus	0	5
Cicer	2	2
Melilotus	7	2
Tetragonolobus	4	2
Biserrula	3	2
Total	**588**	**1089**

found. Eleven samples of wild lentil (Lens ervoides and L. orientalis) were collected and, in addition, two samples of wild chickpea (Cicer judaicum) from the north of the country.

The site data from the 1989 and 1990 surveys will be merged and analyzed to describe the distribution and diversity of pasture and forage legumes in Jordan.

A. Shehadeh and J. Valkoun

1.2.7. Summary of germplasm acquisitions in 1989/90

The Center's germplasm holdings increased significantly as a result of geographically and ecologically diverse collecting activities. This large increase will further contribute to the useful genes and their rare alleles in the collection.

In total 6007 accessions were added to the collections as a result of missions in Syria, Jordan, Algeria, Morocco, Tunisia, Libya, Bulgaria and the USSR and through requests from other seed banks. The single largest collection was received from China for barley (2029 entries) and from CIMMYT for durum wheat (1370 entries). See Table 1. ***GRU staff***

1.3. Germplasm multiplication, characterization and evaluation

1.3.1. Joint evaluation of barley landraces with ARC Douma, Syria

A total of 175 accessions of Syrian barley landraces were jointly characterized with Syrian National Program scientists as part of their training in cereal germplasm evaluation and characterization. The trial was of the augmented design with five checks (Rihane-3, Harmal, Tadmor, Arabi Abiad and Arabi Aswad). Plots were four rows, each 3 m long and 37 cm apart. A number of quantitative and qualitative traits were scored (Table 9).

Results indicated wide differences between genotypes in plant height, varying 30-80 cm. The material produced generally taller plants than the checks (Fig. 1). Several accessions exceeded the tallest check, Rihane-3. This indicates that the tested genotypes are promising for this trait under the difficult conditions of last season, characterized by drought, and early and late frost damage.

Table 9. Characters evaluated in 1989/90 for barley landraces originated from Syria.

Quantitative characters	Qualitative characters
Seed yield	Frost damage
Days to heading	Growth habit
Days to maturity	Row type
Spikelet group/spike	Hoodedness/awnedness
Plant height	Rachilla hairs
1000 kernel weight	Awn roughness
Protein %	Lemma color
	Spike density
	Kernel covering
	Grain color

The number of spikelets per spike is one of the traits contributing to grain yield. The tested genotypes showed a wide variation: 10-25 spikelets/spike while the checks displayed a narrower variation (Fig. 2). Grain yield per plot (Fig. 3) ranged between 200-2100 grams. Fifty three genotypes exceeded the best check, Arabi Abiad.

B. Humeid

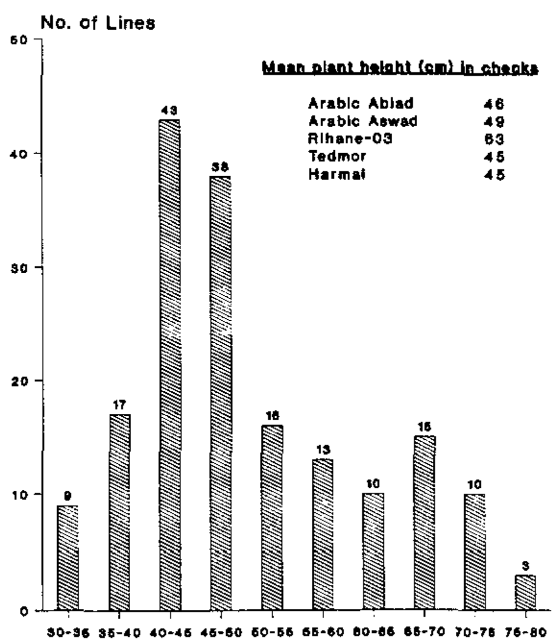


Fig. 1. Plant height (cm) for 175 accessions of Syrian barley landraces, compared with five checks (1989/90 season).

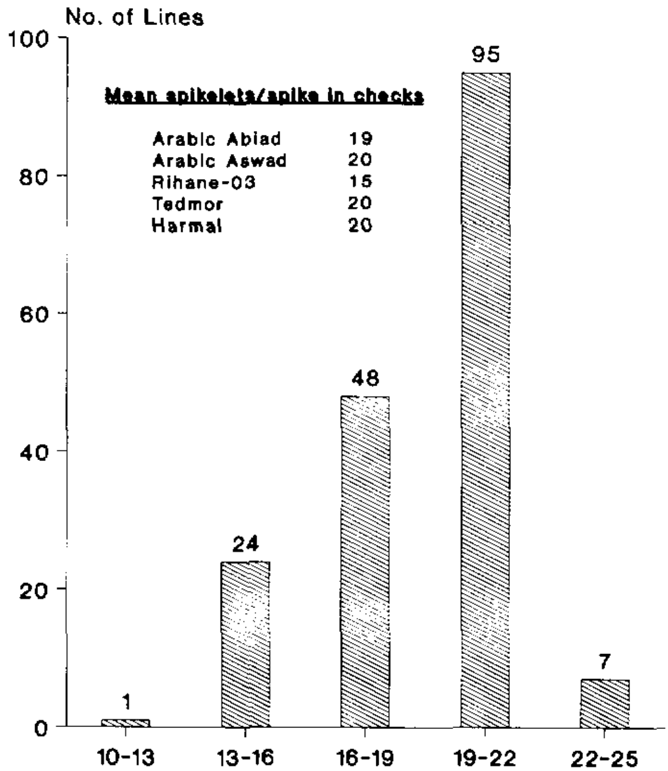


Fig. 2. Number of spikelet groups per spike for 175 barley landraces from Syria and compared with five checks in the 1989/90 season.

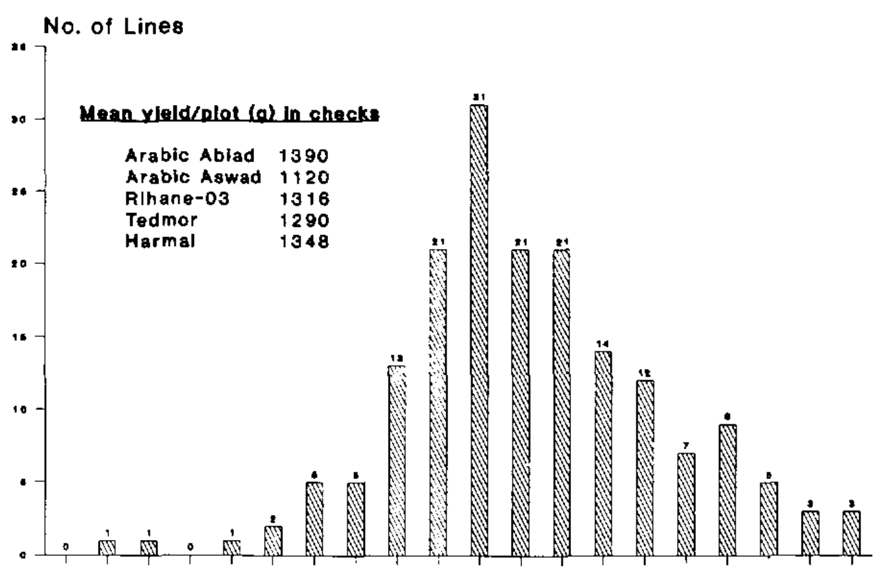


Fig. 3. Seed yield per plot (g x 100) for 175 accessions of Syrian barley landraces compared with five checks (1989/90 season).

1.3.2. Characterization and preliminary evaluation of Chinese barley landraces

Traditional barley germplasm originating from China may be of interest in the breeding programs for semi-arid, stressful environments in West Asia and North Africa (WANA) since the Chinese gene pool of barley developed in isolation from WANA. The origin of the semi-dwarf varieties in wheat demonstrated that East Asia may provide the breeders with genes of worldwide impact. The geographic position and relief as well as the climatic conditions in some regions of the Peoples' Republic of China might have favored development of germplasm with a general adaptation and/or tolerance to stresses prevailing in WANA.

Recently, scientists of the Chinese Academy of Agricultural Sciences (CAAS) in cooperation with IBPGR have collected a large number of landraces of barley in 18 provinces. Under agreement with IBPGR this unique germplasm was provided to ICARDA for multiplication, evaluation and preservation in the GRU active and base collections.

Due to problems with the phytosanitary certificate the seed was received late. As a result 2029 accessions were planted in the post-quarantine area in non-replicated two-row plots as late as December 13 and 14, 1989. The plots were 1.0 m long with row and plot distance 0.3 m and 0.6 m, respectively. Since the season was dry with only 233.4 mm of rainfall additional irrigation of 40.0 mm was applied on April 5, 1990.

The following data were taken in the field or in the laboratory: early frost damage, late frost damage, growth habit, growth class, growth vigor, days to heading, days to maturity, powdery mildew infection, leaf color, plant height, seed yield, lemma color, grain color, row type, and seed cover. Seed weight per spike and thousand kernel weight will be included later. Grain-filling period was estimated as the difference between days to maturity and heading. Most of the data have been computerized and analyzed.

To assess vernalization requirements of the Chinese landraces those with sufficient amount of seed were planted in a separate field experiment on March 18, 1990 when the temperatures were continuously higher than the vernalization limits for barley. Five seeds were sown in hills spaced in 0.5 m distance. Only data on ability to enter the generative phase were taken.

In the first experiment a wide range of variation was found in the characters which were related to the general adaptation or tolerance to the abiotic stresses. Some accessions survived the early frost spell without visible damage, whereas 360 accessions (ca. 18 %) were nearly killed or only few plants recovered later. The severe frost damage affected growth and development of the susceptible entries and, consequently, the frequency distributions and correlations between the characters in the accessions were also influenced by the difference in seedling frost tolerance.

However, some of the medium susceptible genotypes were able to compensate fully the initial damage and ranked among the top-performing group with regard to seed yield (Table 10). There was little variation in the late frost damage, ranging from mild to medium, and this had no visible effect on other characters.

The number of days to heading is one of the basic indicators of general adaptation to a particular environment because the optimum timing of the generative phase may increase yield stability and/or productivity. Data presented in Fig. 4 show a wide range in heading

Table 10. Characteristics of the top-yielding accessions.

Plot	Origin	GRCL*	FRDA1	ERVI	DAHE	GRFI	PLHT	POML	YISE
4769	Shaanxi	S	5	8	123	28	103	5	5340
4826	Shandong	S	5	7	121	34	97	5	5351
5327	Gansu	-	3	6	123	28	100	5	5096
5368	Jiangsu	W	7	5	123	28	91	5	5163
5371	Jiangxi	W	3	7	123	30	93	5	5751

Table 11. Character means in relation to the province of origin.

Origin	No. of acc.	FRDA1*	DAHE	GRFI	PLHT	POML	YISE
Beijing	28	4.36	116.6	30.2	66.7	5.79	1934
Gansu	36	4.78	122.0	29.1	88.7	5.17	2402
Hebei	60	3.97	126.4	26.8	89.3	3.68	2008
Heilongjiang	154	4.80	126.4	23.8	91.0	6.37	1592
Henan	40	7.75	119.1	25.8	86.2	5.70	1952
Hubei	155	5.31	117.6	26.6	82.0	4.18	1831
Jiangsu	76	2.63	134.7	29.7	73.6	4.63	1553
Jiangxi	47	5.21	116.0	27.2	78.8	4.40	1836
Liaaning	37	6.57	125.5	24.9	95.7	5.81	1593
Nei Menggu	16	6.12	120.7	26.5	85.4	5.00	2167
Shandong	258	6.64	121.6	26.9	85.5	4.79	2266
Shanghai	101	3.30	125.3	27.5	90.1	5.95	2077
Shanxi	106	7.11	119.7	26.1	82.7	4.40	2073
Shaanxi	102	3.80	124.2	27.0	95.3	4.71	2449
Sichuan	80	3.42	132.7	22.3	67.6	6.22	664
Yunnan	106	3.19	127.6	23.6	68.7	5.34	1114
Zhejiang	582	3.32	127.2	24.9	80.5	5.41	1374
Hunan	45	5.44	120.7	23.6	82.9	4.69	1701

* GRCL = S - no vernalization requirement
W - vernalization sensitive
FRDA1 = early frost damage (9-no visible symptoms, 1-lethal)
ERVI = early vigor (9-maximum, 1-minimum)
DAHE = number of days to heading
GRFI = number of days from heading to maturity
PLHT = plant height in cm
POML = powdery mildew reaction (1-immune, 9-highly susceptible)
YISE = grain yield in kg/ha

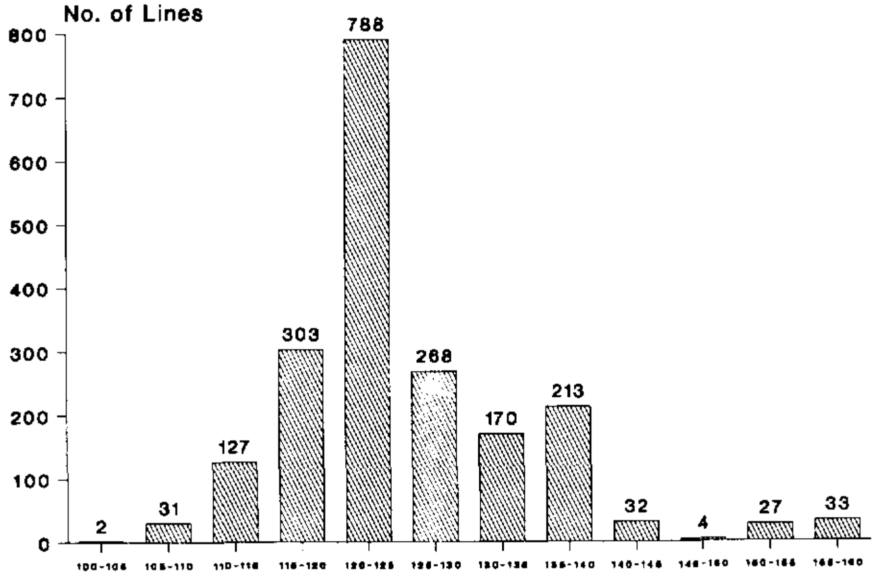


Fig. 4. Days to heading for Chinese barley landraces in 1989/90 season.

time among the Chinese landraces under the Near East environment. The earliest accession headed in 101 days from planting while the latest needed 157 days. The distribution of frequencies has two peaks and is clearly non-random. Two basic factors determined the shape of the distribution curve - genotypic variation in the heading time per se in the categories between 100 - 135 days, and the early frost damage in the categories later than 135 days since all those late accessions were heavily affected by the frost. The bulk of the lines (nearly 40 %) belong to the category 120 - 125 days and the five top-yielding accessions headed in 121 or 123 days (Table 10). Under the conditions of this experiment the optimum heading time seems therefore to be around 123 days. High-yielding lines were also found in the adjacent categories (115-120 and 125-130). Landraces which headed earlier than 115 days (ca. 8 %) may have potential value for low-rainfall breeding programs but, since the late-planting experiment indicated that many of them need some vernalization, their earliness may be affected in absence of low temperatures.

Plant height is the other important trait in barley germplasm for semi-arid agriculture in WANA. In general, tall plants are more drought tolerant and produce more straw. In the Chinese landraces the plant height varied from 33.50 to 120.0 cm and the frequency distribution is presented in Fig. 5.

Similar to the days to heading the plant height was influenced by the early frost damage but to a lesser extent. The heavily-damaged accessions were usually shorter than 80 cm. However, frost-tolerant dwarf landraces of the category 60-70 cm were also found and two of them provided plot yields equivalent to almost 4000 kg/ha. The 80 - 90 cm category was the most frequent, but 90 % of the high-yielding accessions (> 4000 kg/ha) were taller than 90 cm. Fig. 5 demonstrates that the tall genotypes are well represented in the collection of Chinese barley and, in addition, this trait is often associated with other positive characters.

Grain yield is the best measure of general adaptation. Plot grain yield varied from 1.0 g to 518.0 g (11 - 5750 kg/ha). The very low grain yield of less than 50 g (Fig. 6) and, to some extent, the next category of 50 - 100 g was again due to the severe early frost damage. Other accessions belong to lower-yielding categories because of their insufficient drought and/or heat tolerance. However, 250 landrace accessions (12.3 %) performed well, producing more than 250 g/plot. Top-yielding accessions (>4000 kg/ha) were usually tall and not very early with 117-132 days to heading. Their early frost resistance was generally not high and only 3 out of the 31 top-yielding accessions were placed in the most resistant

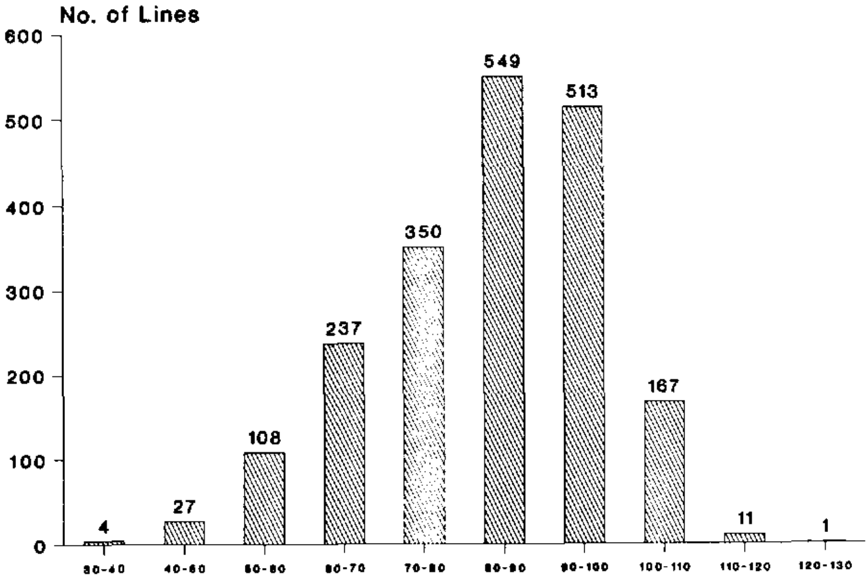


Fig. 5. Plant height (cm) for Chinese barley landraces in 1989/90 season.

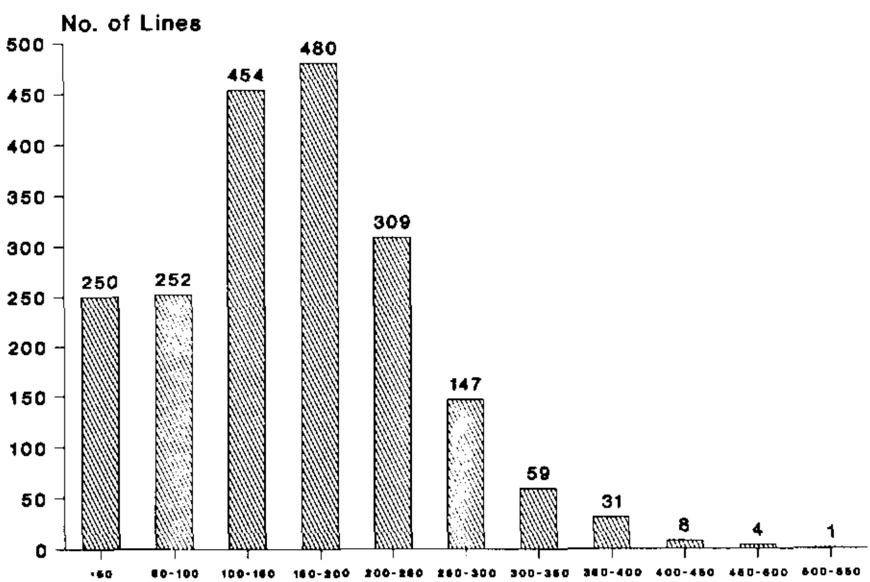


Fig. 6. Plot grain yield (g) for Chinese barley landraces in 1989/90 season.

category 9, whereas the majority of the lines were moderately resistant (category 5).

During the growing season a severe epidemic of powdery mildew developed and response to the pathogen attack could be evaluated. Only 13 of the 2029 landrace accessions (0.6 %) were immune to this disease but nearly 18 % of the accessions were moderately resistant (score 3).

No collecting information was available except for the province of origin but, nevertheless, this enabled to relate results of the germplasm evaluation to ecogeographic conditions, at least in general terms (Table 11). Data on early frost damage show that landraces from provinces where barley is grown in cold winters as a winter crop possess higher levels of frost tolerance than those from southern provinces with mild winters or spring barleys.

The number of days to heading is controlled by three independent genetic systems in cereals - vernalization response, photoperiod response and the sum of effective temperatures. In this study there was an additional factor, the early frost damage, which substantially prolonged the time to heading in the most affected accessions. Early accessions were found among landraces with sufficient frost tolerance from central and southern provinces and also from Beijing.

Usually a very strong correlation exists between heading and flowering time and, therefore, in this study the length of grain-filling period was expressed as the difference between days to maturity and days to heading. In most cases a short grain-filling period indicated a low tolerance to the terminal heat and drought stress that occurred at the end of May, 1990. Landraces from southern provinces with humid climates, as well as from the Heilongjiang province, which is located in the north of the country, had the shortest grain-filling periods (Table 11) as a result of their higher sensitivity to the terminal stress. Later accessions were the most affected.

Material from the Hebei and Hubei provinces was the most resistant to powdery mildew, and 12 immune accessions were detected. The most susceptible materials came from the northern Heilongjiang and southern Sichuan provinces.

Differences in adaptation between landraces as expressed in mean grain yield could be associated with the province of origin since these means vary from the minimum 664 kg/ha in Sichuan germplasm to 2449 kg/ha in landraces from Shaanxi province (Table 11). The higher mean yields may be related to similarity in ecogeographic conditions in those Chinese provinces and northern Syria. Indeed the two provinces with highest grain yield, Shaanxi and Gansu, are located at a similar latitude in semi-arid regions with rainfall between 200-500 mm and 100-400 mm, respectively, and similar temperature extremes due to the continental climate of inland China. A part of the Nei Menggu (Inner Mongolia) province belongs also to this region and therefore its germplasm is also fairly well adapted to the WANA conditions. Another group of provinces that produced better adapted germplasm are in the main winter-barley growing region. Cold winters and low rainfall in the growing season are typical for this region and terminal heat stress occurs at the end of the season. Landraces from the northern provinces Heilongjiang and Liaoning do not adapt well to the environment of northern Syria because of high photoperiod sensitivity and low tolerance to terminal heat and drought stresses. Germplasm from the southern provinces of Sichuan, Yunnan, Zhejiang and Jiangsu was poorly adapted, due to the lack of frost and drought tolerance. Shanghai landraces performed unexpectedly well considering the ecogeographic conditions of this province.

Classification of the landraces according to province of origin allows some prediction of their performance in new environments but this is, of course, an oversimplification of the actual situation because the administrative territorial divisions do not necessarily correspond to the ecogeographical ones.

Grain yield frequency distributions showed two peaks in five provinces, most clearly so in the Jiangsu landraces which included some of the top-yielding accessions (Table 10), while most of them performed very poorly because of severe frost damage.

On the basis of preliminary evaluation data a number of accessions was selected per province for further evaluation in the Cereal Improvement Program (Table 12). Five groups of germplasm were selected:

1. potential for higher altitudes in WANA - high frost tolerance associated with medium to high yield or medium frost tolerance with high yield;
2. earliness - < 114 days to heading;
3. resistance to powdery mildew - score 0;
4. plant height - > 103 cm;
5. productivity - grain yield >3000 kg/ha.

The highest percentages of selected high-yielding accessions are among Gansu and Shaanxi landraces (Table 12). The exception, as discussed earlier, is the high frequency (17.1 %) of well-performing landraces from the Jiangsu province.

On the basis of the preliminary evaluation data 497 accessions (24.5 %) were selected for further evaluation in the Cereal Improvement Program and possible utilization in barley breeding.

From this preliminary evaluation of the large collection of Chinese barley landraces it is concluded that a certain proportion of the germplasm proved to be potentially useful for barley breeding. This proportion may be substantially higher among landraces from provinces where environmental conditions during the barley-growing season resemble those of WANA.

Table 12. Number and percentage of accessions selected for further evaluation.

Origin	No. of acc.	Cold tolerance		Resistance to powdery mildew		Earliness		Height		Yield	
		n	%	n	%	n	%	n	%	n	%
Beijing	28	3	10.7	-	-	7	25.0	-	-	1	4.0
Gansu	36	7	19.4	-	-	-	-	2	5.6	11	30.6
Hebei	60	10	16.7	7	11.7	2	3.3	5	8.3	7	11.7
Heilongjiang	154	4	2.3	-	-	1	0.6	2	1.3	3	1.9
Hubei	155	14	9.0	5	3.2	32	20.6	2	1.3	7	4.5
Jiangsu	76	9	11.8	-	-	-	-	2	2.6	13	17.1
Jiangxi	47	2	4.3	-	-	12	25.5	-	-	3	6.4
Liaoning	37	4	10.8	-	-	-	-	7	18.9	3	8.1
Nei Menggu	16	6	37.5	-	-	-	-	-	-	2	12.5
Shandong	258	44	17.0	1	0.4	15	5.8	2	0.8	41	15.7
Shanghai	101	6	5.9	-	-	3	3.0	5	5.0	19	18.8
Shanxi	106	15	14.2	-	-	6	5.7	2	1.9	11	10.4
Shaanxi	102	22	21.6	-	-	-	-	11	10.8	23	22.5
Sihuan	80	-	-	-	-	-	-	-	-	-	-
Yunnan	106	1	0.9	-	-	5	4.7	-	-	-	-
Zhejiang	582	17	2.9	-	-	19	3.3	6	1.0	11	1.9
Hunan	45	3	6.6	-	-	2	4.4	-	-	-	-
Total	**2029**	**170**	**8.4**	**13**	**0.6**	**124**	**6.1**	**46**	**2.3**	**159**	**7.8**

Introduction of this new, previously unexplored gene pool into barley improvement projects for semi-arid environments in WANA may increase the diversity of genes and gene combinations for adaptation and stress tolerance. ***J. Valkoun and B. Humeid***

1.3.3. Multiplication and preliminary evaluation of barley originating from Algeria, Egypt and Syria

A number of barley landraces, which were collected in recent missions to Algeria, Egypt and Syria, as well as wild barley (Hordeum spontaneum) accessions from Syria (see GRU Annual Report 1989) were planted in the post-quarantine area at Tel Hadya for multiplication and preliminary evaluation during November 7 to 19, 1989 (Table 13). Experimental conditions and design were similar to the experiment with Chinese barley landraces described in 1.3.2., but single head progenies were planted in one row only; the distance between rows was 0.3 m. and between plots 0.6 m. The following characters were evaluated:

early frost damage	1-low; 9-high
late frost damage	" "
growth habit	1-erect; 3-prostrate
days to heading	
days to maturity	
plant height (cm)	
powdery mildew reaction	1-immune; 9-highly susceptible

Grain-filling period was calculated as the difference between days to heading and days to maturity.

Mean values of the characters recorded are presented in Table 13. Single head progenies derived from Egyptian barley landraces were, in general, more affected by the January frost spell than accessions from other countries, whereas Syrian 2-rowed barleys displayed a high level of cold tolerance. With the exception of wild barley from Syria the late frost on March 17, when air temperature dropped to -8.9°C, did not produce as much damage as the January frost. Bulk progenies of Algerian landraces of 6-rowed barley seemed to be as tolerant to the late frost as Syrian accessions of 2-rowed barley but this may be due to differences in earliness.

Erect growth habit was typical for wild barley, whereas the cultivated forms varied in this character. Six-rowed barleys from Egypt and Algeria comprised a higher number of progenies with intermediate and prostrate phenotype.

The mean values of days to heading (Table 13) indicate that substantial differences are related to country of origin and type of germplasm. For example, cultivated barley from Syria is five to six days earlier than Algerian accessions and four days earlier than its wild progenitor, *Hordeum spontaneum*. The range of variation in this character is presented in Table 14. The frequency distributions show that part of the Egyptian germplasm is as early as the Syrian landraces. The difference in mean values may be partly explained by a difference in frost tolerance, since regeneration of heavily damaged plants delayed heading.

As expected there was less variation among the means in days to maturity than in days to heading due to the terminal drought and heat stress, which also affected the grain-filling period.

A wide range of variation in plant height was found in single head progenies both from Egypt and Algeria, but their mean values were substantially different.

Table 13. Mean values of characters in wild and cultivated barley from Algeria, Egypt and Syria.

Character	*Hordeum spontaneum*	Cultivated barley			
		Syria	Egypt	Algeria	
	Syria (SH)*	2 row (SH)	(SH)	(SH)	(BK)
Early frost damage	5.42	5.97	4.56	5.02	5.09
Late frost damage	5.32	6.10	5.16	5.46	6.13
Growth habit	1.02	1.50	1.92	1.50	1.88
Days to heading	148.9	144.8	147.7	150.9	149.4
Days to maturity	182.8	180.3	182.5	181.0	183.9
Grain-filling period	34.0	35.6	34.8	30.0	34.5
Plant height (cm)	(**)	(**)	82.9	89.6	78.6
Powdery mildew reaction	5.8	6.2	5.4	5.7	4.5
Number of accessions	250	349	411	896	67

Table 14. Distribution of days to heading in barley from Algeria, Egypt and Syria.

Interval	*Hordeum spontaneum* Syria (SH)*	Cultivated barley Syria (SH)	Egypt (SH)	Algeria (SH)
132-136	0.0	0.0	0.2	0.0
136-140	4.0	25.5	22.6	0.2
140-144	11.2	20.9	7.3	0.3
144-148	20.8	31.0	16.1	15.1
148-152	48.0	17.2	23.1	45.0
152-156	4.0	0.9	15.6	28.2
156-160	8.4	1.4	11.2	8.9
160-164	0.8	1.1	1.5	1.8
168-172	0.8	0.6	0.5	0.1
Number of accessions	250	349	411	896

* : SH - single head progenies; BK - bulk progenies
** : Data not recorded

Frequency distributions in Table 15 show the difference even more clearly because the 60 - 70 cm category is the most common one for Egyptian accessions, whereas for Algerian material this was the 90 - 100 cm group.

Mean scores of the reaction of barley germplasm to a powdery mildew infection (Table 13) are less informative than distribution of the scores among five response categories (Table 16). Wild barley displayed the highest frequency of immune single head progenies (14.4 %). The immune category was rare in cultivated barley from Syria and Egypt and absent among Algerian landraces. In both wild and cultivated Syrian germplasm the immune single head progenies were found only in populations from the more humid coastal provinces. These might be products of gene introgression from the wild progenitor, Hordeum spontaneum, since the accessions were derived from sympatric populations.

Table 15. Percentage distribution of plant height in single head progenies of cultivated barley from Egypt and Algeria.

Interval (cm)	Egypt	Algeria
30-40	0.2	0.0
40-50	2.4	0.1
50-60	9.3	0.2
60-70	30.7	1.0
70-80	29.7	10.2
80-90	18.5	36.7
90-100	7.3	44.0
100-110	3.0	7.4
110-120	0.0	0.5
Number of accessions	411	896

Although data on seed yield are not available, it is concluded that wild and cultivated barley show a general adaptation to the semi-arid environment but also that *specific features are related to country or region of* origin. On the basis of the preliminary evaluation more than 200 accessions were selected for further evaluation for drought and cold tolerance. Accessions from highly saline sites will be studied separately in the greenhouse for salinity tolerance. *J. Valkoun and B. Humeid*

Table 16. Percentage distribution of powdery mildew scores* in single head progenies of cultivated and wild barley.

Score	Hordeum spontaneum	Cultivated barley		
	Syria (SH)**	Syria (SH)	Egypt (SH)	Algeria (SH)
1	14.4	0.6	2.2	0.0
3	2.4	3.7	26.0	8.3
5	22.4	38.1	35.8	47.5
7	42.8	49.3	21.2	43.4
9	18.0	8.3	14.8	0.8
No. of acc.	264	244	411	892

* : 1 - immune; 9 - highly susceptible
** : SH - single head progenies; BK - bulk progenies

1.3.4. Preliminary evaluation of wheat landraces from Algeria and Egypt

Bulk and single head progenies of durum and bread wheat landraces collected in Algeria, together with single head progenies from Egyptian landraces of bread wheat (see GRU Annual Report 1989) were planted in the post-quarantine field. Experimental design, conditions and data evaluation were similar to the barley experiments, described in 1.3.2. and 1.3.3.

Data means for early and late frost damage, growth habit, days to heading and maturity, grain-filling period and plant height are summarized in Table 17 according to the type of germplasm.

There was no difference in the early frost damage between Algerian durum wheat and bread wheat from Algeria and Egypt. The durum wheat accessions were, in general, less affected by the late frost. The means of growth habit scores are similar for the three types of germplasm.

Mean values of days to heading reveal considerable differences among the three groups of wheat germplasm. Egyptian single head progenies of bread wheat headed nearly 12 days and about 1 week earlier than bread and durum wheat accessions from Algeria, respectively. Frequency distributions illustrate the diversity within the germplasm groups (Table 18). The most frequent categories for durum wheat from Algeria and bread wheat from Algeria and Egypt were 162-166, 166-170 and 150-154, respectively. However, some early accessions were also found among the Algerian germplasm, as well as late single head progenies in the germplasm from Egypt. These large differences cannot entirely be explained by variation in photoperiodic response, and it is assumed that vernalization requirements may be involved as well in Algerian germplasm.

Mean values of days to maturity follow the same pattern as days to heading, but the differences are smaller due to terminal abiotic stresses (Table 17). For the same reason the grain-filling period shows the opposite tendency, being shortest in the Algerian bread wheat.

Table 17. Mean values of characters in durum and bread wheat from Algeria and Egypt.

Character	Durum wheat	Bread wheat	
	Algeria	Algeria	Egypt
Early frost damage	5.08	5.08	5.08
Early frost damage	6.22	5.50	5.66
Growth habit	2.04	1.91	2.12
Days to heading	159.9	164.2	152.4
Days to maturity	196.8	199.2	192.7
Grain-filling period	36.9	34.9	40.4
Plant height	105.4	100.5	93.3
No. of acc.	207 SH* + 44 BK*	174 SH + 23 BK	185 SH

Table 18. Percentage distribution of days to heading in durum and bread wheat from Algeria and Egypt.

Interval	Durum wheat	Bread wheat	
	Algeria	Algeria	Egypt
142-146	0.0	0.0	0.6
146-150	6.3	2.6	20.0
150-154	3.2	1.1	35.1
154-158	15.1	6.2	33.0
158-162	30.3	11.9	7.6
162-166	37.1	23.3	2.7
166-170	8.0	48.2	0.5
170-174	0.0	4.7	0.0
174-178	0.0	2.1	0.5
No. of acc.	207 SH* + 44 BK*	174 SH + 44 BK	185 SH

* : SH - single head progenies; BK - bulk progenies (Tables 17, 18)

Durum wheat accessions were taller than the bread wheats and the Egyptian accessions were, on average, the shortest (Table 17). However, there is a wide range of variation in this character among the three germplasm groups (Table 19). *J. Valkoun and B. Humeid*

Table 19. Percentage distribution of plant height in durum and bread wheat from Algeria and Egypt.

Interval	Durum wheat	Bread wheat	
	Algeria	Algeria	Egypt
60-70	0.0	0.5	1.1
70-80	2.4	2.0	4.3
80-90	7.6	6.1	32.4
90-100	19.9	37.1	38.9
100-110	19.9	42.6	17.8
110-120	33.1	10.2	4.9
120-130	6.8	1.5	0.5
130-140	0.4	0.0	0.0
No. of acc.	207 SH* + 44 BK*	174 SH + 23 BK	185 SH

* : SH - single head progenies; BK - bulk progenies

1.3.5. Multiplication and preliminary evaluation of durum wheat from the CIMMYT world collection.

A total of 1269 durum wheat accessions, received from the CIMMYT world collection, were planted in the post-quarantine area in the same way as cereal germplasm introductions described in 1.3.3. and 1.3.4., i.e. non-replicated plots of 1 row, 1 m long with 0.3 m distance between the rows. Data on early and late frost damage, days to heading and maturity, plant waxiness and height were recorded.

As expected a large variation was found among all the recorded traits. The range and distribution of the

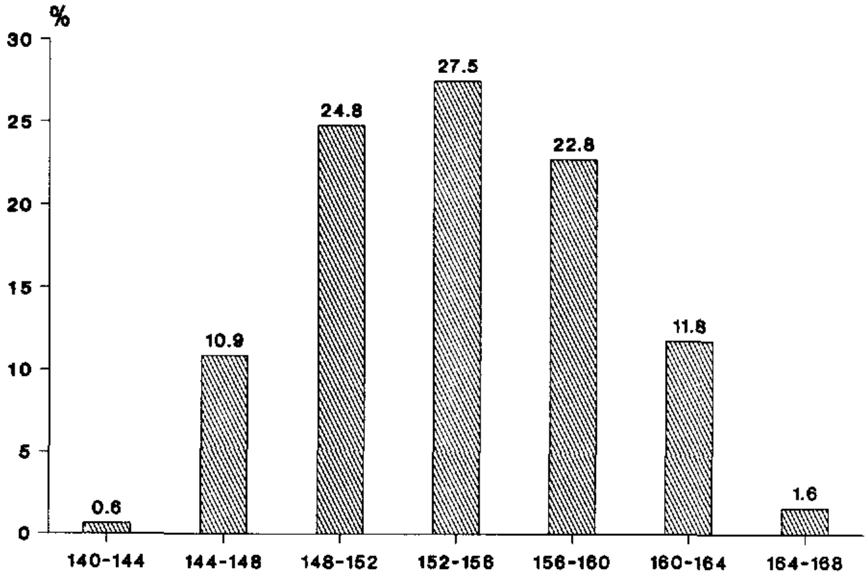


Fig. 7. Percentages of categories of days to heading in durum wheat from the CIMMYT collection.

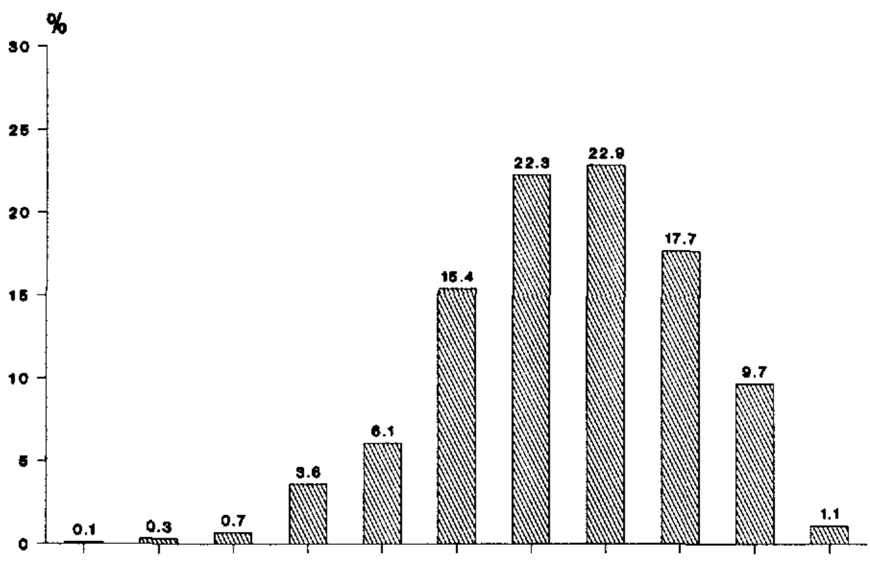


Fig. 8. Percentages of categories of plant height (cm) in durum wheat from the CIMMYT collection.

diversity is presented in Figs. 7 and 8 for days to heading and plant height, respectively. Response to early and late frost damage varied considerably, days to maturity from 180 to 203 days, and grain-filling period from 25 to 50 days.

This durum wheat collection has potential for semi-arid environments of WANA, but the high diversity in geographic origin of the germplasm makes generalizations difficult. ***J. Valkoun and B. Humeid***

1.3.6. Evaluation of wheat germplasm from the VIR Leningrad (USSR) world collection

On the basis of the agreement between ICARDA and VASKHNIL (USSR) Dr. Z. Khalikulov of the Central Asian Branch of VIR Leningrad conducted a study of VIR germplasm during his stay at ICARDA in the 1989/90 season. The germplasm was selected from the VIR world wheat collection for drought, heat and salinity resistance according to evaluation data from previous trials in the USSR. In the trial 120 winter bread wheat, 83 spring bread wheat, 13 winter durum wheat, and 72 spring durum wheat accessions were planted in the post-quarantine field at Tel Hadya in a simple lattice design with two replications. Plots consisted of two rows, each 2 m long with a distance of 0.3 m between the rows and 1.5 m between the plots. The germplasm included both 107 accessions of landraces and 181 of improved varieties. In origin, 65.6% of the germplasm came from the USSR, the rest from other parts of the world. No supplementary irrigation was applied to the experiment; the plants thus received only 233 mm of rainfall.

The following data were taken in the field, in the greenhouse or after harvest: days to emergence, tillering capacity, days to heading and maturity, seed and straw

Table 20. Characterization of top-yielding accessions from the Soviet Union in the winter bread wheat trial (abbreviations under Table 21).

Name/ VIR No.	Origin	YISE	% best check	GH	DAHE	GRFI	PLHT	YIBI	HI
Nesser	(check)	315	100.0	1	144	39	84	935	0.34
53173+	USSR/Stavropol	295	93.7	4	150	38	92	925	0.32
54024+	USSR/Moldavia	285	90.5	4	150	46	99	1065	0.27
GV/ALD"S"	(check)	270	85.7	1	142	42	86	810	0.33
New Tom	(check)	265	84.1	5	147	38	69	680	0.39
49794+	Romania	260	82.5	4	148	36	98	895	0.29
60053	USSR/Rostov	260	82.5	4	148	40	82	730	0.36
45238	Italy	255	81.0	2	143	39	68	715	0.36
55759+	USSR/ Dnepropetrovsk	255	81.0	4	150	36	89	780	0.33
55250+	USSR/ Uzbekistan	250	79.4	1	142	39	98	835	0.30

Table 21. Characterization of top-yielding accessions from the Soviet Union in the spring durum wheat trial.

Name/ VIR No.	Origin	YISE	% best check	GH	DAHE	GRFI	PLHT	YIBI	HI
58279	Mexico	225	125.0	2	124	47	84	560	0.40
53921	USSR/Kazakhstan	210	116.7	2	139	33	90	740	0.28
58100	USSR/Kharkov	205	116.9	2	130	38	108	810	0.25
59895	India	190	105.6	2	126	42	65	470	0.40
59089	USSR/Voronezh	180	110.0	2	134	38	103	470	0.38
59891	USSR/Kuybishev	180	100.0	2	134	38	114	680	0.26
59081+	India	180	100.0	2	129	39	92	645	0.28
Stork	(check)	180	100.0	2	125	40	74	590	0.35
22434	USSR/Rostov	165	91.7	2	139	37	106	725	0.23
48990	USSR/Saratov	165	91.7	2	136	38	102	510	0.32

\+ = heat tolerant in previous VIR tests
YISE = seed yield/plot in g
GH = growth habit according to the VIR scale (1-erect, 5-prostrate)
DAHE = days to heading
PLHT = plant height in cm
YIBI = biological yield (= seed yield + straw yield/plot in g)
HI = harvest index
GRFI = grain filling period: days to maturity minus days to heading

yield, number of tillers/m^2, 1000 kernel weight, plant height, peduncle length, spike length, yellow rust resistance, saw fly resistance, lodging resistance, growth habit and frost resistance.

Results of the experiment will be analyzed later when all the evaluation data are available. However, a brief characterization of ten top-yielding entries from the winter bread wheat and spring durum wheat experiments (Tables 20 and 21) and a preliminary assessment of the overall performance (data not presented), may indicate the potential value of VIR germplasm for wheat improvement in WANA. In general, germplasm originating from the USSR is too late under the conditions of northern Syria, due to high photoperiodic and/or vernalization sensitivity. As a result it is strongly affected by terminal drought and heat stress. Consequently, harvest index values are very low compared to the well-adapted checks in both bread and durum wheat. Some of the top-yielding accessions, however, produced similar or higher total biomass (biological yield) than the best check, which is indicative of their overall drought tolerance. Introduction of alleles for photoperiod insensitivity and lower vernalization requirements into this drought-tolerant genetic background could substantially increase the level of adaptation of the USSR germplasm to the semi-arid environment of WANA, whereas the original germplasm may have greater potential for the highlands of the region.

A number of accessions was selected in the field by the ICARDA wheat breeders for further evaluation and enhancement in the Cereal Improvement Program.

Z. Khalikulov (VIR, Tashkent Branch, USSR), J. Valkoun and B. Humeid

1.3.7. Evaluation and taxonomic study of Aegilops

A set of 454 accessions of Aegilops germplasm collected in the period of April-August 1989 in Algeria, Bulgaria, Cyprus, Egypt, Syria and Turkey was planted in an unreplicated nursery with three systematically repeated checks, (Aegilops searsii, Acc. no. 400061; Ae. triuncialis, Acc. no. 400021; Ae. vavilovii, Acc. no. 400067) and, in addition, a fourth randomized check (Ae. biuncialis, Acc. no. 400831).

Qualitative and quantitative characters were evaluated on plot basis using the IBPGR wheat descriptor list. Qualitative characters included early vigor, juvenile growth habit, growth class, leaf shape, leaf attitude, flag leaf attitude and waxiness of the plants. The Aegilops trial was not protected against yellow rust but the very dry season prevented serious damage to the plots. Nine quantitative characters were evaluated on three single plants selected randomly from each plot. They included: number of tillers per plant, number of productive tillers per plant, plant height (average of 3 readings per individual plants), spike length (average of 3 readings per individual plants), number of spikelets per spike, flag leaf length and width. In addition the number of days to heading and days to maturity were calculated starting from the day of first effective rain after planting (28 November 1989). Data on 3 quantitative characters are shown in Table 22.

In addition to the field trial 106 accessions of Aegilops and wild Triticum were multiplied separately in the isolation area at ICARDA's Tel Hadya Station, whereas 115 collections with few available seeds were multiplied in the plastichouse.

In the frame work of the taxonomic revision of Aegilops

Table 22. Minimum, maximum, mean and standard deviation for 3 characters in *Aegilops* germplasm (1990 evaluation).

Aegilops species	No. of tested acc.	Plant Height (cm)				Number of days to heading				Number of spikelets per spike			
		Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
bicornis	6	41	74	49.7	6.64	160	170	165.66	4.45	12	16	14.81	1.00
biuncialis	57	33	65	46.05	5.45	168	193	177.9	9.15	3	8	3.81	1.26
caudata	13	39	69	53.42	8.22	188	193	191.46	2.40	5	10	7.96	1.27
columnaris	7	45	59	50.32	3.82	160	193	174.71	12.06	4	6	5.4	0.97
cylindrica	60	45	85	60.55	7.78	160	193	187.03	6.86	8	13	10.07	0.98
kotschyi	12	25	45	34.53	3.59	160	168	160.66	2.30	5	7	5.76	0.41
ovata	78	21	62	40.21	7.11	160	193	172.48	8.97	3	6	3.91	0.58
peregrina	20	22	76	47.68	13.57	160	193	172.20	11.06	3.6	5	4.56	0.60
speltoides	11	33.5	95	68.09	13.83	174	193	188.54	6.65	10	18	12.46	1.52
triaristata	41	32	65	49.39	7.34	170	193	185.80	6.11	3	7	5.36	0.92
triuncialis	101	27	76	54.20	7.67	168	193	185.67	7.84	4	8	5.84	0.87
umbellulata	10	29	57	41.19	6.27	178	193	184.45	5.79	4	6	4.86	0.57
ventricosa	18	32	80	49.30	11.29	168	193	172.38	8.57	8	13	10.06	1.22
vavilovii	(I)*	37	86	69.66	8.33	162	174	168.44	2.52	8	13	10.51	0.75
triuncialis	(II)	47.5	70	60.43	4.81	168	174	169.05	2.01	5	7	6.45	0.52
searsii	(III)	51.5	95	69.03	8.35	168	174	168.75	2.04	12	17	14.12	1.31
biuncialis	(IV)	32.5	58	48.58	4.14	160	168	166.5	3.22	2	3	2.91	0.23

* : I-IV = Check

and the wild species of Triticum the herbaria of the following institutions were visited, partly in conjunction with collection missions (number of inspected herbarium sheets between brackets): the Natural History Museum (661), London, England; the Royal Botanic Gardens (712), Kew, England; the Museum d'Histoire Naturelle (792), Paris, France; the Laboratoire de Taxinomie et Ecologie des Végétaux Supérieurs (100), Rabat, Morocco; the Department of Botany of the University of Sofia (148), Sofia, Bulgaria, and the herbarium of the N.I. Vavilov All-Union Institute for Plant Industry (VIR) in Leningrad (580), USSR. The later material confirmed the richness of the Soviet Union with respect to the occurrence of Aegilops and wild Triticum. A short visit was paid to the V.L. Komarov Botanical Institute of the Academy of Sciences of the USSR (7). A future study of the extensive wild wheat collection present there will clarify the distribution of wild wheat relatives in the USSR and adjacent regions.

During a stay in the Netherlands additional material was studied from the herbaria of Bruxelles (453), Cambridge (USA) (217), Jena (173), Leiden (485), Oxford (110), Padua (1), Philadelphia (119), Prague (234), Reading (152), and Zürich (341) that were received on loan by the Laboratory for Plant Taxonomy of the Agricultural University at Wageningen.

As a result of this work the distribution of many Aegilops species became better known. Nomenclatural problems around Ae. caudata were solved and important type material relating to infraspecific taxa of the wild wheat relatives was examined. Many taxonomic decisions were taken, resulting in a more simple and straightforward concept of the group involved. ***M. van Slageren and F. Sweid***

1.3.8. Multiplication and preliminary evaluation of food legume germplasm

In total 2136 germplasm accessions of lentil, chickpea and faba bean were planted in the field or, especially wild species, in the plastic house for seed increase. For both multiplication and preliminary evaluation 1992 accessions were planted (Table 2).

Taxonomic characterization of wild lentil and chickpea

Wild species of Lens and Cicer may be potential donors of useful genes for cultivated lentil and chickpea, respectively. Although only a few of them, though including both progenitors, are crossable with the cultivated species, future advances in biotechnology will further facilitate utilization of the wild gene pool.

Twenty eight wild Lens and 10 wild Cicer accessions, collected or received in the previous year, were planted in the plastic house for multiplication and taxonomic studies. The following characters were evaluated for the Lens spp.: size of the first leaflet, stipule shape, and the dark inverse w-shaped mark on the seed coat near the hilum. Four accessions received from another gene bank proved to be misidentified and will be further tested by electrophoresis and crossing techniques.

The current status of wild Lens and Cicer collections in the ICARDA collection is presented in Tabs. 23 and 24.

Multiplication and evaluation of cultivated chickpea

Separate from the ICARDA chickpea collection 4150 chickpea germplasm samples of both desi and kabuli type were received from ICRISAT and planted in the isolation area for multiplication and health inspection in a non-replicated experimental design, with one row of 5 m per accession, and 4 repeated checks.

Table 23. Number of accessions and frequency distribution of wild Cicer germplasm at ICARDA.

Species	accessions	percentage
judacium	64	27.23
reticulatum	56	23.82
pinnatifidum	48	20.42
bijugum	37	15.74
echinospermum	11	4.68
chorassanicum	7	2.97
cuneatum	6	2.55
yamachitae	5	2.12
montbretii	1	0.42
Total	**235**	**100.00**

Table 24. Number of accessions and frequency distribution of wild Lens germplasm at ICARDA.

Species	accessions	percentage
orientalis	155	48.74
ervoides	90	28.30
nigricans	35	11.00
odemensis	35	11.00
montbretii	3	0.94
Total	**318**	**100.00**

Using flower and seed characteristics 940 kabuli and intermediate type accessions were identified and the following traits evaluated: days to 50 % flowering, days to 90 % maturity, canopy width, seed yield, biological yield, 100-seed weight, seed color, seed roughness, seed shape and flower color. In addition the harvest index was calculated.

Table 25. Results of lentil germplasm evaluation.

Country of origin	No. of accessions	Character means			
		50% FL*	90% MAT	FP	LPHT
Soviet Union	33	121.1	161.9	40.7	14.8
Turkey	33	117.1	157.8	40.7	11.8
Syria	21	108.9	152.9	44.0	12.9
USA	6	123.0	158.2	35.2	15.2
Algeria	7	113.3	154.0	40.7	11.4
Local check 1	10	107.3	155.0	47.7	12.0
Local check 2	10	103.0	147.8	44.8	8.8

Table 25. (continued) Results of lentil germplasm evaluation.

Country of origin	Character means				
	PHT	SD/PD	SYD	HI	100 SW
Soviet Union	26.2	1.10	118.1	8.0	3.6
Turkey	24.4	1.24	229.4	50.0	3.0
Syria	26.3	1.30	328.1	23.3	4.4
USA	27.3	1.09	118.3	11.0	4.3
Algeria	24.1	1.27	184.0	13.1	3.4
Local check 1	26.5	1.06	425.9	23.4	6.0
Local check 2	22.3	1.39	457.0	29.1	3.2

* : 50% FL - Days to 50% flowering
90% MAT - Days to 90% maturity
LPHT - Lowest pot height (cms.)
PHT - plant height (cms.)
SD/PD - number of seeds per pod
SYD - seed yield (g)
HI - harvest index
100-SW - 100 seed weight (g)

As to origin, about half of the accessions came from Iran and germplasm from India, Spain, Turkey, USSR was also well represented with more than 25 accessions of each country.

Multiplication and preliminary evaluation of cultivated lentil

Newly received or collected lentil germplasm (112 accessions) was multiplied and evaluated in a non-replicated trial with two repeated local checks. Data on 13 traits were recorded and the means of selected characters per country of origin are presented in Table 25. The earliest flowering germplasm comes from Syria, while the latest material is from the USA and the USSR. Days to 50 % flowering are a better indicator of earliness than days to 90 % maturity because the latter character is strongly affected by the terminal drought and heat stress. Premature desiccation of the late-flowering accessions prevents translocation of assimilates to seeds and as a result, harvest index and seed yield are very low. Photoperiod sensitivity is the obvious reason for the late flowering of germplasm from higher latitudes (USSR, USA, Turkey). Optimal timing of the phenological phases is therefore essential for germplasm adaptation to stressful environment. ***J. Valkoun, A. Ismail and L. Holly,***

1.3.9. Multiplication and characterization of forage legume germplasm/evaluation of Medicago rigidula

A total of 1237 new forage legume accessions, which were either received from Southampton University or collected in Jordan and Syria, were planted for multiplication, characterization and taxonomic identification in 1989/90. Depending on the seed quantity the accessions were planted only in the plastic house or also in the field in plots of one to three rows of 3 m. In addition to this new germplasm, 2672 forage legume accessions were planted for multiplication to obtain sufficient amounts of good quality seed for conservation, further evaluation and distribution (see Table 2).

Evaluation of Medicago rigidula

During the 1989/90 season, 279 accessions of different varieties of Medicago rigidula were evaluated. The trial

Table 26. Means of five traits for 161 accessions of Medicago rigidula var. rigidula*.

Province of origin	no. of acc.	Mean score of frost damage	Mean of time to flowering	Mean of mat. period	Mean of leaf area	Mean of 100 pod weight
Aleppo (I)	18	3.89	133.4	52.1	1.18	14.11
Idleb (I)	23	4.22	132.9	53.1	1.41	15.70
Lattakia (C)	11	6.09	136.7	55.9	1.19	15.45
Homs/Hama (I)	6	4.33	138.3	50.2	0.97	10.64
Tartous (I)	3	6.33	130.0	55.2	1.69	13.11
Kamishli (I)	11	3.91	137.1	48.4	1.23	13.07
Raqqa (I)	5	3.00	131.6	60.0	1.09	12.22
Damas.-Sweida-Dara'a (I)	4	4.00	132.5	60.0	1.03	13.58
Amman-Irbid(I)	1	7.00	138.0	48.0	1.28	10.96
Gaziantep (I)	11	4.82	140.2	49.1	1.10	12.89
Marash (I)	4	3.50	143.0	50.0	0.95	10.58
Hatay (C)	4	4.00	142.5	44.5	1.11	15.65
Mersin (C)	4	2.50	140.5	49.0	1.53	10.29
Adana (C)	7	4.71	152.9	40.0	1.28	10.53
Mosul (I)	35	4.09	138.5	48.4	1.16	10.91
Sicily (C)	5	6.20	135.6	56.0	3.10	22.56
Unknown	9	5.22	147.8	45.9	1.37	13.44
Total	**161**					
Total Mean		**4.39**	**137.81**	**50.55**	**1.27**	**13.26**
LSD at 5%		1.41	7.75	6.14	0.49	3.72

* : codes for place of origin: coastal (C); inland (I).

was planted in NUR design with systematically repeated checks. Thirteen characters were scored, including vegetative traits (branch length, branch architecture), reproductive traits (flowering time, maturation period, maturity time, 100 pod weight), and frost damage.

The data were analyzed by a one-way classification analysis of variance for each variety in accordance with the region where they originated.

Table 27. Means of five traits for the different varieties of *Medicago rigidula.**

Species/ vars.	Provinces	No. of acc.	frost damage (score)	days to flowering (d)	matur. period (d)	leaf area (cm^2)	100 pods (g)
rigidula	Aleppo	12	5.17	134.0	51.4	0.93	15.84
var.	Idleb	17	4.77	133.3	52.5	1.56	18.87
agrestis	Lattakia	4	6.00	142.0	45.8	1.11	15.32
	Mean		5.04	136.1	50.7	1.30	15.99
	LSD at 5%		2.26	9.4	7.3	0.99	4.49
rigidula	Aleppo	10	4.20	132.4	53.5	1.34	14.02
var.	Idleb	2	5.00	140.0	49.5	0.97	14.64
cinariscens	Lattakia	4	5.50	149.5	46.0	1.64	15.92
	Mean		4.51	137.9	50.2	1.34	12.80
	LSD at 5%		1.11	8.6	7.8	0.58	4.32
rigidula	Aleppo	9	3.22	132.2	55.1	1.49	12.11
var.	Idleb	3	3.00	134.7	49.3	1.80	12.31
submitis	Lattakia	3	6.33	144.7	51.7	1.12	9.46
	Mean		4.31	136.6	53.5	1.50	12.04
	LSD at 5%		1.70	7.8	5.7	0.78	3.55

* : mean for three selected provinces of Syria (Aleppo, Idleb, Lattakia), and mean of regions for each variety are presented.

Separately 161 accessions of *M. rigidula* var. *rigidula*, originating from 17 different regions were analyzed. The accessions, originating from inland provinces of Syria (Aleppo, Idleb, Raqqa, Kamishli) and Iraq (Mosul) showed tolerance to frost, flowered earlier and had an intermediate seed maturation period, while the accessions from coastal provinces in Syria and from Sicily showed low tolerance to frost and flowered later. The Turkish accessions from Gaziantep, Maras, Hatay, Mersin, and Adana were also frost tolerant and showed an intermediate maturity period. For the 161 accessions of M. rigidula var. rigidula leaf area was positively correlated with 100 pod weight. Means of five traits are shown in Table 26.

The fifty accessions of M. rigidula var. agrestis, the 35 accessions of var. submitis and the 33 accessions of var. cinarescens, originating from 10, 9 and 7 different regions respectively, were analyzed as separate groups. Means of five traits for each variety for three selected provinces of Syria, as well as for all regions of origin are summarized in Table 24. ***L. Holly, A. Shehadeh and J. Valkoun***

1.4. Enhancing wheat productivity in stress environments utilizing wild progenitors and primitive forms

At the beginning of 1990 the special project funded by Italy "Enhancing Wheat Productivity in Stress Environments Utilizing Wild Progenitors and Primitive Forms" was transferred to the Genetic Resources Unit from the Cereal Improvement Program. However, the project continues to work in close collaboration with scientists of the CIP.

Wheat breeders working on resistances to biotic and abiotic stresses are increasingly turning towards alternate sources of genes, which can be found in wild progenitors and primitive forms. These wild and primitive forms have survived in the ICARDA region for centuries in seasons which were good or bad for plant survival. Hence it is believed that they possess genes for tolerance to harsh and varied conditions. In the past, the wide range of diversity present in this type of genetic resource was utilized to a limited extent only, but recent results from other institutions, and the last two seasons' work on this project have been very encouraging (CIP Annual Reports, 1988 and 1989).

1.4.1. Evaluation of *Aegilops* spp.

Two hundred pure lines, selected from a collection of 662 *Aegilops* accessions, were planted at Tel Hadya in two experiments (Table 28). One set was planted under rainfed conditions (total rainfall 233 mm) and another was provided with 75 mm of irrigation in three applications of 25 mm each (total 408 mm).

Fertilizer at the rate of 60 kg/ha P and 40 kg/ha N was applied before planting. Pesticide application and weeding was carried out as and when needed.

Table 28. Number and species of *Aegilops* lines in two replicates at Tel Hadya during 1989/90.

Ae. biuncialis	36	*Ae. peregrina*	4
Ae. caudata	11	*Ae. speltoides*	4
Ae. columnaris	17	*Ae. squarrosa*	1
Ae. crassa	4	*Ae. triuncialis*	62
Ae. kotschyi	4	*Ae. triaristata*	5
Ae. longissima	4	*Ae. umbellulata*	6
Ae. ovata	41	*Ae. vavilovii*	1
		Total	**200**

Five important characters were recorded: spike length, frost tolerance in vegetative phase, plant height, days to heading and days to maturity.

In spite of the low total rainfall at Tel Hadya in the 1989/90 season and the application of irrigation to the same samples in the second experiment there was no significant difference between the two, except in the case of frost tolerance where the C.V. in the rainfed experiment was significantly higher than in the irrigated. It would seem that availability of extra water had rendered the Aegilops spp. in a better position to tolerate spells of sub-zero temperatures.

Drought tolerant single plants in the first experiment and frost tolerant plants in the second experiment have been isolated and harvested as pure lines. Simple statistics of two species, representing the highest number of lines in the experiment, are presented in Table 29. ***A.B. Damania***

1.4.2. Evaluation of T. dicoccum

Triticum dicoccum (Schrank) Schübl. or emmer wheat (genome AABB, 2n = 28) is among the most ancient of all domesticated cereals and is known to have been cultivated as far back as 7500 B.C. It was the most important cereal in the early farming areas of the Near East. A small collection of 17 accessions of this species was evaluated at Tel Hadya and Breda. Results are presented in Table 30.

In areas such as the Mediterranean basin, Europe, Central Asia, Egypt, and India T. dicoccum was grown until it was replaced by the more advanced, free-threshing T. durum. Emmer wheat is still grown for food on a limited scale in, among others, Czechoslovakia, Ethiopia, Iran, Transcaucasia, eastern Turkey, the Balkans, and the southern Apennines in Italy. In Italy

Table 29. Simple statistics for two *Aegilops* species planted at Tel Hadya under rainfed and irrigated (in brackets) conditions during 1989/90.

	Mean	S.D.	C.V.	Max.	Min.
Ae. biuncialis					
Spike length (cm)	3.8 (3.5)	1.7 (1.5)	44.6 (42.8)	9.5 (9.0)	2.5 (2.5)
Frost tolerance*	2.1 (2)	1.2 (0.6)	55.9 (32.7)	5 (3)	1 (1)
Plant height (cm)	33.3 (32)	8.6 (9.2)	25.8 (28.7)	53 (48)	19 (16)
Days to heading	159 (153)	5.6 (9.0)	3.5 (5.9)	172 (169)	151 (143)
Days to maturity	188 (183)	4.8 (6.2)	2.5 (3.9)	199 (195)	179 (176)
Ae. triuncialis					
Spike length (cm)	6.7 (6.3)	1.3 (1.4)	20.5 (22.0)	11 (8.5)	3.5 (3)
Frost tolerance	1.6 (1.7)	0.9 (0.6)	58.4 (38.7)	5 (3)	1 (1)
Plant height (cm)	41.7 (38.5)	6.6 (7.0)	15.8 (18.2)	55 (51)	28 (18)
Days to heading	165 (158)	6.2 (6.9)	3.8 (4.3)	176 (171)	150 (145)
Days to maturity	191 (186)	3.8 (5.3)	1.9 (2.8)	199 (195)	183 (176)

* : scored 1 to 5: 1 = tolerant and 5 = susceptible.

Table 30. Statistics for 17 samples of *T. dicoccum* evaluated at Tel Hadya and Breda during 1989/90.

	Mean	S.D.	C.V.	Max.	Min.
			TEL HADYA		
Early growth vigor*	4.13	0.8	20.2	5	2
Frost tolerance**	2.5	1.5	59.1	5	1
Total tillers	11.1	1.7	15.4	14	8
Fertile tillers	6.7	1.6	24.7	10	4
Peduncle length (cm)	34.4	5.3	15.5	49	26
Plant height (cm)	39.3	7.4	7.94	82	25
Days to heading	153.0	4.4	2.87	162	142
Days to maturity	183.0	3.9	2.14	189	177
			BREDA		
Early growth vigor*	3.6	1.2	33.6	5	1
Frost tolerance**	1.9	0.7	36.4	4	1
Total tillers	5.2	2.9	56.8	2	2
Fertile tillers	2.8	1.2	45.2	6	1
Pedundel length (cm)	22.9	4.6	20.1	37	16
Plant height (cm)	63.6	7.2	11.4	75	46
Days to heading	159.0	6.5	4.0	178	145
Days to maturity	188.0	4.0	2.1	197	181

* : scored 1 to 5: 1 = low and 5 = high
** : scored 1 to 5: 1 = tolerant and 5 = susceptible

it was considered good for use as an animal feed, but recently it is also being promoted as a health food due to its high fiber content. It is said to cut risks of colon cancer and heart diseases (Agric. Res. 1990).

Economically useful traits for earliness and frost tolerance were observed in a few accessions. There was, however, a high coefficient of variation for all observed characters except days to heading and days to maturity. Another study is carried out on *T. dicoccum* in collaboration with Tishreen University at Lattakia, Syria. This project has yielded more and useful results on the variability present in this primitive wheat (see 1.9.4.). *A.B. Damania*

1.4.3. Screening T. dicoccoides germplasm for stress tolerance

Wild emmer, Triticum dicoccoides (Körn. ex Asch. & Graebn.) Schweinf. (syn. T. turgidum var. dicoccoides) is a tetraploid species with 2n = 28 and genome AABB. It is the immediate progenitor of all cultivated forms of tetraploid and hexaploid wheats. The species is endemic primarily in the western arc of the Fertile Crescent, which is near ICARDA's headquarters in Syria. A large collection of this valuable genetic resource has been assembled and documented at the Genetic Resources Unit. T. dicoccoides crosses easily with cultivated durum wheat and produces fertile progenies. The high protein content of this species has been transferred to durum wheat through crossing and selection. Less work has been done on utilization for stress tolerance.

Of T. dicoccoides 344 accessions were planted for the second season at Tel Hadya and Breda in a modified augmented design using Cham 1 and Haurani (durum wheats), as well as Cham 4 and Mexipak (bread wheats) as systematic checks. The characters scored included early growth vigor, frost tolerance, plant height, days to heading, days to maturity, peduncle length, and total tillers per plant.

Of the checks, Cham 1 and Haurani, are considered to be well adapted to harsh environments. Although the rainfall this season at Breda and Tel Hadya was only 185 and 233 mm, respectively, there were several accessions of T. dicoccoides which had superior performance over the two checks. For instance, there were 35 accessions which possessed significantly better early growth vigor than the checks at Tel Hadya. At Breda the same accessions were superior to the checks but not statistically significant.

During the 1989/90 season low rainfall was also accompanied by cold spells with temperatures dipping substantially below zero, and cold tolerance was recorded twice. At Tel Hadya only eight accessions were entirely tolerant to cold, whereas at Breda 100 accessions were unaffected. The low number of accessions tolerant to cold at Tel Hadya was due to the unusually severe cold spells this season. For example, during the second week in March the mean maximum temperature at Tel Hadya was only 1.6°C, whereas in Breda it was 3.2°C. During the third week it was -0.5, and 1.7°C, respectively. The late frost on 14-16 March was severe enough to do considerable damage to the experiment at Tel Hadya (mean frost tolerance score, 2.9), including the four checks (mean frost tolerance score was 2.7). The mean score at Breda for the test lines as well as the checks was 1.7, with a large proportion of T. dicoccoides lines showing tolerance to the cold. Where damage was done recovery was rapid and complete. Over the last two seasons T. dicoccoides has performed better under Breda conditions than at Tel Hadya, showing its superiority under heat and drought stress.

The average number of tillers were twice as many at Tel Hadya than at Breda. At both sites T. dicoccoides had twice as many total tillers as the checks. However, fertile tiller numbers were only slightly higher than the checks.

The days to heading and days to maturity were not significantly different from the checks at both sites.

The peduncle length and plant height were significantly different at Tel Hadya and Breda. The

Table 31. Coefficient of variance and means for characters recorded on T. dicoccoides at Tel Hadya and Breda during 1989/90.

Character	Tel Hadya			Breda		
	Means accs.	Means checks	C.V.	Means accs.	Means checks	C.V.
Early growth vigor*	3.6	3.6	16.17	3.2	2.8	23.4
Frost tolerance**	2.9	2.7	17.1	1.7	1.6	29.8
Total no. of tillers	10.1	5.1	13.4	5.1	3.4	17.1
No. of fertile tillers	3.9	3.3	17.9	2.7	2.5	26.4
Days to heading	142.0	141.0	0.93	150.0	148.5	1.27
Days to maturity	172.0	176.0	9.30	178.0	182.0	0.49
Peduncle length (cm)	28.7	26.6	11.14	19.7	18.0	19.25
Plant height (cm)	75.9	76.7	6.02	49.5	52.9	11.4

* : scored 1 to 5: 1 = low and 5 = high
** : scored 1 to 5: 1 = tolerant and 5 = susceptible

lower plant height and peduncle length at Breda are typical symptoms of drought. The mean and C.V. for checks and accessions at both locations for eight characters are given in Table 31. ***A. B. Damania***

1.4.4. Evaluation of T. boeoticum

Triticum boeoticum Boissier, wild einkorn, (genome AA, 2n = 14) is the wild diploid progenitor of the cultivated T. monococcum (einkorn). The earliest known carbonized grains of this brittle diploid wheat occur in the prehistoric settlement of Tel Mureybit in northern Syria dating from the eighth millenium B.C. Since there is no evidence of systematic agriculture at this site it is presumed that this cereal was collected from the wild by the earlysettlers rather than farmed. However, by the seventh millennium B.C. it seems to have been cultivated together with the non-brittle form T. monococcum, which gradually replaced it.

In our evaluation of a collection of 194 accessions of

T. boeoticum considerable variation was found for all characters except days to heading and days to maturity. Most significant was the high degree of frost tolerance at Tel Hadya as well as Breda. At Tel Hadya 166 accessions (85%) were frost tolerant and significantly superior to the checks Cham 1, Cham 4, Haurani, and Mexipak. Among the checks Haurani was the most tolerant to frost.

Table 32. Mean values for four characters of T. boeoticum differing significantly at Tel Hadya (TH) and Breda (BR).

Character		Mean values*				
		T. boeot.	Cham 1	Cham 4	Haurani	Mexipak
Total number of tillers	(TH)	12	4	5	5	5
	(BR)	6	3	4	3	4
Total number of fertile tillers	(TH)	5	3	5	4	4
	(BR)	3	2	3	2	3
Peduncle length (cm)	(TH)	46	29	29	40	25
	(BR)	21	13	18	22	10
Plant height (cm)	(TH)	115	81	77	97	82
	(BR)	60	53	53	56	50

* : Mean values of T. boeoticum based on 194 observations at each location; of checks based on 10 observations at each location.

Out of the eight characters recorded at Tel Hadya and Breda, viz. early growth vigor, frost tolerance, total no. of tillers, total no. of fertile tillers, peduncle length, plant height, days to heading, and days to maturity, there were significant differences between the two sites for total no. of tillers, no. of fertile tillers, peduncle length, and plant height. Table 32 gives the mean values for the latter four characters in comparison to the checks.

The 1989/90 season has been very unusual with late frost, drought, etc. However, it was a good year for evaluation of stress tolerance as reflected in the results from experiments with T. dicoccides and T. boeoticum. *A.B. Damania*

1.4.5. Prebreeding and development of genetic stocks

Biotic and abiotic stresses pose a substantial hazard to

Table 33. Crosses made during 1989/90 at Tel Hadya between wild, primitive, and cultivated species of wheat.

Serial no.	Female		Male	Number of seeds obtained
1	T. durum (Haurani)	x	T. dicoccoides	1
2	T. durum (Haurani)	x	T. dicoccoides	1
3	T. durum (Haurani)	x	T. dicoccoides	1
4	T. durum (Haurani)	x	T. dicoccoides	13
5	T. durum (Haurani)	x	T. dicoccoides	3
6	T. durum (Cham 1)	x	T. dicoccoides	8
7	T. durum (Cham 1)	x	T. dicoccoides	2
8	T. durum (Cham 1)	x	T. dicoccoides	6
9	T. durum (Cham 1)	x	T. dicoccoides	2
10	T. durum (Cham 1)	x	T. dicoccoides	2
11	T. durum (Cham 1)	x	T. dicoccoides	12
12	T. durum (Cham 1)	x	T. dicoccoides	12
13	T. durum (Cham 1)	x	T. dicoccoides	1
14	T. dicoccum	x	T. turgidum	5
15	T. dicoccum	x	T. turgidum	6
16	T. dicoccum	x	T. turanicum	5
17	T. dicoccum	x	T. dicoccum	3
18	T. dicoccum	x	T. polonicum	1
19	T. dicoccum	x	T. dicoccum	1
20	T. dicoccum	x	T. dicoccum	7
21	T. dicoccum	x	T. turanicum	3
22	T. dicoccum	x	T. turanicum	6
23	T. polonicum	x	T. dicoccum	5
24	T. polonicum	x	T. turgidum	13
25	T. spelta	x	T. compactum	2

wheat production in much of WANA. Even a modest increase of 10% in wheat production under drought stress without sacrificing yield under favorable conditions could translate itself into huge reductions in farmers' losses in the unfavorable years.

During the previous two seasons a number of lines of T. dicoccoides as well as of T. dicoccum have been identified as disease and drought tolerant. Subsequently 25 different crosses were made during the 1989/90 season between T. dicoccoides and Cham 1. Also Haurani was crossed with T. dicoccoides using the latter as the male parent since Tahir (1986) had reported lower fertility when dicoccoides was used as a female parent. In addition a number of accessions of primitive forms such as T. polonicum, T. turgidum and T. carthlicum, which were reported tolerant to drought and resistant to yellow rust, were also crossed with accessions of T. dicoccum to improve gene combinations in the latter. Progenies of these crosses will be planted in the plastic house in the 1990/91 season and their characteristics studied. The number of crosses and seeds obtained are presented in Table 33. ***A.B. Damania***

1.4.6. Evaluation of T. dicoccum and T. dicoccoides for disease resistance

Forty six accessions of T. dicoccum selected in the 1988/89 season for drought and frost tolerance were screened in two replications in the common bunt (Tilletia caries, T. foetida) nursery using only local isolates. Out of these, 12 accessions were immune to common bunt in both replicates and four were resistant. They are presented in Table 34. In addition, 100 accessions of T. dicoccoides were screened at Tel Hadya for yellow rust (Puccinia striiformis) and common bunt, and at Lattakia

Table 34. Accessions of *T. dicoccum* resistant to common bunt.*

Serial number	Accession number	Level of resistance**
1	IC 12377	Immune
2	IC 12424	Immune
3	IC 12466	Immune
4	IC 12499	Immune
5	IC 12521	Immune
6	IC 12529	Immune
7	IC 12532	Immune
8	IC 12533	Immune
9	IC 12536	Immune
10	IC 12537	Immune
11	IC 12563	Immune
12	IC 12570	Immune
13	IC 12443	Resistant
14	IC 12477	Resistant
15	IC 12448	Resistant
16	IC 12514	Resistant

* : Results obtained after observations in two replicates.
** : 5-15% infection is considered resistant. 0% is immune.

for stem rust (*Puccinia graminis* f. sp. *tritici*) and Septoria blotch (*Mycosphaerella graminicola*, syn. *Septoria tritici*). Septoria and yellow rust were infected artificially, whereas stem rust incidence was due to natural infection.

Results of the screening for yellow rust are presented in Fig. 9. No accessions with complete resistance were found. The *T. dicoccoides* accessions unaffected by the natural infestation of stem rust are: IC 600219, IC 600399, and IC 600838. For common bunt 23 accessions were immune, enumerated in Table 35.

The results presented here were based on at least two observations. Further screening is in progress to confirm

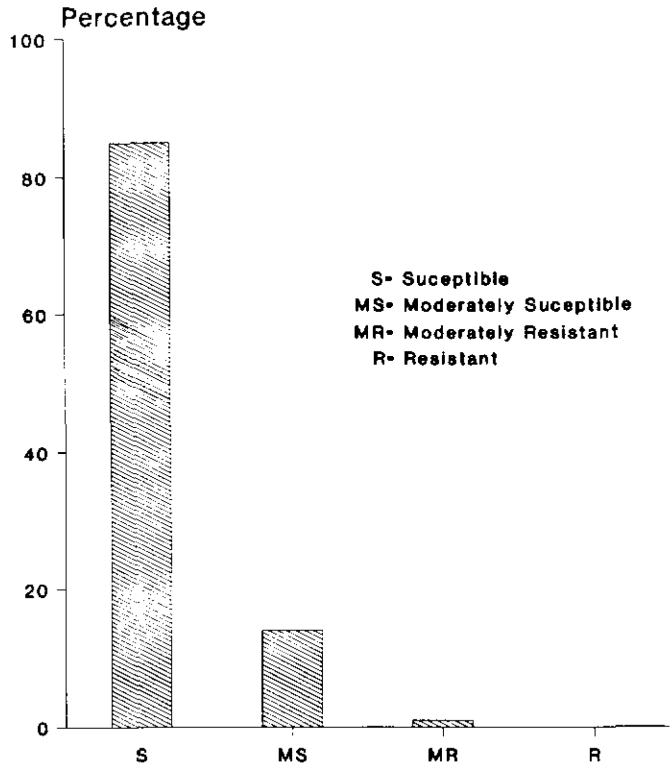


Fig. 9. Results of screening accessions of *T. dicoccoides* against yellow rust at Tel Hadya.

Table 35. Accessions of T. dicoccoides immune to common bunt at Tel Hadya.

1	IC 600373	13	IC 600454
2	IC 600500	14	IC 600483
3	IC 600438	15	IC 600365
4	IC 600204	16	IC 600793
5	IC 600195	17	IC 600446
6	IC 600469	18	IC 600187
7	IC 600390	19	IC 600515
8	IC 600366	20	IC 600458
9	IC 600210	21	IC 600449
10	IC 600450	22	IC 600205
11	IC 600477	23	IC 600451
12	IC 600853		

results at other locations. ***O.F. Mamluk (Cereal Improvement Program) and A.B. Damania***

1.4.7. Evaluation and utilization of wild relatives (Aegilops spp.) at the University of Tuscia, Viterbo, Italy

Collaborative research in the framework of the project on "Enhancing Wheat Productivity in Stress Environments Utilizing Wild Progenitors and Primitive Forms" continued in 1990 with the following activities: a) evaluation of germplasm for storage proteins, and b) exploitation of newly developed wheat mutants promoting chromosome pairing in hybrids with alien germplasm.

Evaluation of germplasm for storage proteins

Variation for storage proteins was studied in the D genome of Aegilops and in certain Triticum spp. along three main lines, as follows: 1. Detection of genetic variation in Aegilops squarrosa and synthetic amphiploids of the D genome. 2. Detection of variation in different accessions of species possessing the D genome cluster. 3. Study of low molecular weight glutenin subunits coded by the Gli-D1 and Glu-D3 loci in diverse bread wheat cultivars.

1. The storage protein genes present in Ae. squarrosa showed a considerable variation which could be potentially useful in wheat improvement. In most cases novel allelic variants were detected but blocks peculiar of the D genome in bread wheat were also found. Synthetic amphiploids which possess the D genome could be used as bridges for breeding novel bread wheat cultivars. Once the amphiploid is

developed it needs to be established if it possesses the selected desirable characters. The data showed that the electrophoretic patterns of the parental species are almost always conserved in the amphiploid.

2. The 'D genome cluster' includes polyploid species which have at least one genome coming from Ae. squarrosa, viz. the tetraploids Ae. ventricosa (genome DUn), Ae. cylindrica (CD), Ae. crassa (DM), and the hexaploids Ae. crassa (DDM), Ae vavilovii (DMS), and Ae. juvenalis (DMU). Several accessions of the above species were analyzed by acid polyacrylamide gel electrophoresis (PAGE). It was not possible with PAGE, however, to discriminate between species due to the large intraspecific variation which results in an overlapping of the electrophoretic patterns. Gliadin blocks similar to those found in Ae. squarrosa and in diverse bread wheat cultivars were also detected.

3. Interest has been shown in the study of low molecular weight glutenin subunits (LMWGS) coded by the D genome of bread wheat cultivars whose role in bread-making quality is well known. The genes coding for these subunits (Glu-D3) are closely linked to genes coding for gamma and omega gliadins (Gli-D1).

The patterns for high molecular weight omega-gliadins, coded by the 1D chromosome of bread wheat (AABBDD), analyzed so far fall into two distinct groups, commonly referred to as "Chinese Spring type" and "Cheyenne type". The same holds for the LMWGS coded by the 1D chromosome. This was in sharp contrast with the high degree of variation found for omega-gliadins in Ae. squarrosa.

Exploitation of newly developed mutants promoting chromosome pairing in hybrids with alien germplasm.

The major problem in transfering desirable traits from most wild relatives to cultivated wheat is the failure of alien chromosomes to pair those of wheat. Out of several ways to overcome this problem, the most promising one may be to promote homoeologous pairing by genetic means. In most cases of interspecific and intergeneric crosses, wheat mutants for the most potent gene suppressing homoeologous pairing, i.e. Ph1, have been invariably used so far. However, in certain cases alterations to other wheat pairing genes could provide a better fit. For example, the effect of less potent genes than Ph1 could be more desirable when pairing and recombining between homoeologous chromosomes of wheat and closely related species such as Aegilops is wanted. The 'intermediate pairing' that results in the use of such genes is less effective. But, on the other hand, they permit a more 'regular' type of pairing to occur with less complex multivalent associations, leading to less unbalanced gametes and consequently to a higher possibility of backcross progeny recovery.

Following this, a new mutation promoting chromosome pairing has been developed at the University of Tuscia in a bread wheat genotype and subsequently tested for its effect on hybrids resulting from crosses with Aegilops spp. Hybrids between wheat genotypes with single or combined pairing mutations were obtained with accessions of Ae. kotschyi, Ae. biuncialis, and Ae. ovata. These accessions carry genes for resistance to powdery mildew and various rusts (see ICARDA, Cereal Improvement Program, Annual Report, 1989).

In all hybrid combinations, especially those involving Ae. kotschyi, a pairing of 40% was achieved when associated with the presence of a ph2 + extra-2D wheat genotype, in comparison with 20% and 17% pairing when ph2 and extra-2D were separately present, respectively. A comparable, but more prominent effect, was detected in Ae. biuncialis hybrids with 45% total chromosome pairing in the ph2 + extra-2D genotypes, versus approximately 30% for the separate mutants. A similar trend emerged from crosses involving Ae. ovata but the pairing was less clear as the presence of ovata genes suppressed homoeologous pairing. Backcross derivates between the above hybrids and well-adapted durum and bread wheat cultivars are being obtained through pollination of a selection of meiotically high-pairing hybrid plants.

C. Ceoloni, L. Ercoli, S. Masci, E. Porceddu (University of Tuscia) and A.B. Damania

1.5. Agro-ecological characterization of Syrian durum wheat landraces

1.5.1. Patterns of variation

Collecting missions for durum wheat landraces (Triticum turgidum durum Desf.) in 1987 and 1988 have yielded 84 landrace populations. The landraces probably evolved at or near the site of collection. Each accession was collected as a bulk sample and as individual spikes. The bulk samples were multiplied and evaluated for agronomic traits; the single head progenies were evaluated for variation components. The day of heading, the flag leaf length and width and the plant height were observed in the field. After maturing, five spikes of each progeny were randomly harvested and scored or measured afterwards in the laboratory for length and color of awns and spikes, number of spikelets per spike, and degree of seed shrivelling.

Collection regions have been defined ealier on the basis of a selected set of climatic variables, and such that these were relatively uniform within region as compared to among regions. Landrace groups were identified on the basis of the names given by farmers.

Phenotypic variation within and among populations, landrace groups and regions were analyzed with a nested ANOVA (Table 36):

1. Populations
   a. landrace groups
      populations within landrace groups
   b. regions
      populations within regions
2. Lines within populations.

Table 36. Estimates of phenotypic variation components as a percentage in the total variation in a collection of Syrian durum wheat landraces.

Character	among populations	among landrace groups	among regions
awn color	99.2	92.8	86.1
days to heading	98.9	77.7	76.6
spike lenght	98.8	91.9	84.8
spike color	98.8	89.6	81.6
awn length	98.1	91.6	83.7
flag leaf width	95.0	72.0	74.8
flage leaf length	72.8	68.9	71.8
seed shrivelling	94.4	63.9	71.8
spikelets per spike	93.6	65.1	59.3
plant height	88.7	65.1	58.1
mean	96.0	78.7	74.5

In general the contribution of among population variation to the total variation was much higher than of lines within populations with 96% and 4%, respectively. Only plant height showed the slightly lower among population variation of 89%, which is still considerable, however. As a result, phenotypic variation could be allocated almost entirely to differences among populations. Among landrace groups, the contribution to the total variation varied from 64% to 92%, with a mean of 79%. Among regions, these values were 59%, 86% and 75%, respectively. Variation among landrace groups and among regions thus contributed more or less equally to the total variation, although for some characteristics a classification on the basis of landrace groups appears more discriminative.

Multivariate analysis among landrace groups was carried out with Principal Component Analysis (PCA), using population mean values. This resulted in three principal components (pc's), of which the first two accounted for 51% and 29%, respectively, of the variance in the factor space. The first axis was positively related to days to heading, awn and spike color and awn and spike length; the second axis to flag leaf width and spikelets per spike. Plant height and flag leaf length were explained about equally by both first two factors, while degree of seed shrivelling was highly related to the third axis.

In Figure 10, the landrace groups are plotted against the first two pc's. The Haurani and Bayadi landrace groups overlapped, and were generally characterized by early heading, short, light colored awns and spikes, broad flag leaves and a high number of spikelets per spike. Baladi landraces appeared in the middle of the first axis, and the Shihani landrace group showed more or less high values for all characteristics. Suweidi and Surieh landraces were late in heading, had long and dark colored awns and spikes, were tall and had long flag leaves. Surieh landraces were further characterized by moderately narrow flag leaves and relatively few spikelets per spike. Hamari landraces were similar for the last two characteristics.

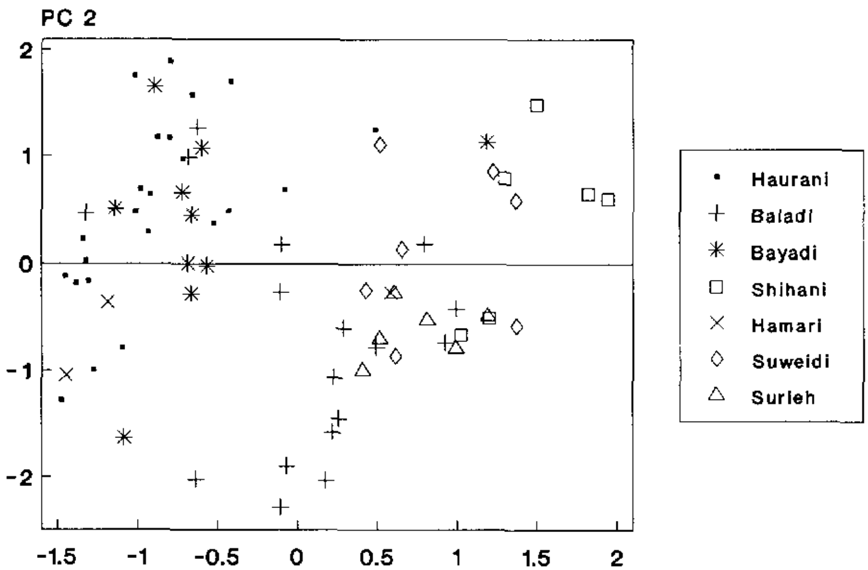


Fig. 10. Landrace groups plotted against the first two principal components, formed in PCA.

1.5.2. Calibration of a crop growth simulation model

Explanatory analysis through a crop growth simulation model is a part of the overall project on Syrian durum wheat landraces. For this a selection of 38 populations was evaluated separately. Material was evaluated for agronomic traits during two years (1989 and 1990), at four locations (Tel Hadya, Breda, Homs, Izra'a) and with or without fertilizer.

As the WHEAT crop growth model is calibrated for modern varieties it had to be modified for landraces. Parameters describing plant characteristics were subsequently adjusted. Evaluations at Tel Hadya in 1990 served as the initial source of data, since most observations relating to yield, yield components, development stages, yellowing of flag leaf, spike and stem, and maturity were scored here.

Landraces are later in development than modern varieties. Pre-anthesis development in the model is determined by a parameter and temperature. Thus adjustment of this parameter sufficed. Because plants had senescenced before physiological maturity had been reached, post-anthesis development was not included.

Initial runs showed an unrealistic amount of foliage, with a corresponding high Leaf Area Index (LAI). This was adjusted through the incorporation of an exponential growth phase, which limits the growth as compared to non-exponential growth. For the durum wheat landraces this phase seems to last longer than for modern varieties. The philosophy is that assimilates, produced in early development stages cannot be absorbed until shooting, and that growth is thus sink-limited.

The partitioning of assimilates in landraces differs from modern varieties in various respects, but most important are the possibly lower shoot/root ratio and lower harvest index of landraces. Whereas on shoot/root ratio data are hardly available, the lower harvest index is mainly caused by the lower number of grains/m^2. This, in turn, is the combined effect of tillers/m^2, and the proportion of ear-bearing tillers, spikelets/spike, flowers/spikelet, and abortion. Without detailed information, however, organ formation is difficult to simulate. In contrast to the lower number of grains/m^2, the rate of grain filling in landraces is higher. Therefore, the rate of grain filling was increased slightly in the model.

The pattern of flag leaf yellowing was corresponding with observations, but the yellowing was initially simulated one to two weeks too late. The model also did not indicate a stress effect of nitrogen, water shortage or temperature on yellowing, but efforts to incorporate such stresses (for investigative purpose) caused imbalances elsewhere. Because post-anthesis green area duration has a dominant influence on final grain yield, this matter needs future attention. Yellowing of spike and stem in the model are determined by the development stage, but since plants had not reached physiological maturity, spike and stem yellowing were simulated too late. Therefore, all yellowing was made input.

The start of spike photosynthesis, which equals the day of heading, is also determined by the development stage, and the model calculates a time span of two weeks between heading and anthesis. Whether it is a landrace characteristic or an environmental effect remains to be determined but field observations show that anthesis is only two to five days after heading. Therefore, the concerned forcing function was adjusted. ***A. Elings***

1.6. Germplasm preservation and utilization

1.6.1. Germplasm preservation

During the 1989/90 season work on the preservation of germplasm continued. Achievements reported here refer to the active and base collections.

Active collection

The transfer of the active germplasm collection from the old to the new, medium-term stores of the GRU has been completed during this season.

A total of 78076 accessions has up to now been transferred, divided as follows:

43919 accessions of cereal germplasm
18782 accessions of food legumes germplasm
15366 accessions of forage legumes germplasm

and are now kept in storage in cotton bags at 0°C and < 25% R.H. The total number of accessions held in GRU's collections is presented in Table 3 in relation to the origin of the materials.

Base collection

The base collection build-up started late June 1990. Of each accession of durum wheat three seed lots of 25 grams with a moisture content of 6 ± 1 % were prepared, packed, sealed in laminated aluminum foil packets and deposited in the long-term storage room at a temperature of -21 ± 1°C. Two seed lots were destined for the GRU base collection and one lot for duplication in another country as a security against loss. The standard for long-term seed storage makes the loss in viability for all germplasm seeds extremely slow and this reduces the frequency at which accessions have to be monitored and regenerated.

In total 18396 seed samples, including 6132 accessions of durum wheat germplasm, were sealed under vacuum and deposited. ***B. Humeid and GRU Staff***

1.6.2. Collection management

Seeds must be viable and capable of germination, and viability must be monitored. Germination tests have been carried out in the laboratory on accessions in the active collection.

In 1990, 4369 germination tests were carried out.

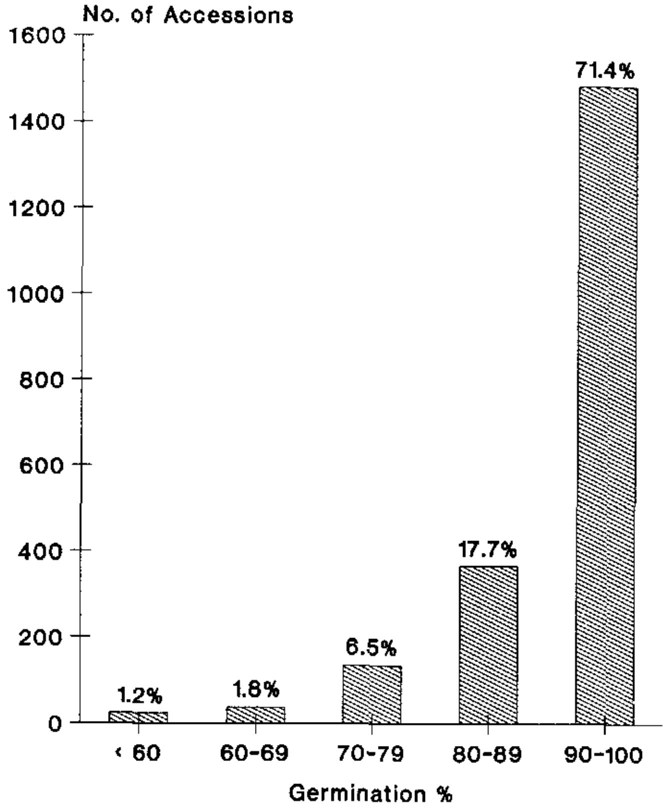


Fig. 11. Barley germplasm viability test (2077 accessions)

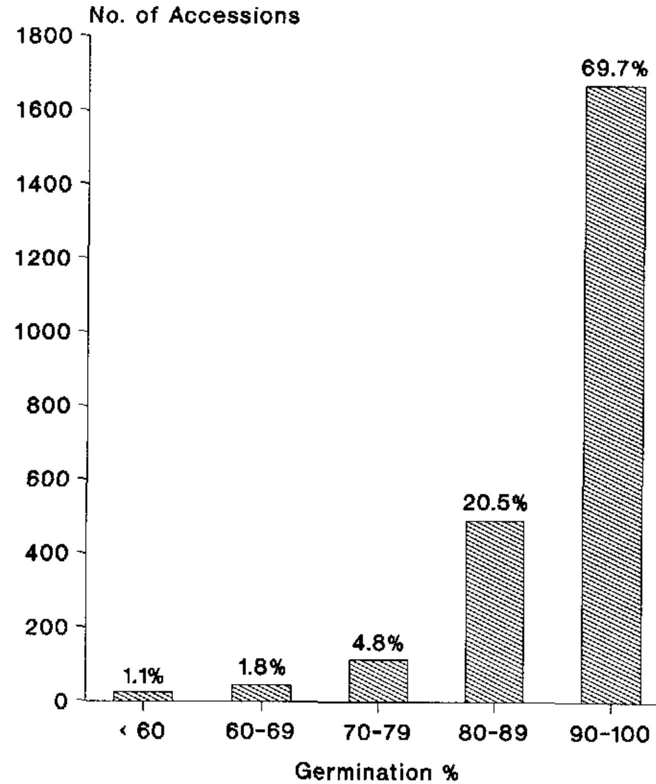


Fig. 12. Durum Wheat germplasm viability test (2347 accessions).

Results of viability testing of barley germplasm which has been stored in medium-term for 6 years (Fig. 11) indicate that more than 70 % of the tested accessions have high viability and 89 % of those accessions have a good germination percentage. On the other hand 9.5 % of the tested accessions showed insufficient viability and need rejuvenation to achieve the standard viability percentage.

Figure 12 shows that nearly 70 % of the durum wheat germplasm tested is highly viable and 90.2 % of the tested accessions have a good germination percentage, while 7.7 % needs rejuvenation. ***B. Humeid and GRU Staff***

1.6.3. Germplasm utilization

ICARDA has a policy of free availability of its germplasm. The Genetic Resources Unit devoted considerable time to fulfill requests for germplasm from the Center's seed bank. In 1989/90, 11622 entries have been dispatched from the active collection of the GRU to meet requests, of which 4436 entries were sent to scientists in 29 countries and 7186 accessions to scientists in the commodity programs at ICARDA (Table 37). ***GRU Staff***

1.7. Documentation of Genetic Resources

1.7.1. Current activities

The passport and collection (p & c) data files for all crops were updated in 1989/90 with newly acquired and collected accessions (see Table 1), which resulted in 6007 new accessions added to the data base. The GRU has now 80697 accessions documented, of which 43058 are cereals, 20039 food legumes, and 17600 pastures and forages (Table 38).

Table 37. Number of samples distributed from GRU/ICARDA in 1989-90.

		Legumes		
Country	**Cereals**	**Forage**	**Food**	**Total**
Albania	2	-	-	2
Algeria	-	-	2	2
Argentina	-	-	18	18
Australia	-	-	2	2
Austria	285	-	-	285
Bulgaria	119	-	10	129
Canada	30	-	8	38
China	36	39	70	145
Colombia	-	61	40	101
Czechoslovakia	9	-	-	9
Egypt	-	4	-	4
Germany	1	-	-	1
India	57	64	41	162
Iraq	32	-	49	81
Italy	465	-	280	745
Japan	285	-	-	258
Morocco	5	-	-	5
Netherlands	43	-	-	43
New Zealand	-	11	-	11
Pakistan	-	100	-	100
Poland	-	-	24	24
Spain	22	-	-	22
Syria	8	82	-	90
Tunisia	-	15	-	15
Turkey	36	10	-	46
United Kingdom	30	780	16	826
USA	244	41	11	296
USSR	704	88	182	974
Yemen	-	-	2	2
ICARDA	4594	784	1808	7186
Total	**6980**	**2079**	**2563**	**11622**

In Table 38, the distribution of the accessions of the three major crop groups is given for WANA, for continents and for countries with high representation. More than half of ICARDA's accessions (excluding breeding lines) originate from its mandate region: 58% of the cereal accessions, with Ethiopia, Jordan, Morocco, Syria and Turkey as important contributors, 63% of the food legumes accessions, with Afghanistan, Iran, Syria and Turkey as major countries of origin, and 61% of the pastures and forages, mainly originating from Jordan, Syria and Turkey. Important countries of origin outside WANA for cereals are China, Colombia, Germany, Greece, Italy, Portugal, The Soviet Union, Switzerland, The United States of America, and Yugoslavia; for food legumes Chile, India, Spain, and The Soviet Union; for forages Great Britain, The Soviet Union, and Sweden.

As far as cultivated species are concerned, the major part of the collection is formed by landraces, preserved as populations consisting of genotypically different individuals and/or single head progenies.

Since p & c files of cereals and food legumes had received attention in previous years, files on pasture and forage species were standardized in 1989/90 and combined into a uniform format. Pisum, Lathyrus and Medicago data bases are completed, Vicia and Trifolium need final corrections, and data bases on Avena and other minor species are still to be processed.

The T. aestivum data base was reviewed and discrepancies between the actual accessions in store and the accession books were corrected.

It was discovered that as an inheritage of the past, the T. durum file contained a certain amount of duplicates caused by the acquisition of identical accessions from the genebanks of Bari and USDA. These duplicates were eliminated and the resulting list is currently used to upgrade the collection. Altough the number of stored durum wheat accessions will decrease as a result, the quality of the collection will improve.

In collaboration with the Legume Program, a chickpea

Table 38. Number of accessions documented per country of origin for the three major crop groups (minor collections are not shown).

Origin	Cereals	Legumes	Forages	Total
WANA	**24974 (58%)**	**12542 (63%)**	**11427 (65%)**	**48992 (61%)**
Afghanistan	157	1134	81	1372
Algeria	752	108	292	1152
Cyprus	150	181	358	689
Egypt	411	224	205	840
Ethiopia	9353	989	327	10669
Iran	173	2665	246	3084
Iraq	107	120	213	440
Jordan	1032	567	950	2549
Lebanon	130	144	184	458
Libya	35	1	173	209
Morocco	1252	378	422	2052
Oman	118	4	23	145
Pakistan	970	474	122	1566
Saudi Arabia	8	-	-	8
Sudan	-	151	15	166
Syria	1599	1250	5547	8999
Tunisia	988	335	95	1418
Turkey	4260	1542	2057	7859
Yemen	1	72	117	190
Europe	**6435**	**2273**	**2620**	**11328**
Austria	32	2	1	35
Bulgaria	241	60	73	374
Czechoslovakia	5	48	30	83
France	109	51	96	256
Germany	910	112	196	1218
Great Britain	57	119	325	501
Greece	699	164	269	1132
Hungary	130	44	129	303
Italy	470	183	449	1102
Poland	32	67	68	167
Portugal	716	94	117	927
Romania	65	37	5	107
Soviet Union	1625	359	179	2163
Spain	148	832	24	1004
Sweden	44	14	450	508
Switzerland	781	2	1	784
Yugoslavia	340	65	18	423

Table 38. (continued) Number of accessions documented per country of origin for the three major crop groups (minor collections are not shown).

Origin	Cereals	Legumes	Forages	Total
Asia (except WANA)	**2581**	**2806**	**294**	**5681**
Bangladesh	-	37	-	37
Bhutan	30	-	-	30
China	2201	81	20	2302
India	190	2292	219	2701
Japan	133	7	12	152
Nepal	19	22	3	44
Africa (except WANA)	**179**	**5**	**22**	**206**
America	**2220**	**1421**	**213**	**3854**
Argentina	56	13	3	72
Brazil	29	4	1	34
Canada	129	175	41	345
Chile	50	710	3	763
Colombia	576	58	-	634
Ecuador	6	112	1	119
Mexico	93	148	2	243
Peru	23	43	-	66
USA	1235	150	152	1537
Australia	**70**	**11**	**121**	**202**
ICARDA Breeding lines	**3478**	**2203**	-	**5078**
Unknown	**6599**	**1305**	**2903**	**10807**
Grand Total	**43058**	**20039**	**17600**	**80697**

catalogue for winter planting was produced. The preparation of a durum wheat catalogue in collaboration with the Cereal Improvement Program is reaching its final stage. Both catalogues will contain passport and collection information, as well as evaluation data on agronomic traits.

The Documentation Section served staff from the GRU and ICARDA, and of institutions elsewhere with overviews of passport and collection data, either on request or sent along with seed shipments. Besides this, assistance was given in, among others, field book preparation, label production, entry of evaluation results, and data analysis. ***A. Elings, A. Antypas and GRU staff***

1.7.2. Ecogeographical database for wild wheat relatives
The International Board for Plant Genetic Resources (IBPGR) initiated in April 1988 the production of a database to hold ecogeographic passport data on world wide germplasm collections of Aegilops and wild Triticum spp. This documentation project was transferred as a joint IBPGR/ICARDA project to the GRU in August 1989.

The aims of the project were:
- to catalogue the wild wheat genetic resources held in international germplasm collections,
- to map the ecogeographical distribution,
- to identify duplicates and gaps in order to recommend priorities for future collection,
- to establish a comprehensive database to hold ecogeographical passport data on wild wheat germplasm and allow this database to be accessed on request by national programs and institutions.

Out of 111 institutes and collectors contacted both through correspondence and selected visits, 89 replies were received. The data varied from detailed to poor, and data from some collections did not arrive in time to be added. Visits proved productive, particularly in cases where institutes did not hold data in computerized form.

Several authors have cited different classification schemes for both Aegilops and wild Triticum spp., which resulted in a problem of choice on which taxonomic scheme to use. As it is envisaged that the yet unpublished new scheme prepared by Dr. M. van Slageren will be used by the database, for the time being all records are kept under their original name.

Separate databases were prepared for each institute collection. Here the original donor number, collection number, collection date and collecting institute or collector were kept in order to cross-reference and determine duplicates after merging these separate databases into the final one. Ecogeographic data received either in hard copy or in computerized form were added to the final database. In cases where latitude and longitude coordinates were not given these were estimated by referring to locality details provided and examination of collection maps, if available. When the latitude and longitude coordinates were known or estimated, the distribution of a particular species could be plotted geographically on suitable mapping software. The database was finally divided into two sections: one containing passport data on germplasm collections, and the other containing passport data on herbarium collections.

A total of 17039 records on accessions from 33 countries are currently held in the database. Of these, 14872 accessions represent germplasm material from 52 genebanks and collected in 28 countries. In addition, 2167 records relate to herbarium material from 11 herbarium collections and collected in 31 countries. The whole database is, besides at ICARDA, present at IBPGR Headquarters in Rome, Italy.

The largest and most diverse collection is held at the Plant Germplasm Institute of the Kyoto University, Japan, with over 4000 accessions. Over 50% of this collection is not duplicated in other genebanks. The second largest collection is held at VIR Leningrad, Soviet Union, with over 3000 accessions, and again much of this is not duplicated in other genebanks. The bulk of the material held at VIR is collected in the Soviet Union, which as a country of origin is poorly represented by other genebank collections. During the past years the ICARDA collection of wild wheat relatives has increased in size (to about 1500 entries at the moment of inclusion in the wild wheat database) and now contains important recently collected material from WANA. Other large collections (over 1000 accessions) can be found at the Istituto Del Germplasma, Bari, Italy, at the Zentralinstitut für Genetik und Kulturpflanzenforschung, Gatersleben, Germany, at CSIRO and Australian Winter Cereals collection, Australia, and at USDA, Beltsville, USA.

The existing germplasm material covers much of the distribution area of the species. Greece, Turkey, Jordan and Syria are well represented, but there are only few accessions from north Africa (Libya, Tunisia, Algeria, Morocco) and Eastern Europe (Albania, Bulgaria, Romania, Yugoslavia and Hungary).

Much attention can still be paid to improvement of the quality and standardization of the data, and to the production of geographic distribution maps and description of ecogeographical characteristics, once the taxonomic revision has been completed. Not all worldwide data have as yet been included.

The project ended in May, 1990, and responsibility for the database has been transferred to ICARDA. The database will be maintained by the Documentation Officer of the GRU, from whom copies or extracts can be requested. ***K. Powell (IBPGR) and A. Elings***

1.7.3. Database on Mediterranean annual forage and pasture legumes

An initial survey of forage species in 1986-87 at IBPGR had resulted in a preliminary database of some 21400 records. As a result it was felt that a more comprehensive and useful database could be produced by a longer term project. ICARDA, where forage research is conducted, was considered the most suitable place to carry out this project.

The project has concentrated on countries directly bordering the Mediterranean Sea, as well as Bulgaria, Jordan, Iraq, Iran, Afghanistan and the Transcaucasian republics of the Soviet Union. The database includes all samples identified as wild or 'semi-wild', and referred to by the donor as a forage. In principle, all information that was supplied was added to the database. The nomenclature of the group is complicated and consistency has been pursued, leading to the changing of some names that were received. No herbarium vouchers were seen, and thus the accuracy of the original taxonomic identification could not be checked.

The database was written in dBASE III+, and its structure is based on five database files, which contain different types of information on each sample and can be related.

Data were either physically entered, or appended to the data base, depending on the form in which they were received. In most cases, they had to be standardized beforehand. If necessary and possible, longitude and latitude were assigned, and transcription errors and obvious mistakes were corrected. Because of the difficulty in screening for and verifying of duplicates, both records in suspect cases were kept.

The database now holds 33855 records of 720 pasture and forage taxa. Each record contains a varying amount of data, reflecting the information supplied by the donor. Only supply of more data will increase the completeness of records. Data are still available worldwide that have not yet been added to the database.

The major genera in the database are: Medicago (12671 records), Trifolium (8424), Lathyrus (2624), Vicia (2497), Festuca (1552), Dactylis (1148), Lolium (743), Lupinus (558), Lotus (416) and Lens (341). Major countries of origin are Italy (4731 records), Turkey (4363), Spain (3731), Greece (2497), Syria (2334), Libya (2141), Portugal (2097), France (1954), and the USSR (1116).

Distribution of the database and further exchange of information will facilitate the exchange of germplasm and aid in the identification of future collection priorities.

After the termination of the project in June 1990, responsibility for the database was accepted by ICARDA. The GRU Documentation Officer can be addressed for copies and for sorting of information. ***M. Daily-Hunt (IBPGR) and A. Elings***

1.8. Training

Training in different aspects of genetic resources work is an on-going activity in the Genetic Resources Unit. In addition to hosting individual trainees from the Syrian National Program and from commodity programs at ICARDA, the GRU also held in-country training courses to strengthen the competence of national program personnel and to facilitate the development of an effective genetic resources network in ICARDA's region. Activities in the 1989/90 season are summarized here:

1.8.1. Individual short-term training

Excluding visiting scientists, nine persons were individually trained at the Genetic Resources Unit (Table 39). Three devoted their training to seed bank management, reflecting the importance of germplasm conservation in WANA. Although most of the training was provided by GRU scientists, other instructors from ICARDA contributed to various activities.

1.8.2. In-country training course in Jordan

A training course on "Genetic Resources Management" was organized by the GRU of ICARDA on June 10 - 21, 1990, in Amman, Jordan. The ICARDA regional coordinator for West Asia and the IBPGR regional coordinator gave lectures in addition to GRU staff. The course was attended by 13

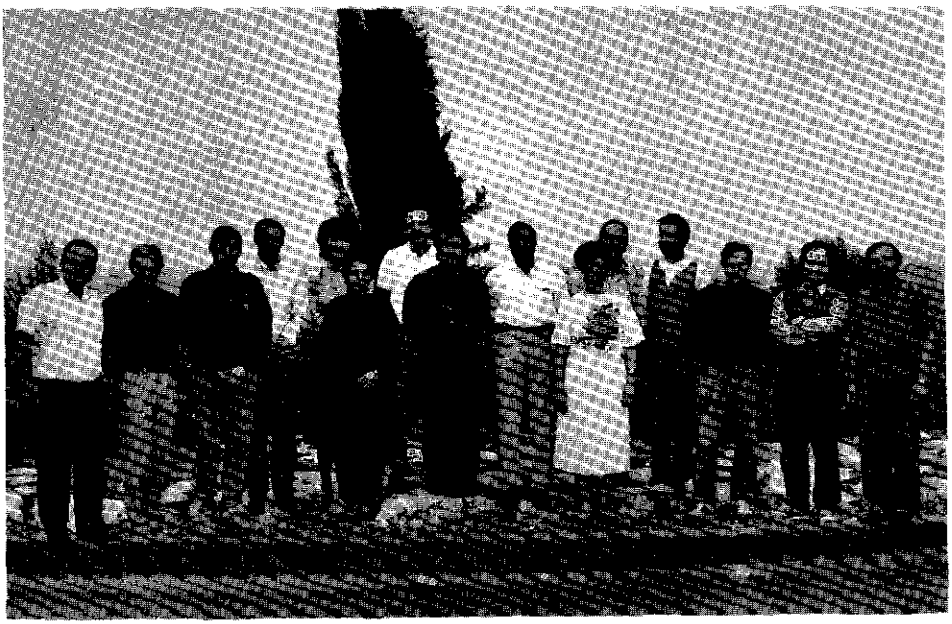
Table 39. Trainees in the Genetic Resources Unit in 1989/90.

Topic	Type of course	No. of trainees	Country	Duration of training
Gen. res. management	In-country	3	Iraq	two weeks
Gen. res. management	In-country	5	Jordan	two weeks
Gen. res. management	In-country	3	Syria	two weeks
Gen. res. management	In-country	2	Turkey	two weeks
Forage legumes germplasm evaluation	Individual	1	Syria	one month
Food legumes germplasm evaluation	Individual	1	Syria	one month
Cereals germplasm evaluation	Individual	1	Syria	one month
Seed bank management	Individual	1	Yemen	one month
Seed bank management	Individual	1	Pakistan	one month
Seed bank management	Individual	1	Morocco	two weeks
Cereals germplasm evaluation	Individual	1	China	one month
Various	Individual	1	Syria	one month
Various	Individual	1	Korea	three months

researchers who participated in classroom and field activities (Table 39). Topics covered genetic resources activities such as collection, evaluation, conservation, documentation, and seed health testing. ***GRU Staff***

1.8.3. Group training course in electrophoresis

A specialized training course in "Use of Electrophoresis in Cereal Improvement" was conducted jointly with the Cereal Improvement Program during October 1990. This two-week course was sponsored by the University of Tuscia, Viterbo, Italy and ICARDA. Two experts from Italy, Professor D. Lafiandra and Mr. G. Colaprico, provided lectures and practical demonstrations to eight trainees from the region: Cyprus (1), Iran (1), Pakistan (1), Syria (2), Turkey (1), and from ICARDA (2).



Trainees and instructors who participated in the electrophoresis group training course,15 - 30 October 1990.

Interested technicians from ICARDA attended various lectures. The trainees profited from exposure to the latest techniques in electrophoretic analysis of cereals. Other senior staff from the Cereal Improvement and the Legume Programs gave lectures in cereal quality and biotechnology. ***A.B. Damania, H. Ketata (Cereal Improvement Program) and J. Valkoun***

1.8.4. Graduate research

Graduate research on "Genetic variability in populations of the primitive wheat Triticum dicoccum (Schrank) Schübl." leading to a Master of Science degree continued into the second year with GRTP scholar Ms. Sawsan Hakim who was transferred to the Genetic Resources Unit. This work is carried out jointly with the University of Tishreen, Lattakia, under the framework of the collaborative agreement with ICARDA. Sixty-nine accessions of T. dicoccum were planted in single rows, each 2.5 m long, at Tel Hadya and Breda during the first season. Twenty-four agro-morphological characters were recorded and the simple statistics of 11 numerically measured characters are presented in Table 40. There was significant variability among accessions at both locations.

There was significant difference in early growth vigor and spike position between Tel Hadya and Breda, but not in other characters, which is perhaps due to the below average rainfall at both sites. In the next season thirty accessions of T. dicoccum selected for drought tolerance from the previous season were planted in two replicates at Tel Hadya and Breda. As a safety measure a single replicate was also planted in a plastic house. ***S. Hakim (Tishreen University, Lattakia, Syria) and A.B. Damania***

Table 40. Simple statistics of T. dicoccum accessions planted at Tel Hadya and Breda during 1989/90.

Characters	Means	C.V.	Max.	Min.	Range
Tel Hadya					
Days to heading	162.0	5.36	193.0	136.0	57.0
Flag-leaf length (cm)	11.7	30.3	25.3	1.3	24.0
Flag-leaf width (cm)	1.03	27.7	2.10	0.40	1.7
Plant height (cm)	49.0	25.8	87.2	17.5	69.7
Peduncle length (cm)	12.4	36.5	31.0	2.0	29.0
Days to maturity	187.0	8.07	211.0	157.0	54.0
Total tiller number	7.2	5.18	47.0	1.0	46.0
Fertile tillers	3.3	76.7	18.0	1.0	17.0
Spikelets per spike	22.9	21.6	35.0	7.0	28.0
Seeds per spike	6.30	143.0	56.0	0	56.0
Weight of seeds/spike	0.38	84.5	2.3	0	2.3
Breda					
Days to heading	163.0	1.16	175.0	123.0	52.0
Flag-leaf length (cm)	13.2	19.7	19.4	7.3	12.1
Flag-leaf width (cm)	1.11	23.3	1.60	0.6	1.0
Plant height (cm)	52.2	19.7	77.0	33.0	44.0
Peduncle length (cm)	16.3	27.2	29.4	6.5	22.9
Days to maturity	19.0	6.44	203.0	146.0	57.0
Total tiller number	3.8	53.0	11.0	1.0	10.0
Fertile tillers	2.6	51.4	9.0	1.0	8.0
Spikelets per spike	22.3	22.8	37.0	12.0	25.0
Seeds per spike	2.54	39.0	5.0	0	5.0
Weight of seeds/spike	0.58	46.8	1.21	0.03	1.18

2. SEED HEALTH LABORATORY

A major highlight this year was the completion of the remodelling of the old GRU building for the Seed Health Lab. Space is no longer a constraint!

2.1. Activities on newly introduced seeds

From November 1989 to October 1990, 111 seed consignments from 40 countries were received after passing Syrian quarantine. About the same number of consignments was rejected by the Syrian quarantine authorities. Nevertheless, this constitutes a 16% increase in seed arrivals over the previous year. Each shipment usually consisted of several different genotypes, the range was between 1 and 8394 (seeds from Lebanon).

2.1.1. Laboratory testing and treatment

Seeds received from abroad were first fumigated or treated at -18°C for one week to control insect pests, then inspected for admixtures of soil, weed seeds, bunt balls, or for seeds with visible symptoms of infection. Table 41 indicates the results of additional health tests. In the 1989/90 season, 3 shipments of wheat were found contaminated with *Tilletia indica* spores, a pathogen that does not occur in Syria and were destroyed. Those seeds which were not treated by the sender were treated at the Seed Health Laboratory with a broad spectrum fungicide, i.e. Vitavax for cereals, and thiabendazole or benomyl for legumes, before planting.

2.1.2. Field inspection

As an additional safeguard against the inadvertent

Table 41. Seed health tests conducted on seeds newly introduced in 1989/90.

Crop	Number of lines tested	clean	infected	Tests carried out	Pathogens observed
durum wheat	504	328	176	Centrifuge wash test	Tilletia caries and/or T. foetida (99), T. indica (74), T. caries spp. and T. indica (3)
bread wheat	3336	2499	837	Centrifuge wash test	Tilletia caries and/or T. foetida (496), T. indica (334), T. spp. and T. indica (5), T. spp. and Urocystis agropyri (2)
barley	769	617	152	Freezing blotter test	Helminthosporium spp. (62), Fusarium spp. (86), Fusarium spp. and Helminthosporium spp. (4)
triticale	180	170	10	Centrifuge wash test	Tilletia indica (10)
oats	1	1	-	Centrifuge wash test	-
lentil	140	137	3	Freezing blotter test Agar media test	Botrytis spp. (3)
faba bean	46	43	3	Agar media test	Fusarium spp. (2), Fus. spp. & Botrytis spp.
chickpea	249	249	-	Agar media test	-

Table 41. (continued) Seed health tests conducted on seeds newly introduced in 1989/90.

Crop	Number of lines tested	clean	infected	Tests carried out	Pathogens observed
Pea	80	47	33	Agar media test	_Pseudomonas_ spp. (33)
medics	24	24	-	Test for stem nematode	-
rape seed	17	17	-	XTS agar media test Agar media test	-
safflower	8	8	-	Centrifuge wash test and agar media test	-
alfalfa	1	1	-	Agar media test	-
Total	5355	4141	1214		

introduction of pests and pathogens all newly introduced material is by Center policy planted in the isolation area, in the north-west corner of the Tel Hadya station. Although the level of contamination with Tilletia indica was low, the lines concerned were not planted. The area in 1989/90 was approximately 18 ha of small plots. In a careful field inspection no exotic diseases were detected on plants grown in isolation.

2.2. Activities on seeds dispatched internationally

In the 1989/90 season 458 consignments were dispatched from ICARDA to 73 different countries. These included 173 shipments of cereal and food legume International Nurseries; the remaining were individual requests for germplasm and breeder seed. Compared to the previous season, the total number of outgoing shipments decreased by 13%. Phytosanitary Certificates which met the requirements of the importing countries were issued by the Syrian authorities and sent with the seeds. To facilitate seed inspection, all consignments other than International Nurseries were packed and sealed by the Seed Health Lab.

2.2.1. Field inspection

The seed increases for International Nurseries were inspected plot by plot, on a total of about 100 ha. In addition 10 ha of germplasm multiplication for possible international distribution were checked. Potentially seed-borne pathogens detected were: Ascochyta fabae, Fusarium spp., Tilletia foetida and T. caries, Urocystis agropyri, Helminthosporium spp., Rhynchosporium secalis, Ustilago nuda, U. tritici, Orobanche spp. Plants suspected of virus infection were rogued.

Table 42. Seed health tests conducted on seeds dispatched internationally from ICARDA in 1989/90.

Crop	Number of lines tested	clean	infected	Tests carried out	Pathogens observed
durum wheat	458	372	86	Centrifuge wash test	*Tilletia caries* and/or *T. foetida* (57), *Urocystis agropyri* (18), *T.* spp. and *U. agropyri* (11)
bread wheat	478	412	66	Centrifuge wash test	*Tilletia caries* and/or *T. foetida* (50), *Urocystis agropyri* (16)
barley	293	155	138	XTS agar medium test Centrifuge wash test Freezing blotter test	*Helminthosporium* spp. (33), *Fusarium* spp. (97), *Fusarium* spp. and *Helminthosporium* spp. (8)
lentil	87	76	11	Freezing blotter test	*Fusarium* spp. (11)
faba bean	132	123	9	Test for stem nematode Freezing blotter test Agar media test	*Fusarium* spp. (5), *Botrytis* spp. (4)
chickpea	220	203	17	Freezing blotter test Agar media test	*Fusarium* spp. (17)
vetch	2	2	-	Test for stem nematode	-
pea	4	4	-	Test on *Pseudomonas* F agar	-
medics	2	2	-	Test for stem nematode	-
Total	**1676**	**1349**	**327**		

Approximately 36 ha of seed multiplication fields (registered varieties of wheat, barley, chickpea and lentil) were inspected according to the OECD system (inspection of 10 randomly selected sample areas of 20 m^2 per variety). All these fields were free from seed-borne diseases.

2.2.2. Laboratory testing and treatment

Samples of seeds harvested from fields where disease symptoms were observed, as well as random samples, were tested in the laboratory (Table 42). The majority was found healthy or infected with non-quarantine pathogens such as _Fusarium_ spp. or _Tilletia_ spp. (common bunt). Particular attention was given to lines harvested from the field in which _U. agropyri_ (flag smut) was found. Any lines found contaminated in the centrifuge wash test were eliminated from the shipments.

Unless specific requests were made by the recipient for untreated seed, for example for laboratory analysis or germplasm for long-term storage, only seeds treated with fungicides were dispatched. Legumes seeds were also routinely fumigated.

2.3. Training

Aspects of seed health were covered in lectures and practical in seed testing, cereal disease methodology, and genetic resources training courses, as well as in residential courses and with some of the individual trainees.

In Algeria a course on field inspection for diseases in legume seed production was conducted.

2.4. Research Activities

For an efficient monitoring of the health status of incoming seeds information on the distribution of pathogens is a prerequisite. Only if it is known which pathogens might be expected from a country or region the appropriate test methods can be applied. Such information is rather fragmentary, and it is necessary to supplement it by systematic surveys. In addition, a different approach was tried: the assessment of the likelihood of a pathogen occurring under specific climatic conditions. This approach may be also useful in deciding whether it is necessary to take steps not to send infected or contaminated seeds to a location, which is the case if a pathogen does not occur in the location in spite of favorable climatic conditions.

Ascochyta blight of chickpea was used as a model. A total of 35 standard meteorological stations in chickpea growing areas were selected and classified into "disease" and "non disease" categories based on information from the relevant literature. The location of the stations and the distribution of Ascochyta blight are shown in Fig. 13. Monthly data for mean daily maximum and mean daily minimum temperature, mean precipitation and mean number of days with precipitation, and mean windspeed for the month of conventional planting and the four subsequent months were analyzed by stepwise discriminant analysis (SDA). In addition to the original data, simple transformations such as the product of rain and wind, the difference between maximum and minimum temperature, the quotient of rain and number of rainy days, or the quotient of rain and minimum temperature were included. Such transformed data may be more meaningful for the epidemiology of a disease than the original data.

The technique can be used to classify an individual (here: location) into one of two alternative groups (here: climatic conditions favorable or unfavorable for disease development) based on a set of measurements (here: climatic parameters). At each step the variable that adds most to the discrimination between the groups is entered into the discriminant function. The resulting linear function is then used to classify datasets not used in the development of the function. This method has been widely used in plant taxonomy, e.g. by Fisher to separate Iris species, or in plant genetics. This technique was so far not used in the development of plant disease prediction models.

From the classification functions the following discriminant function was computed:

$$y = 1.11 + 0.22\,x_1 + 0.05\,x_2 + 0.32\,x_3 - 0.91\,x_4 + 0.51\,x_5 - 1.15\,x_6$$

x_1 = mean daily temperature in month 1 of the vegetation
x_2 = mean precipitation in month 2 of the vegetation
x_3 = average precipitation per rainy day in month 1 of the vegetation
x_4 = average precipitation per rainy day in month 2 of the vegetation
x_5 = mean number of rainy days in month 1 of the vegetation
x_6 = mean number of rainy days in month 2 of the vegetation

The disease risk can be estimated for any location if the above parameters are known. If the computed score is > 0, the location is to be classified as "no disease risk", if it is < 0, it is "disease risk".

Of the six parameters contributing to the discrimination, five are related to rainfall in the first two months of vegetation, and the sixth is the mean daily temperature in the first month after planting. Particularly important are obviously the precipitation parameters in the second month of vegetation, i.e. rainfall, number of days with rainfall, and the average rainfall per rainy day. The latter is obtained by a division of the former two, and may be more important for the development of the disease. Two coefficients are negative, namely the average precipitation per rainy day (x_4) and the number of rainy days in month 2 of the vegetation (x_6). This indicates that locations with larger values of these variables may be classified more likely as "disease risk". Both parameters result in prolonged periods of leaf wetness, which is favorable for an epidemic of fungi requiring leaf wetness for infection, such as Ascochyta blight. Rainfall in the second month of vegetation (x_2) has a positive coefficient which seems to counteract the effect of the previous two parameters. A comparison of the standardized coefficients ($x_2 = 0.09$, $x_4 = -1.70$, $x_6 = -2.14$) indicates that this is the case only to a small extent. The average precipitation per rainy day (x_3) and the number of rainy days in month 1 of the vegetation (x_5), as well as the mean temperature in the same period

Table 43. Examples for assessing the risk of _Ascochyta_ blight occurring in additional locations or growth seasons.

Area	Month of planting	x_1	x_2	x_3	x_4	x_5	x_6	Disease score	Disease risk
Plovdiv, Bulgaria	April	12.2	55	6.1	6.1	7	9	-3.84	+
Kenyan highlands	June	15.7	17	5.8	3.4	5	5	0.98	-
Bogota, Colombia	April	13.7	105	5.3	5.0	19	21	-7.94	+
Neustadt, Germany	April	10.0	50	3.4	3.8	14	13	-4.37	+
Aleppo, Syria	March	10.9	28	5.4	7.0	7	4	-0.76	+
Aleppo, Syria	April	16.4	8	7.0	4.0	4	2	3.46	-

(x_1) also neutralize the effect of x_4 and x_6: if they are high, the computed score is more likely to be positive and thus the disease risk tends to be lower. The reason for this could be that high temperature and rainfall parameters boost plant growth at the time shortly after planting, and that their effect on the disease development is relatively low during the period of germination and seedling growth.

In Table 43 some examples for the application of this method are given: for the areas of Plovdiv, Bulgaria, Bogota, Colombia, and Neustadt, Germany the computed score indicates a disease risk, whereas for the Kenyan highlands no serious outbreaks of Ascochyta blight are to be expected. While in Bulgaria a high incidence of Ascochyta blight is reported, the disease has not been reported from Colombia or Germany. For the area of Bogota, a disease risk is predicted for spring-planted chickpea, and care should be taken not to introduce the pathogen. No chickpea is grown in Germany, and a reflection on a disease risk in absence of the crop seems very theoretical. However, farmers could decide that chickpea is a potentially valuable crop, and in such case it would be advisable to be prepared for potential disease risks. Furthermore, the disease risk depending on planting time in a location can be assessed. In the area of Aleppo in northern Syria the disease occurs if chickpeas are planted in December. If planting is delayed to March, the prediction is still "disease risk", but with a lower probability than in December. A further delay to April results in the prediction "no disease risk". Spring planting, although considerably reducing crop yields, is in fact a common practice of farmers in this area in order to avoid outbreaks of Ascochyta blight. Only in extraordinary wet years March plantings

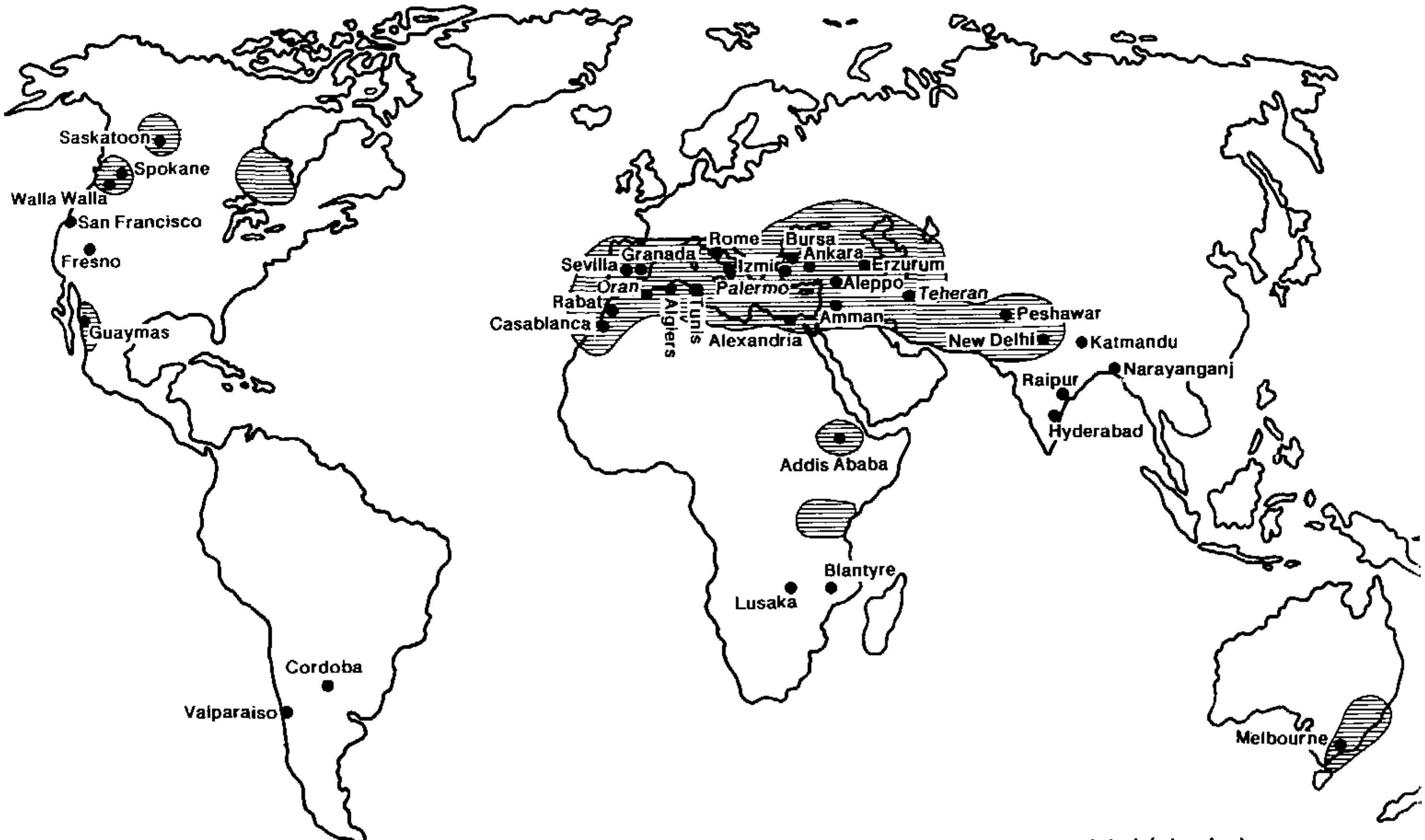


Fig. 13. Geographical distribution of *Ascochyta rabiei* (shaded areas) and locations analyzed in this study.

are affected by Ascochyta blight.

It is recognized that besides unfavorable climatic conditions there are possibly other reasons for the absence of reports on the disease occurrence in areas where chickpea is grown. There is a chance that the disease occurs, but was not described in the internationally accessible literature. In this case it can be assumed that the incidence is low, and/or that the disease does not occur regularly. Another reason for the absence of the disease could be the lack of inoculum. However, since international exchange of seeds entails the risk of infected seeds being planted in these areas, an outbreak of a seed-borne disease such as Ascochyta blight can be expected under favorable conditions.

Because climate data, i.e. long-term averages, and not weather data are used for the analysis, this approach is not suitable for a disease forecast in a particular year. A "no disease risk" result does not mean that the disease will not occur in the area; outbreaks may result from a year with favorable weather or from the planting of new susceptible varieties. However, the risk of Ascochyta blight developing to epidemic proportions is low in these areas.

This approach, which can also be applied to other hosts/ pathogens or pests, could be valuable in focussing quarantine efforts on pathogens which pose a high risk of epidemic development to an area if introduced, such as in the above mentioned example of Colombia. An estimation of the potential disease risk may also be useful when new crops are introduced into a region. This had been the case with chickpea in eastern Washington and northern Idaho in the seventies, and a few years later substantial yield losses were encountered due to Ascochyta blight which had been introduced with seeds. ***M. Diekmann and S. Asaad***

3. VIROLOGY LABORATORY

Research activities of the virology laboratory during 1989/90 continued to focus on disease problems of legume and cereal crops. Facilities were significantly improved this year which permitted the laboratory to purify viruses and produce antisera of acceptable quality. With support from UNDP the laboratory prepared ELISA kits for a number of viruses which will be made available, free of charge, to interested laboratories in WANA. Services to the Legume and Cereal Programs continued with evaluation of breeding lines for their reaction to selected viruses. Cleaning gene bank accessions from seed-borne viruses was initiated.

3.1. Viruses of Food Legumes

3.1.1. Survey of virus diseases

A virus was identified infecting faba bean and causing yellowing of the whole plant followed by necrosis. The symptoms are very similar to those caused by bean leaf roll virus (BLRV). Characterization indicated that the virus, similar to BLRV, is not mechanically transmitted but persistently by aphids. However, it is smaller in size (18-19 nm) than BLRV (25 nm). Detailed studies conducted in Germany by Katul and Casper showed that the virus genome is composed of ss-DNA rather than ss-RNA as is the case with BLRV. On this basis, the virus isolated from faba bean was identified as distinct from BLRV and was tentatively named faba bean necrotic yellows virus (FBNYV). When 62 samples of faba bean from Egypt, Ethiopia, Sudan and Syria showing yellowing symptoms were tested for the presence of FBNYV, 33 were found positive.

In 18 samples, a mixed infection of BLRV + FBNYV was identified. The coexistence of the two viruses is due to the similarity in the mode of transmission and host range.

When 178 lentil samples, with symptoms suggestive of virus infection, collected from Algeria, Egypt and Syria were tested serologically, luteoviruses (BLRV or BWYV) were the most common (Table 44). This increased incidence of aphid-tramsitted viruses in lentil this season could be due to the relatively warm winter.

Table 44. Viruses in lentil samples with virus-like symptoms collected from Algeria, Egypt and Syria during spring of 1990.*

Country	No. of plants sampled	Number of plants found positive						
		BBSV**	BYMV	PsbMV	BBWV	BLRV	BWYV	FBNYV
Algeria	38	2	1	1	0	9	9	7
Egypt	5	0	1	2	0	1	0	1
Syria	135	8	5	6	6	30	26	47
Total	**178**	**10**	**7**	**9**	**6**	**40**	**35**	**55**

* : Identification based on standard serological reaction test (ELISA).

** : BBSV = Broad bean stain virus
BYMV = Bean yellow mosaic virus
PsbMV = pea seed-borne mosaic virus
BBWV = Broad bean wilt virus
BLRV = Bean leaf roll virus
BWYV = Beet western yellows virus
FBNYV = Faba bean necrotic yellows virus

3.1.2. Screening faba bean for bean yellow mosaic virus (BYMV) resistance

Using aphid inoculation, 200 faba bean pure lines were evaluated for their reaction to BYMV. A number of lines were identified with a low disease index since virus disease symptoms were either mild or absent. A population was selected from the following lines characterized by absence of virus symptoms and of virus multiplication. The lines were PBL's 1584, 1567, 2875, 1592, 1530, 1541, 1581 and 1597. Those populations will be further tested.

3.1.3. Yield loss and seed transmission rates

When yield of 19 lentil genotypes was evaluated after inoculation with broad bean stain virus (BBSV), losses due to infection varied between 14% in 'Red Chief' and 61% in ILL 5699. Results are presented in Figure 14. When variability in seed transmission was evaluated in the same lentil genotypes, seed transmission rates varied between 0.2% in 'Red Chief' to 32.4% in ILL 6198 (Fig. 15). Inheritance of the low seed transmission in 'Red Chief' will be studied further.

When faba bean (cv. Syrian local), lentil (cv. Syrian Local) and pea (cv. Syrian Local) were inoculated with pea seed-borne mosaic virus (BSbMV), yield loss induced by virus infection was 26, 29 and 53%, respectively. Seed transmission rates of PSbMV in the same cultivars of faba bean, lentil and peas were 0, 1.3 and 7.1%, respectively. PSbMV was found not to be seed-transmitted in chickpea. ***K. Makkouk and S. Koumari***

3.1.4. Testing seed samples for international nurseries

A total of 464 seed samples of lentil and 513 of faba bean from the international nurseries were tested for seed-borne virus infections. Accessions, where lab tests suggested a possible seed-borne infection were discarded from shipment. ***K. Makkouk and W. Radwan***

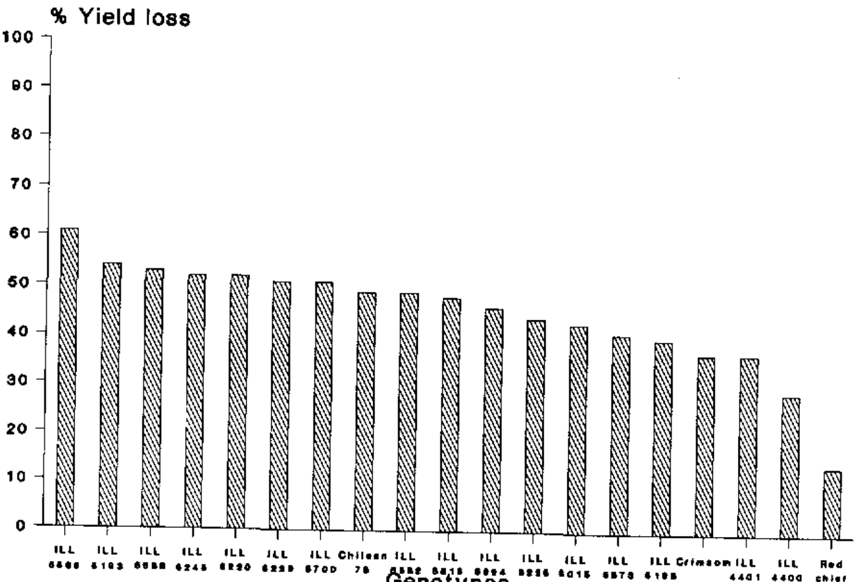


Fig. 14. Yield loss(%) of 19 lentil cultivars when inoculated with broad bean stain virus, as compared to the healthy control.

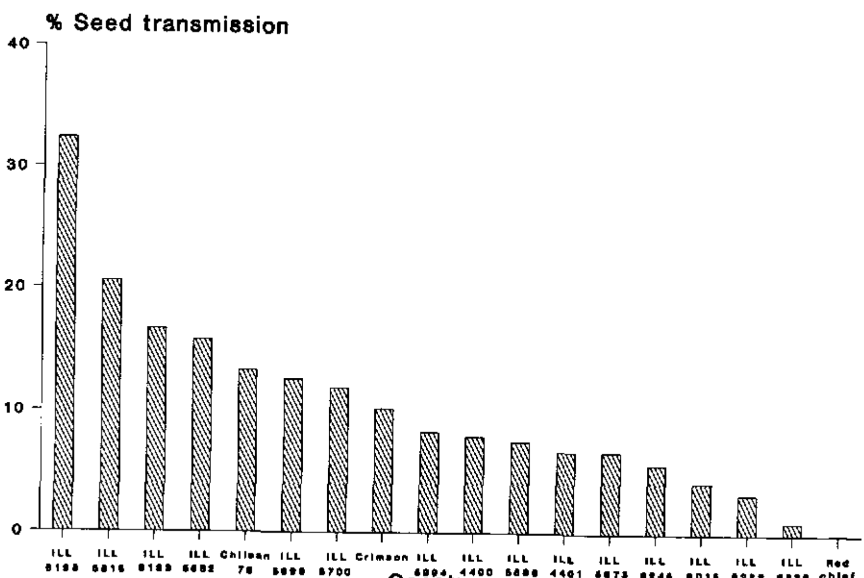


Fig. 15. Variability in seed-transmission rate of broad beam stain virus in 19 lentil genotypes.

3.2. Cereal Viruses

3.2.1. Screening for barley yellow dwarf virus (BYDV) resistance in cereal breeding lines

Over 2000 cereal breeding lines were evaluated for their reaction to BYDV using artificial inoculation by aphids. Table 45 summarizes results obtained with lines that demonstrated tolerance to BYDV. Table 46 summarizes the results of the best performing cereal lines with consistent results over the last three years in Tel Hadya, Syria, as well as in Morocco.

Table 45. Evaluation of cereal breeding lines after artificial inoculation with BYDV during 1989/90.

Cereal nursery	Number of lines tested	Lines with tolerance to infection
Barley		
BKL 1990	340	38*, 87, 98, 104, 108, 129, 142, 173, 188, 233, 267, 312, 318, 319, 324, 330
SLB	168	3-88, 4-63, 15-55, 3-47, 16-54, 15-62, 4-1, Tadmor
Durum wheat		
DCB 1990	80	4, 16, 19, 20, 36, 37, 38, 71, 78, 80
DST 1990	40	2, 3, 13, 17, 27, 31, 32, 37, 20-40
DON-HAA 1990	150	11, 12, 14, 36, 46, 49, 53, 54, 64, 65, 67, 72, 74, 75, 79, 82, 91, 92, 97, 99, 102, 111

Table 45. (continued) Evaluation of cereal breeding lines after artificial inoculation with BYDV during 1989/90.

Cereal nursery	Number of lines tested	Lines with tolerance to infection
durum wheat (continued)		
DCB-HAA 1990	205	19, 39, 47, 49, 55, 60, 77, 134, 151, 152, 153, 199, 200, 201, 202
DKL-1990	240	1, 24, 98, 112, 115, 118, 121, 123, 124, 126, 127, 135, 139, 142, 159, 170, 187, 193, 199, 201, 203
C-YD-DW 1989-90	52	10, 16, 18, 22, 27, 31, 35, 41, 49
Bread wheat		
WST 1990	100	11, 16, 21, 26, 44, 58, 64, 67, 69, 72, 73, 76, 77, 79, 89, 95, 98
WON-MRA 1990	105	4, 8, 26, 37, 43, 47, 51, 53, 71, 76, 78, 79, 82, 84, 85, 94, 96, 98, 101, 102, 103, 104
WCB 1990	189	3, 9, 16, 19, 21, 30, 31, 34, 46, 48, 51, 54, 55, 58, 83, 85, 88, 110, 111, 129, 132, 135, 144, 145, 155, 163, 168, 183
WKL 1990	190	2, 7, 17, 23, 28, 37, 41, 51, 55, 56, 63, 64, 78, 85, 91, 94, 98, 103, 115, 126, 127, 129, 134, 135, 177
RWYT-LRA 1990	72	4, 5, 9, 16, 17, 19, 51, 61

* : Numbers refer to ICARDA nursery serial number, e.g. 38 is BKL 1990-38.

Table 46. Evaluation of the best performing durum wheat, bread wheat and barley lines upon inoculation with BYDV in Tel Hadya, Syria, and Morocco.

	1990		1989	1988
Entry	Morocco	Tel Hadya	Tel Hadya	Tel Hadya
DKL-87-32	5.5*	6	6	5
DKL-88-131	4.5	6	6.5	5
C-YD-DW-88-32	6	6	5	5
DCB-89-56	5.5	6	5	
DKL-89-142	5.5	6	6	
DKL-89-146	4.5	6	6	
WKL-88-29	4	5	6	5
C-YD-BW-88-50	4	6	6	5
WKL-89-44	4.5	5.5	6	
WON-LRA-89-88	5	6	4	
AP-CB-89-134	5	6	5	
Long Miai-10	4.5	5	6	5
IAS-20	4.5	4.5	6	4
85 x 20.3.3	4	5	6	5
ANZA	4	5	6.5	6.5
C-YD-BA-88-32 (ATLAS 68)	5.5	5	6	3
C-YD-BA-88-79	5	4.5	5.5	3
BKL-88-158	5	6	6	4
C-YD-BA-89-49	5.5	4	6	
BKL-89-85	4.5	5	5	
BKL-89-177	3.5	7	6	
BKL-89-278	3	7	6	
BKL-89-279	4.5	4	5	
BKL-85-237	3	5	5	
80-81-C-BQCB-10	3.5	4	6	

* : numbers in the table refer to the symptom score based on 0-9 scale. 0 = no symptoms, 9 = stunting, yellowing and death of plants.

3.2.2. Evaluation of cereal wild relatives as possible sources for BYDV resistance

A total of 280 accessions of _Aegilops_ spp., _Triticum dicoccoides_ and _T. boeoticum_ were tested for their reaction to a PAV isolate of BYDV using artificial inoculation. In this preliminary evaluation (Table 47), 46 accessions were found tolerant to BYDV. These lines will be retested.

Table 47. Reaction of Aegilops and Triticum species to infection with BYDV after artificial inoculation during 1989/90.

Plant species	Total number of acessions tested	No. of accessions found resistant
A. peregrina	63	11
ovata	31	5
biuncialis	28	3
searsii	25	4
vavilovii	24	2
speltoides	20	5
kotschyi	19	1
triuncialis	16	2
columnaris	10	1
triaristata	8	2
crassa	5	1
bicornis	3	0
umbellulata	2	1
longissima	2	1
caudata	2	1
squarrosa	1	0
T. dicoccoides	17	5
boeoticum	4	1
Total	**280**	**46**

3.2.3. Production of BYDV antiserum

A PAV isolate of BYDV was purified from infected barley. This preparation was used to produce a polyclonal antiserum in rabbits. The antiserum produced was of good quality when evaluated by ELISA, where a high specific reaction was obtained compared to a low reaction against healthy tissue. The antiserum will be provided to laboratories in the region, free of charge, for survey purposes. ***K. Makkouk and W. Ghoulam***

3.3. Cleaning germplasm in the genebank from seed-borne infection

Seed samples from 769 barley accessions were tested for barley stripe mosaic virus and 80 were found to contain seed-borne infections. Similarly, seed samples from 382 accessions of lentil and 100 of faba bean were tested for the presence of broad bean stain virus, pea seed-borne mosaic virus and bean yellow mosaic virus infection. Of the accessions 81 of lentil and 10 of faba bean were found to contain a seed-borne infection. Accessions identified with seed-borne viruses will be cleaned up when multiplied in the field.

Evaluation for virus infection was carried out during multiplication for 76 lentil accessions, and infected plants were eliminated. By evaluating the seeds harvested from these accessions, 59 of the 76 accessions were free from seed-borne viruses. ***K. Makkouk and W. Radwan***

3.4. Training

Eight scientists spent short term (2-8 weeks) training periods in the virology laboratory, working on different aspects of virus research. A graduate student from the University of Damascus is conducting her Ph.D. thesis research on chickpea viruses.

A two-week intensive course on virology was held during May 1990. Twelve participants from of WANA countries joined the course. Dr. L. Bos of IPO, Wageningen, The Netherlands, assisted in the course lectures and practicals. ***K. Makkouk***

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