GENETIC RESOURCES UNIT

Annual Report for 1993

ICARDA

About ICARDA

Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is governed by an independent Board of Trustees. Based at Aleppo, Syria, it is one of 18 centers supported by the Consultative Group on International Agricultural Research (CGIAR), which is an international group of representatives of donor agencies, eminent agricultural scientists, and institutional administrators from developed and developing countries who guide and support its work.

The CGIAR seeks to enhance and sustain food production and, at the same time, improve socioeconomic conditions of people, through strengthening national research systems in developing countries.

ICARDA's mission is to meet the challenge posed by a harsh, stressful and variable environment in which the productivity of winter rainfed agricultural systems must be increased to higher sustainable levels; in which soil degradation must be arrested and possibly reversed, and in which the quality of the environment needs to be assured. ICARDA meets this challenge through research, training and dissemination of information in a mature partnership with the national agricultural research and development systems.

The Center has a world responsibility for the improvement of barley, lentil, and faba bean, and a regional responsibility in West Asia and North Africa for the improvement of wheat, chickpea, forage and pasture—with emphasis on rangeland improvement and small ruminant management and nutrition—and of the farming systems associated with these crops.

Much of ICARDA's research is carried out on a 948-hectare farm at its headquarters at Tel Hadya, about 35 km southwest of Aleppo. ICARDA also manages other sites where it tests material under a variety of agroecological conditions in Syria and Lebanon. However, the full scope of ICARDA's activities can be appreciated only when account is taken of the cooperative research carried out with many countries in West Asia and North Africa.

The results of research are transferred through ICARDA's cooperation with national and regional research institutions, with universities and ministries of agriculture, and through the technical assistance and training that the Center provides. A range of training programs is offered extending from residential courses for groups to advanced research opportunities for individuals. These efforts are supported by seminars, publications, and specialized information services.

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

This report was written and compiled by program scientists and represents a working document of ICARDA. Its primary objective is to communicate the season's research results quickly to fellow scientists, particularly those within West Asia and North Africa, with whom ICARDA has close collaboration. Thus, the report was not prepared in accordance with the established format guidelines, nor was it edited by Communications, Documentation and Information Services staff.

CONTENTS

1. GENETIC RESOURCES ACTIVITIES

1.1 Introduction and highlights

In the 1992/93 season (from October 1, 1992 to September 30, 1993) the Genetic Resources Unit at ICARDA continued the ongoing activities in genetic resources collection, acquisition, characterization and preliminary evaluation, documentation, conservation, and distribution to users. Research was focused on study of genetic diversity in natural populations of crop wild relatives and in germplasm collections held in the ICARDA gene bank.

The following are highlights for 1992/93:

<u>Germplasm collection, exploration and acquisition (Table 1)</u>

1) A total of 490 new population samples of wheat and barley and their wild relatives were collected in collaboration with national programs in Iran, Iraq, Lebanon, Pakistan, and Syria;
2) Seventy-three new accessions of food legumes and their wild relatives were collected as a result of joint collecting efforts of ICARDA and national programs in Morocco, Pakistan, and Syria;
3) An ecogeographical survey of <u>Vicia</u> and <u>Lathyrus</u> in Morocco, conducted jointly with INRA, Morocco and CLIMA, Australia, yielded 362 and 115 new population samples, respectively. New data on geographical distribution of species and ecological variables associated with the biodiversity were also obtained;
4) Factors affecting survival of natural populations of wild progenitors of wheat and barley were investigated in a monitoring trip to southern Syria;
5) ICARDA germplasm holdings were increased by 1200 accessions received from other gene banks and institutions.

Table 1. Germplasm introduction at ICARDA in 1992/93

Crop	Collected by GRU	From other institutions	New acquisitions (total)
Barley	72	368	440
Wild barley	40	11	51
Durum wheat	8	113	121
Bread wheat	117	189	306
Wild wheat	253	322	575
Cereals	490	1003	1493
Chickpea	5	1	6
Wild *Cicer*	5	-	5
Lentil	36	-	36
Wild *Lens*	15	-	15
Faba bean	12	16	28
Food legumes	73	17	90
Medicago	-	110	110
Vicia	348	-	348
Lathyrus	107	62	169
Others	17	-	17
Forage legumes	472	172	644
Grand total	**1035**	**1192**	**2227**

Germplasm multiplication, characterization and evaluation (Table 2)

1) More than 8000 accessions were multiplied in the field or in the plastic house;
2) A total of 6566 accessions were characterized and/or evaluated for a number of descriptors;

Genetic diversity studies and research related to in-situ conservation

1) Diversity between wild *Triticum* populations from Jordan and Syria was studied by means of multivariate statistical analysis based on six descriptors with more than 1200 single

plant progenies derived from 31 natural populations;

2) Geographical patterns of diversity and within-population genetic diversity was determined for wild Lens using both morphological descriptors and isozymes;

3) An experiment based on self-reproducing populations of wild progenitors and relatives of wheat, barley, lentil, and forage legumes was established in two different environments for an initial period of three years to study factors affecting in-situ conservation;

Table 2. Germplasm multiplication, characterization and evaluation in 1992/1993

	Multiplied	Characterized and/or evaluated	
Crop	**(accessions)**	**(accessions)**	**(traits)**
Barley	1194	1129	13
Wild barley	-	24	14
Durum wheat	1916	40	7
Bread wheat	24	221	7
Wild wheat	532	231	7-14
Other wheat	226	112	7
Cereals	3892	1757	-
Chickpea	15	267	20
Wild Cicer	156	-	-
Lentil	1050	414	20
Wild Lens	138	368	41
Faba bean	1504	-	-
Food legumes	2863	1049	-
Medicago	221	1787	11
Vicia	616	-	-
Lathyrus	417	1032	29
Trifolium	38	-	-
Others	321	941	6
Forage legumes	1613	3760	-
Grand total	**8368**	**6566**	**-**

Taxonomical studies

1) A monograph on the taxonomy of the genus *Aegilops* L. was finalized and prepared for publication.

Germplasm documentation, conservation and utilization

1) A seed stock control system was developed and implemented to increase the efficiency of the management of germplasm collections;
2) New mapping software was introduced to facilitate interpretation and presentation of geographical data;
3) Initial viability was determined for 9000 germplasm accessions;
4) An additional 12500 accessions were included in the base collections and the total number of accessions in the base collections reached 56000.
5) A total of 9000 accessions of food legumes were prepared for safety duplication;
6) The total number of germplasm accessions held in the ICARDA active collections reached 103750 by December, 1993 (see Table 3).

Table 3. Status of ICARDA collections by origin (December, 1993)

	Cereals	Food Legumes	Forage Legumes	Total
WANA	27999	12955	16340	57294
ICARDA lines	5739	3012	-	8751
WANA Total	33738	15967	16340	66045
Europe	8467	3709	4048	16224
Asia	4948	3148	346	8442
Africa	214	181	52	447
America	3869	1803	731	6403
Oceania	133	46	196	375
Unknown	1669	1336	2809	5814
TOTAL	**53038**	**26190**	**24322**	**103750**

7) Nearly 19000 seed samples were distributed from the ICARDA gene bank and more than 11000 of these were dispatched to users in West Asia and North Africa (Table 4).

Table 4. Distribution of ICARDA germplasm to users in 1992/1993

	Cereals	**Food legumes**	**Forage legumes**	**Total**	
User	**No.**	**No.**	**No.**	**No.**	**%[a]**
WANA	806	2134	1214	4154	22.2
ICARDA	3196	1340	2727	7263	38.8
Total WANA	4002	3474	3914	11417	61.0
Other	4217	2264	829	7310	39.0
Total	**8219**	**5738**	**4770**	**18727[b]**	
(%)	**43.9**	**30.6**	**25.5**	**100**	**100.0**

a: Percent of the grand total.
b: Grand total.

Training and international cooperation

1) A short-term group training course in germplasm documentation was conducted jointly with IBPGR and Morocco for ten participants from North African countries;
2) Individual training in genetic resources activities was provided to ten participants from national programs of West Asia and North Africa.
3) A network for collaboration in plant genetic resources in West Asia and North Africa (WANANET), which is supported jointly by ICARDA, IPGRI and FAO, became fully operational in 1993 and most of its working groups have held workshops;
4) A Letter of Agreement for collaboration in genetic resources between the Vavilov Institute of Plant Industry, St. Petersburg, Russia and ICARDA was signed in July, 1993.

This Annual Report presents the activities as a unit, irrespective of the diverse funding of several staff members and their projects. In order to facilitate the donors of these special projects to take notice of the achievements during 1993, the respective projects and their sections are listed below:

- "Enhancing wheat productivity in stress environments utilizing wild progenitors and primitive forms", funded by Italy, principal scientist Dr A.B. Damania, is reported in Sections 1.2.3., 1.2.4., 1.3.1., 1.4.1., 1.4.2., and 1.4.3.

- "Collection and characterization of germplasm of wild relatives of wheat", funded by the Netherlands, principal scientist Dr M. van Slageren, is reported in Sections 1.2.1., 1.2.2., 1.2.5., 1.3.2., 1.3.3., 1.4.3., and 1.4.5.

- "Measurement of biodiversity within the genus Lens", funded by ODA, U.K., Dr L.D. Robertson and Ms M. Ferguson, is reported in Section 1.4.6.

Two laboratories are associated with the GRU: i) the Seed Health Laboratory and ii) the Virology Laboratory. Their activities are presented separately in Sections 2 and 3 of this Annual Report, respectively.

J. Valkoun and GRU staff

1.2. New germplasm collected or introduced in 1992/93

1.2.1. Collection of wild wheat relatives in Iraq

From 14-17 June, 1993, a collection mission was held in northern Iraq, the first one in this country in many years. The regions visited were the Jebl Sinjar, west of Mosul, the hills southeast and northeast of this city, and the Jebl Makhuf, near Ash Sharqat, around 100 km south of Mosul. In all, 41 accessions and 9 herbarium samples were collected (Table 5).

Table 5. New accessions of Aegilops, Triticum and Hordeum resulting from 1993 collection missions

Species	Iran(1)[a,b]	Iran(2)[b]	Iraq	Lebanon	Total[c]
Aegilops					
biuncialis	3	-	6	12	21
caudata	-	-	-	4	4
columnaris	6	-	1/1	10/1	17
crassa	8	9	5	-	22
cylindrica	23	18	-	-/1	41
juvenalis	-	-	2	-	2
neglecta	-	-	1	-	1
ovata	-	-	-	10	10
peregrina		-			
peregrina	-	-	1	5	6
searsii	-	-	-	2	2
speltoides					
ligustica	-	-	3	-	3
speltoides	-	-	6/1	-	6
tauschii	10	-	-	-	10
triuncialis					
persica	-	-	1	-	1
triuncialis	16	9	7/1	8	40
umbellulata	2	1	1	-	4
vavilovii	-	-	-	2	2
Total					**192**
Triticum[d]					
(cultivated)					
aestivum					
aestivum	20	72	-	2	94
compactum	5	-	-	-	5

Table 5. (continued)

Species	**Iran(1)[a,b]**	**Iran(2)[b]**	**Iraq**	**Lebanon**	**Total[c]**
turgidum					
dicoccon	1/1	-	-	-	1
durum	3	1	-	2	6
turgidum	-	1	-	-	1
(wild)					
monococcum					
boeoticum	3/2	-	1/1	2	6
turgidum					
dicoccoides	-	-	-/1	12/3	12
urartu	1	-	-/1	7/3	8
Total					**133**
Hordeum[d]					
(cultivated)					
vulgare	7	41	-	-	48
(wild)					
bulbosum	-	1	2	-	3
vulgare					
spontaneum	6	2	5	18	31
Total					**82**

a : For all countries: left number = germplasm; right number = herbarium sample; single numbers refer to germplasm only.
a : Iran(1)=Section 1.2.5. and Iran(2)=Section 1.2.4.
c : Numbers refer only to germplasm accessions.
d : Local cultivars and landraces.

Hordeum spontaneum was abundant and, though not a target of the mission, serve to complement the ICARDA collection of these wild relatives for which Iraq is severly underrepresented.

For wild Triticum, the Jebl Sinjar was most interesting. T. dicoccoides was found growing on limestone bedrock along slopes and in the degraded, open oak park-forest that is a common habitat for Aegilops species. The limestone parent rock differs distinctly from the basalt on which this species is commonly found in southern Syria. On the top of the Jebl Sinjar, at around 1460 m, a mixed growth of no less than three wild Triticum (boeoticum, dicoccoides and urartu) was found. However, all were still green and only herbarium samples could be taken. The fourth wild species, T. timopheevii ssp. araraticum, is also reported from northern Iraq, but was not found in the Sinjar area. In Iraq, the main distribution of this species is in the northern and northeastern regions, although one herbarium collection from Sinjar is known. Mr. Shukur Al-Kaisi, from the ARI in Abu Ghraib, revisited this area in mid-July and collected some mature spikes of the wild Triticum species.

Although various herbarium collections of the D-genome species Aegilops tauschii are known from the Sinjar area, none was found.
Michiel van Slageren and Shukur Al-Kaisi (ARI)

1.2.2. Exploration mission for wild relatives of wheat and barley in Lebanon

This trip was conducted as a collaborative activity between the Agricultural Research Institute (ARI), Lebanon, and ICARDA from June 21 to June 24, 1993, with the following objectives:

1. Collect new germplasm of wild Triticum, Aegilops and Hordeum spontaneum to fill the gaps in ICARDA germplasm collections.
2. Provide sources of new disease resistance genes for cereal breeding programs at ICARDA and ARI Lebanon and NARSs in general.

The target areas centered around Rachaya in the southeast and the Beka'a valley in the east and northeast of the country. For Aegilops this mission complemented the 1992 expedition, which had focused on the western parts of the country and which had not revealed any wild Triticum species.

The present mission yielded a great number of germplasm samples as well as some herbarium collections (see Table 5) and provided useful sites to be earmarked for in-situ conservation of wild Triticum and Hordeum species (e.g., Aiha, near Kfar Kouk, and near Yanta, a site of joint occurrence of T. boeoticum, dicoccoides and urartu). Another suitable site for in-situ conservation of Triticum dicoccoides was discovered in the vicinity of Aita Al Foukhar, where a large population seemed to be structured into a number of morphologically different sub-populations. These, as well as other T. dicoccoides populations in the Yanta area, displayed great diversity in spike color and development. For the first time the species was found in the eastern slopes of the Lebanon mountains at 1470 m asl, as well as in the western Beka'a at Cede. Only herbarium samples were taken from the former population, since plants were still green and seeds were not sufficiently developed.

Interesting mixed stands of the wild diploid wheats T. boeoticum and T. urartu were found. This is the first recorded occurrence of boeoticum in Lebanon. New sites for T. urartu were found high in the Lebanon mountains (1810 m asl) and southeast of Ba'albek. In the latter site, the wild wheat population dominated over cultivated barley and it was the only real weedy population of the species found by the collectors in Syria and Lebanon. It is recommended to recollect the late-maturing populations in the high sites near Yanta and in the Lebanon mountains.

Hordeum spontaneum was found and collected in most sites. The species displays a wide adaptation, since its populations were growing in very different environments. An unusual population with a high proportion of black-spike forms was sampled at a west Beka'a site. The best site for in-situ conservation of the species was discovered in the vicinity of Kfar Mechki, Rachaya district.

Nine of the reported 14 species of Aegilops were found in the restricted target area, with Ae. biuncialis, Ae. columnaris and Ae. ovata the most common (Table 5). The most frequently collected species were Hordeum spontaneum (18) and T. dicoccoides (12), providing a useful source of genetic variation to be used in future crosses with cultivars and filling one of the major gaps in wild cereal collections at ICARDA.

For cultivated wheat, two mixtures, consisting of three durum types, Beka'y, Haurani and Senatore Capelli, and one bread wheat, Salamouni, were collected, as well as some admixtures of two-rowed barley with smooth and rough awns and white and grey grains in a field of Rihane. Most wheat fields inspected were of bread wheat, with usually some durum mixed in. A breakdown of the germplasm and herbarium collections is presented in Table 5. Two natural hybrids between Aegilops and Triticum were found among their parents: Ae. biuncialis x T. dicoccoides and Ae. biuncialis x T. aestivum. These combinations have not been described as species of the hybrid genus x Aegilotriticum.

Michiel van Slageren, Jan Valkoun and S. Kharaila (ARI, Tel Amara)

1.2.3. Exploration and survey trip for wild Triticum species and Hordeum spontaneum in Syria

This trip was conducted as a collaborative activity between ARC Douma, Syria and ICARDA May 25-26, 1993, with the following objectives:

- Obtain additional information on the distribution of wild wheat and barley populations in the southern provinces of Syria;
- Identify populations of Triticum urartu, T. boeoticum and T. dicoccoides for conservation in their original habitat;
- Obtain information on the target species and their habitat at mid-vegetation and/or plant maturity;

A total of 14 sites were visited (see Table 6) and the following activities were carried out at the sites:

New sites
- germplasm collection;
- gathering information from farmers on agricultural practices at the collection site;
- soil sampling;

Revisited sites (identified from the results of the 1992 collection trip)

- general characterization of wild wheat populations (phenology, plant vigor - estimated from plant height);
- data collection on the population size, number of spikes/area and number of spikelets per spike for the estimation of reproductive potential;
- gathering information from farmers on farming practices at the site;
- soil sampling;

Table 6. Site description for survey in Syria during 1993

No.	Site	Province	Type[a]	Target species[b]
1	Shaqra	Dara'a	N	TU, TD, HS
2	Aldor	Dara'a	N	TD, HS
3	Mazra'a	Dara'a	N	TD, HS, TDUR
4	Salkhad	Sweida	R (2)	TD
5	Rashida	Sweida	R (3)	TU, TD, HS, AS, AV
6	Sha'af	Sweida	R (5)	TU, TD, HS
7	Om Dubieb	Sweida	R (7)	TD, HS
8	Jbab	Dara'a	N	TD
9	Sheikh Miskin	Dara'a	N	TD, HS
10	Nawa	Dara'a	N	TD
11	Numer	Dara'a	N	TD, HS
12	Kafr Nasij	Dara'a	N	TD, HS
13	Wadi Al Kern	Damascus	R (19)	TU, TB, TD, ASS
14	Sarghaya	Damascus	R (20)	TD, HS, AO

a : N = new site; R = revisited site (1992 col. number).
b : TB = Triticum boeoticum; TU = T. urartu; TD = T. dicoccoides; TDUR = T. durum; HS = Hordeum spontaneum; AS = Aegilops searsii; AO = Ae. ovata; ASS = Aegilops spp.

Among the most significant results of the exploration mission was the discovery of T. urartu growing jointly with T. dicoccoides and H. spontaneum in the middle of the Hauran plain (site 1). This finding is extremely important because it is a link between the urartu populations in the Mount Hermon highlands and the Jebel Al Arab; two areas where the species still grows in massive native stands. This may also indicate that the Hauran plain used to be the natural habitat of the two wheat ancestors and the wild progenitor of barley before the area was cultivated and intensively grazed by sheep.

Populations sampled from sites No. 1, 2, 3, 8, 9, and 12 should be well adapted to drought because the annual rainfall in those sites is below 300 mm. The driest site, No. 8, receives only 230 mm. Therefore, the germplasm collected may have potential for drought tolerance breeding in wheat.

In the highlands of the Jebel Al Arab, Sweida Province, the populations of the wild progenitors of cereals are relatively well protected during the vegetative period, if they are growing on patches of stony, non-arable land interspersed among the farmers' fields. They are usually not grazed before the harvest of durum wheat and the seed bank can be regularly enriched with shattering spikelets. However, when the land is not private and the bedouins' flocks of sheep graze continuously throughout the vegetation period, the final effect is disastrous. Only unpalatable, mostly spiny plants are left and not a single plant of wild Triticum can be seen in the overgrazed land. The effect of overgrazing is most visible in the vicinity of dense stands of wild wheats where grazing is controlled by the farmers.

In the lowlands of the Hauran, Dara'a Province, all land is cultivated and overgrazing by sheep is ubiquitous. Wild Triticum populations can develop only on borders of fields or heaps of stones collected from the fields, especially if these are farther from a village.

The two sites visited in the province of Damascus were in the early phase of vegetation and wild Triticum was at the shooting stage. These populations, therefore, could not be evaluated. However, it was noted that the year was favorable for Aegilops spp., which dominated over other plant genera, including Triticum. Site No. 15, where the only sympatric population of three wild wheat species, T. dicoccoides, T. boeoticum and T. urartu, was found in southern Syria, may be lost soon, since the farmer intends to change the two-year fallow area to an apple plantation.

Finally, it is important to note that the farming systems in both new and revisited sites were still mostly based on traditional agricultural practices: (i) use of landraces of durum wheat, chickpea, and lentil; (ii) fallow is widespread but gradually being replaced with forage legumes; (iii) manure is the most common fertilizer, inorganic fertilizers are not used or used in low doses.

Restricted grazing by sheep, in the areas where cattle is more important then small ruminants (Jebel Al Arab), has a positive effect on the development of wild populations.

Results of the exploration trip can be summarized as follows:

1. Eight new sites for T. dicoccoides, one site for T. urartu and six sites for H. spontaneum provided new information on the distribution of these species in southern Syria;
2. Suitable conditions for in-situ conservation of the wild wheats, T. dicoccoides and T. urartu, and wild barley, H. spontaneum, exist in the eastern part of the province of Sweida at site No. 6. Additionally, for T. dicoccoides and H. spontaneum, suitable conditions exist at sites No. 4 and 7;
3. Of the new sites, No. 12 in the province of Dara'a should be considered for conservation of T. dicoccoides and H. spontaneum, since the populations differ from those in Sweida Province. However, sheep grazing would have to be controlled;
4. The search for suitable in-situ conservation sites of wild cereals progenitors in the Zabadani region of the province of Damascus should continue since none of the two revisited sites seems to be eligible.

J. Valkoun, A. Damania, M. Hamran and Kh. Obari and Y. Waghdani (ARC-Douma)

1.2.4. Collection of cultivated and primitive forms of cereals in Iran

A joint collection mission of ICARDA and the Genetic Resources Unit of the Seed and Plant Improvement Institute (SPII) based at Karaj, Ministry of Agriculture, Iran, was organized in June, 1993. Most of the fields of cultivated wheat and barley had been irrigated with ground water, springs or melting snow for centuries, resulting in salinization of the soil. The Soil Laboratory at ICARDA carried out analysis of random samples. Typical results for a soil sample taken from a wheat field near Isfahan showed an EC of 6.7 mmhos/cm and a sodium absorption ratio of 4.5. In certain irrigated fields leaf (Puccinia recondita and P. hordei), yellow (Pucinnia striiformis), and stem (Pucinnia graminis f.sp. tritici) rusts were observed. Several fields, especially between Isfahan and Golpayegon, were infested to varying degrees with Secale montanum (wild rye) and Avena spp. (wild oat).

All collected wheats ("Gandom" in Farsi) were hexaploid bread wheats, Triticum aestivum (Table 5). Durum wheat (T. durum) cultivation was not observed in the areas visited by the team. Only two samples of tetraploid wheats were collected. These were a variety of T. durum named "Chel Nim Gazy", which in English translates as "40 seeds, when planted, give 1.5 square meter of crop" and a sample from CIMMYT of T. turgidum, both of which were donated by the Director of the Zarghan Agriculture Research Station, 30 km from Shiraz.

In several cases farmers planted a mixture of two or three types of bread wheats and barleys in their fields. In some fields, plants of previously cultivated landraces came up as volunteers. Hence, in almost all fields two to four distinct morphotypes could be observed. It is suspected that they are distinct varieties or landraces mixed with a variety.

Most of the barleys, Hordeum vulgare, were of the 6-row type. A few samples of 2-row barley were collected from the edges or remote corners of the field, and there was ample evidence that these were relics of past cultivation. No naked or hooded barleys were found, although a hooded barley from an exotic source was collected from the experimental field at SPII, Karaj.

Samples of Aegilops spp., the wild relative of wheat, could be collected where they were physiologically mature but still not dry enough to shatter (Table 5). No samples of wild Triticum spp. were seen by the team along the route taken in central Iran. Two samples of Hordeum spontaneum, the wild progenitor of cultivated barley, and a sample of Hordeum bulbosum were also collected. Six species of Aegilops were collected from various ecologically different habitats. Some of the Aegilops species with the D genome in their genetic composition produced natural hybrids with cultivated bread wheat and these were observed growing at the borders of fields. Natural hybrids between Triticum aestivum x Aegilops cylindrica and T. aestivum x Ae. ventricosa (crassa) were also observed and collected. Some of the hybrids showed susceptibility to rusts. Additionally, ten accessions of legumes were collected.

A.B. Damania and M. Nikpour and N. Khaghani, (SPII, Karaj) and A. Soltani (Agriculture Research Station, Yazd)

1.2.5. Collection of wild wheat relatives in Iran

From 8-23 July, 1993, a germplasm collection mission for wild wheat relatives was conducted in the Islamic Republic of Iran. The mission was organized by the Seed and Plant Improvement Institute (SPII) in Karaj, near Tehran. During parts of the trip various personnel from local stations of SPII and students of Tabriz University joined the collection team.

The trip focused on the northwestern part of the country, as this is reported to be a rich area for wheat wild relatives. Additional target species were cultivated wheats and barley. The route taken was as follows: Karaj-Zanjan-Mianeh-Maragheh-Mahabad-Urumiyeh-Salmas-Khvoy-Maku-Jolfa-Aras river, bordering

Nakhichevan-Tabriz-Ardabil-Astara-Bandar Anzali-Karaj. In addition, three side trips were made: (1) in the vicinity of Urumiyeh, including Oshnoviyeh, Naqadeh, and Hayder Abad; (2) northeast of Tabriz, including Ahar and Horand; and (3) both north and south of Ardabil, including Meshkin Shahr and Khalkhal.

The mission was successful in collecting many bread wheat landraces, local material of durum, compactum wheats, and barleys, as well as one lentil and a vetch. Most sensational was the discovery of a field of Triticum dicoccon, emmer wheat, near Dandy, about 75 km SW Zanjan. This field was located from a herbarium sample description. Emmer was found growing in an almost pure stand (with some bread wheat cultivar mixed in), and as an admixture in a another bread wheat field. Also, mixed cultivation of Triticum aestivum with durum and compactum landraces was found not far from the Aras river at the border between Iran and Nakhichevan. Landraces of durum and bread wheat, and 2-rowed and 6-rowed barley were also collected between Ahar and Horand, as well as lentil and Vicia landraces. In the rich area of Meshkin Shahr, northwest of Ardabil, a field with an estimated 95% Triticum compactum and some aestivum was found next to a field of 50-50% durum and bread wheat landraces.

Although herbarium and germplasm collections indicated the presence of all four wild taxa of Triticum, their rarity was surprising. The Azerbaijan region of northwestern Iran was chosen as a target area, as it holds the most records for these materials. Triticum turgidum ssp. dicoccoides is extremely rare and was not found, nor the more common T. timopheevii ssp. araraticum, which is limited to Transcaucasia, eastern Turkey, northern Iraq and northwestern Iran. Of the other taxa, T. monococcum ssp. boeoticum was found only three times, near lake Urumiyeh and near Ahar, northwest of Ardabil, in the borders of wheat fields, and between Ardabil and Khalkhal on a roadside. At the last location the first and only population of Triticum urartu was found, with T. monococcum ssp. boeoticum growing on the other side of the road. The very limited presence of wild Triticum taxa in what is known as a part of their center of diversity is worrisome, as it is well established that they may provide useful traits for wheat improvement.

Only seven species of Aegilops were found out of a total of 12 reported for Iran. Of these seven, two were dominant (Ae. cylindrica and triuncialis) and found at almost all sites, while all others were rare. The mission was thus, somewhat disappointing for these more distant wild relatives of wheat, although, for example, four Aegilops species were collected on the shores of lake Urumiyeh at a very saline location with parts of the sand covered by salt spray. These accessions may, therefore, reveal a good tolerance to salt, which is an important trait for breeders. Another interesting find was an Ae. crassa x Triticum aestivum natural hybrid.

Grazing pressure, although not observed as severe, inaccessibility of the terrain (that is, a lack of minor roads), and sheer limitation of time may be the cause of the disappointing results. However, the landrace materials of the various wheats and barleys, as well as the wild barley, the one lentil and one vetch landraces, compensated for the lack of results for the wild relatives of wheat. Repeated presence of the primitive cultivar groups of wheat illustrates the richness in genetic resources of Iran for these crops. Although emmer and club wheat were found in remote areas, it is likely that more fields may be discovered in the future.

While visiting the herbarium of the faculty of Agriculture of Tabriz University, some Aegilop species were (re-)identified and species characters explained to personnel from the university. After the mission, all 180 Aegilops accessions in the gene bank at Karaj were re-identified, a most useful exercise as many were wrongly named.

Michiel van Slageren, and Mousa Nikpour and Noreddine Lessani (SPII)

1.2.6. Collection of wild relatives of food legumes in Syria

A joint collection mission in Syria with the Agricultural Research Center, Douma was conducted in May, 1993, along the coastal area in the provinces of Lattakia, Tartous and Idleb. This six day collection mission visited 17 sites with an altitude range from 10-1050 m asl. A total of 20 accessions were collected of Lens (12 accessions of L. ervoides, 2 accessions of L. orientalis and 1 accession of L. odemensis) and Cicer (5 accessions of C. judaicum). To access the intra-population variability of the wild Lens species, 15-30 plants of each population were sampled individually for assessment of intra-population diversity.

Y. Wajhani (ARC-Douma) and A. Ismail

1.2.7. Collection of pasture, forage and food legumes in Baluchistan, Pakistan

This collection mission was jointly organized and undertaken by PGRI/NARC/PARC and ICARDA from May 13 through May 24, 1993. The objectives of the mission were to : (1) collect local landraces of lentil and faba bean in Baluchistan, especially from rainfed crops, (2) collect natural populations of pasture and forage legumes in Baluchistan; and (3) added after the start of the mission, to collect landraces of barley and wheat from farmers growing food legumes. The last objective was added since it was recognized early in the mission that collecting landraces in Baluchistan required more time per farmer and that all farmers were growing cereals and food legumes in the same year. So, collections could be made of the diverse cereal landraces at no extra cost in time or resources.

The collection mission covered approximately 1800-1900 km (including backtravels). Travel was difficult for most areas and most of the mission was on tracks and many sites had to be walked to from the tracks. The altitude of the collection sites ranged from 200 to 2130 m asl. However, most sites were over 1000 m and many were over 1200 m asl. A total of 42 sites were sampled. The mission followed the following general itinerary: Quetta-Nushki-Kharan-Nag-Panjgur-Khuzdar-Kalat-Quetta-Sibi-Quetta-Tomagh-Lorali-Muslimbagh-Quetta. Also, several sites around Quetta were collected, including the national park and Quetta golf course.

Mostly landraces of food legumes and cereals were collected (Table 7). Only 22 ecotypes of pasture and forages were collected, mostly Vicia, Trigonella and Melilotus. Also, three accessions of Aegilops squarrosa were collected. The landraces of food legumes and cereals were diverse and half kilo samples

Table 7. Germplasm collected in Baluchistan, Pakistan in 1993

Crop/Genera	Number of samples
Lentil	32
Faba bean	11
Barley	23
Wheat	11
Total landraces	**77**
Vicia	5
Trigonella	5
Melilotus	5
Astragalus	3
Trifolium	1
Pisum	3
Total forages	**22**
Vigna	1
Sorghum helenpense	1
Aegilops squarrosa	3
Unknown	1
Total others	**6**
Grand total	**105**

were taken to adequately sample the diversity present. Most landraces were taken from the crop in the field, either standing or shocked, or from the threshing floor. Most of the pastures and forages were collected from orchards and a few roadsides protected from grazing. The timing of the mission was excellent to sample the farmers' fields.

The following was noted about the samples and the environment: (1) most of the lentil and faba bean landraces collected were with a black seed coat. A significant number of lentil samples were also with an almost grey seed coat color; (2) all local names for the samples were variations in names for the crop, and did not refer to a specific variety of the crop, with the exception of red and white-yellow seed color wheats in some areas; (3) red colored lentil or cream, brown colored faba bean were always referred to as 'Irani'. These were grown locally, but were obviously of Iranian origin; (4) the majority of the landraces of food legumes were grown under irrigation and most of the others were grown with some type of water harvesting techniques; and (5) wheat and barley were grown under irrigation (or water catchments) and dryland.

The flora of Pakistan listed many areas covered by the mission where pasture and forage legumes were found in the 1930s and 40s, however, these were not found during this mission. In fact, many protected areas such as fenced areas and orchards were searched, with little or nothing found. We could see the extremely high stocking rates when collecting, and most rangeland had little left but spiny type shrubs. This also occurred in areas of 300-400 mm rainfall, which should support many pasture and forage legume species.

One area where pasture and forage species should be collected is the area north of Quetta up through Urak, Bostan, Hanna lake and possibly Pishin. Part of this area was collected, but many samples could not be taken because they were too immature. Another area where forages were found was south of Quetta around the Lakpass (south of the pass). These areas should be more extensively covered in the future. Also, Loralai should be explored, as the time to examine this area in this mission was restricted. This area has a higher rainfall area with many forage and pasture species reported in the past.

In general, in the lower to medium rainfall areas the potential to find pasture and forage legume species is minimal because of losses due to overgrazing. Even in the national park established close to Quetta approximately 15 years ago, there were no pasture or forage legumes found. It seems they were lost before the area was protected as a national park.

M. Sadiq Bhatti and M. Arif (PGRI/PARC), and Larry D. Robertson

1.2.8. Biodiversity of Vicieae in Morocco related to distribution and ecology

Morocco offers a wide range of soil types, winter temperatures and rainfall, and is a center of origin of Vicia and Lathyrus. The reported genetic diversity of Vicieae in Morocco, together with the wide environmental range, makes Morocco an ideal country, not only to increase the genetic resource base, but also to study the range of adaptation of the species. This information would aid in identifying potential sites for in-situ conservation of the Vicieae.

An ecogeographical survey of the distribution of Vicia and Lathyrus in both the high-altitude cold regions and the coastal low-altitude area of northern Morocco was conducted in 1993. This survey was used to relate the natural distribution of Vicia and Lathyrus species to some ecologically important soil and climatic factors. The collections covered a total travel distance of 5000 km. The altitude varied from sea level to 2400 m asl and the rainfall from 250 to 1200 mm (25 years average). A total of 174 sites were sampled in four geographical areas (Figure 1):

1. Middle Atlas (Provinces of Khémisset, Khénifra, Ifrane, Fès, Béni-Mellal, Azilal and Marrakech): 61 sites;
2. High Atlas (Province of Marrakech): 9 sites;
3. Low-altitude and coastal area (Provinces of Kénitra,

Larache, Tanger and Tétouan): 46 sites.;

4. Rif Mountains (Provinces of Chefchaouen, Al Hoceïma, Taza and Sidi Kacem): 58 sites.

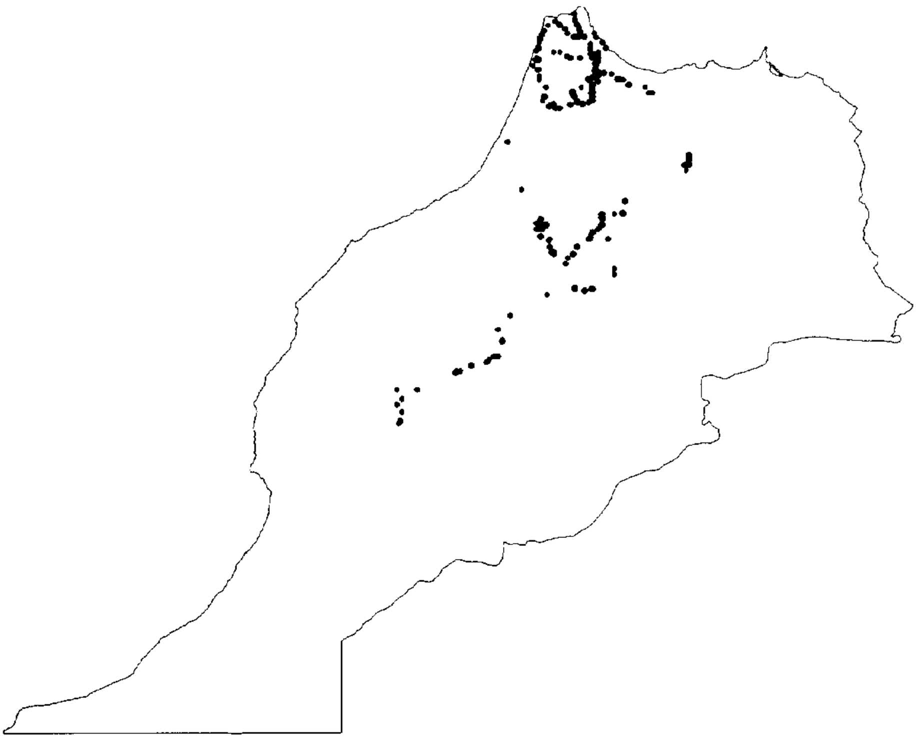

Figure 1. Distribution of collection sites for <u>Vicieae</u> in Morocco for 1993

As far as possible, date were collected on parent rock, soil type and pH, slope, drainage, crop practices, and relative abundance of the species. Altitude was estimated by a hand altimeter and rainfall from locally available data.

A preliminary survey was conducted in March to locate key collection sites and seed collection was undertaken in June-July, 1993. Classical procedures suggest a transect type of approach with frequent short stops. However, so few were the reasonable collection sites that this method was not appropriate. To maximize the number of ecotypes collected under these conditions, we thoroughly sampled the scattered populations of remaining diversity.

More than 450 accessions were collected in this preliminary study of the distribution of Vicia and Lathyrus species in Morocco. This represents the most comprehensive collection of Vicieae from the North African region.

Twenty species of Vicia have previously been described from Morocco. In this mission, only 11 were positively identified. Drought conditions may have reduced the diversity available, while a more detailed study of the vegetative parts may well increase the number. It is apparent, nevertheless, that species such as Vicia narbonensis, V. serratifolia, V. cedrotorum, V. vicioides, V. durandii, and V. glauca are at least rare in Morocco. With the increasingly intense gazing and cropping pressure in Morocco, some of these species may well be victims of genetic erosion. A summary of the species collected is presented in Table 8.

Table 8. Summary of Vicieae species collected in Morocco during 1993

Taxa	No. of samples	Taxa	No. of samples
Vicia villosa ssp. dasycarpa	21	Vicia tetrasperma	2
ervilia	8	tenuifolia	1
hybrida	5	faba	2
lutea	31	spp.	6
monantha		**Total Vicia**	**362**
ssp. monantha	20		
ssp. cinerea	7	Lathyrus aphaca	7
onobrychiodes	5	articulatus	63
pannonica	2	cicera	17
peregrina	2	ochrus	5
sativa		sativus	9
ssp. amphicarpa	1	tingitanus	9
ssp. angustifolia	2	spp.	5
ssp. cordata	5	**Total Lathyrus**	**115**
ssp. hyemalis	1		
ssp. macrocarpa	4		
ssp. nigra	88		
ssp. sativa	149		

The large collection enabled some important ecogeographical observations to be made.

The size and complexity of the Vicia sativa gene pool

While other Vicia and Lathyrus species were dominant in localized environments, the Vicia sativa complex was widely adapted and found in more than 80% of the sites visited. It was apparent from examination of the seeds and pods that the gene pool was considerable and active and that there has been much introgression, especially between V. sativa ssp. sativa and V. sativa ssp. nigra. Seed and pod color and calyx length, for example, represent a continuum between these two.

Although V. sativa as a species is not generally adapted to cold environments or to acid soils, a significant number of ecotypes (1 to 14%) were found in such locations. It appears that the situation may be analogous to that found in Medicago truncatula (Bounejmate 1992). In the latter, the massive gene pool of the medic appears to have facilitated the selection of a small, but significant, number of ecotypes with adaptation well outside the normal range of the species.

The competiveness of Vicia villosa ssp. dasycarpa and Lathyrus articulatus as weeds in crops

A striking feature was the 'success' of some of the Vicieae in competition with cereals. In crops in the Rif mountains and valleys, Lathyrus articulatus was a dominant 'weed' and on occasions had overgrown the cereal crop. In the colder (and higher) Middle and High Atlas, Vicia villosa ssp. dasycarpa was a dominant crop contaminant.

The reasons for their relative success as crop weeds deserve further study, as the two species are quite different. L. articulatus has long sprawling vines and can grow taller than the cereal crop canopy. It has an entirely different growth form than the much shorter and more determinant V. villosa ssp. dasycarpa. The latter species appears to rely on strongly shattering pods and a high percentage of hard seed. Both species have the ability to produce large quantities of seed in a competitive situation with cereals.

Specific soil and climatic adaptation

The Vicia species generally were far more widespread than the Lathyrus. They occupied both a wider soil range and much colder winter environments.

Some of the species demonstrated specific adaptive characteristics, notably:

(1) Vicia sativa ssp. nigra predominated in the highest (and coldest) regions where it was sympatric with the perennial species V. onobrychioides and V. tenuifolia.

V. villosa ssp. dasycarpa was also common in cold, high altitude environments. It may be that V. villosa ssp. dasycarpa has an obligate cold requirement, as it was rare or absent from the milder winter climate of northern regions of the Rif and surrounding coastal plains.

Lathyrus species showed a strong affinity for lower altitudes. ICARDA's breeding aim of greater cold tolerance in Lathyrus ochrus is unlikely to be realized as a result of accessions obtained this mission. All accessions were from mild winter, near coastal, environments. Only L. cicera occurred in the cold winter environments of the Middle Atlas, where it was occasionally sympatric with V. villosa ssp. dasycarpa.

(2) Acid soils were associated with both granite and basalt parent rock. The coarse-textured granitic soils were dominated by Trifolium species and contained much less Vicieae than the more fertile basaltic soils.

V. villosa ssp. dasycarpa was the most widespread species on the mildly acid (pH 5 to 6.5) soils of the Middle and High Atlas, with 52% of its ecotypes found on such soils. In these situations it was a common cereal crop contaminate. Other Vicia species, viz. lutea and sativa had a much smaller proportion of ecotypes (1 to 14%) associated with the acid soils. Lathyrus species showed a strong affinity for loamy soils of higher pH. More than 80% of the ecotypes were from soils of pH 7.6 or greater. On the mildly acid infertile granitic soils, e.g., west of Chefachaouen, Lathyrus was rare.

(3) V. ervilia was commonly cultivated as a crop in the Rif, reflecting the past tradition of culture under French and Spanish influence. It has not spread naturally outside this cultivated area. This may be due to features of its domestication (upright growth habit, non-shattering pods and soft seed) making it uncompetitive in the wild.

The successful seed set of V. ervilia relative to other Vicieae, in what was a serious drought year, demonstrates it's adaptation to low rainfall environments. As an already domesticated species, there is much to recommend further selection within the species.

Genes for non-shattering

Non-shattering pods are an important feature for the domestication of grain and forage legumes. While shattering pods have an ecological advantage in the wild to ensure spread and survival, there appeared to be a small, but potentially important, residual population of reduced shattering genotypes in Vicia sativa ssp. sativa and nigra and possibly Lathyrus articulatus.

The best expression of the reduced shattering phenotypes was in the dry seasonal finish of the Middle Atlas, where all except isolated plants had shattered. The putative non-shattering genotypes were characterized by oblique splitting of the pod wall. It may be that several genes are involved for expression of this trait. Assessment of the efficacy and inheritance of these 'genes' in relation to those already defined by Abd El Moneim (1993) will be one of the more immediate studies required as a follow-up of the mission.

Mustapha Bounejmate (INRA-Morocco), Clive Francis (CLIMA), and Larry D. Robertson

1.3. Germplasm characterization, evaluation and utilization

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

1.3.1.1. Screening wheat genetic resources for disease resistance

Yellow rust

Yellow rust (Puccinia striiformis f. sp. tritici), is an obligate parasite. Screening was carried out using artificial inoculation (four times between January and April, 1993) in a disease nursery at Tel Hadya. The inoculum included races 6E16 and 16E82, which are two of the most prevalent races of yellow rust in the Middle-East. Observations on severity of infection (%) and reaction type were scored as susceptible, moderately susceptible, moderately resistant, and resistant.

1. Landraces from Yemen: Samples of wheat landraces from Yemen were received at ICARDA and were characterized and multiplied during 1991/92. Subsequently, they were screened in the disease nursery at Tel Hadya for resistance to yellow rust. Out of 54 samples, 44 were susceptible to local races of yellow rust, but the following 10 were moderately susceptible or tolerant: IC 22906, 22915, 22916, 22917, 22940, 22944, 22948, 22949, 22954, and 22955.

2. Varieties:

The yellow rust nursery also included twelve samples of improved varieties received from diverse sources around the world. They are: Kailash and Ajantha, two heat tolerant bread wheat varieties developed and released by the Wheat Research Unit at the Marathwada Agricultural University, Parbhani, India; Asahan, a rare old landrace from Ethiopia received from the Vavilov Institute (VIR), St. Petersburg, Russia, where the only sample known to exist is conserved; seven new varieties of spring wheats from Russia, viz. Saratovskaya 55, Saratovskaya 58, Albidum 28, Ershavskaya 32, Lutessens 503 (bread wheats), and Saratovskaya 57 and Saratovskaya Eotistaya (durum wheats); KS91WGRC11 and

KS91WGRC12, and two leaf rust (Puccinia recondita) resistant hard red winter bread wheat lines received from USDA/ARS Manhattan, Kansas, USA. The latter line derives its resistance from Aegilops squarrosa. The only material out of the above which was moderately resistant to local races of yellow rust was KS91WGRC11.

3. Old Japanese bread wheat varieties:

One hundred and thirty-one old varieties of bread wheat from Japan were characterized and multiplied at Tel Hadya in 1991/92 and evaluated in depth in 1992/93. The results of the screening for yellow rust revealed that three samples (IC 207468, 207475 and 207480) out of the 74 Norin dwarf wheats were moderately susceptible to yellow rust. In addition, IC 207528 (Yukichabo syn. Hokuriku 35) was moderately susceptible, whereas IC 207530 (Myoukou), 207534 (Oku), 207542 (Hayato), 207543 (Mikuni), 207546 (Nichirin), 207551 (Muka), 207556 (Horoshiri syn. Kitami 23), and 207562 (Seto) were moderately resistant, with 207552 (Zenkouji) the most resistant.

Yellow rust, leaf rust, stem rust, and common bunt resistance

1. Durum and bread wheat landraces from Ethiopia

The Ethiopian hexaploid and tetraploid wheats received from the Plant Genetic Resources Center/Ethiopia (PGRC/E) in 1990/91 were screened for four of the most important diseases in WANA, viz. yellow rust (Puccinia striiformis f. sp. tritici), leaf rust (Puccinia recondita), stem rust (Puccinia graminis f.sp. tritici), and common bunt (Tilletia caries and T. foetida) during 1992/93. Some accessions possess resistance to more than one disease (Table 9), viz. ICDW 22966 and 22968 are moderately resistant to leaf and stem rusts. Similarly, ICDW 22971 is resistant to yellow and leaf rusts. The only emmer wheat (T. dicoccon) accession (500344) in the material from Ethiopia is moderately resistant to yellow and leaf rusts as well as common bunt.

Table 9. List of moderately disease resistant accessions of tetraploid (ICDW) and hexaploid (ICBW) wheat from Ethiopia

Yellow rust	Leaf rust	Stem rust	Common bunt
ICDW	ICDW	ICDW	ICDW
22967	22966	22966	22984
22971	22968	22968	*T. dicoccon*
22983	22971		500344
22986	22974		
22992	22975		
22975	ICBW		
ICBW	207342		
207346	207343		
T. dicoccon	*T. dicoccon*		
500344	500344		

2. Selected accessions of emmer wheat

Twenty five accessions of emmer wheat (*T. dicoccon*) donated to ICARDA by the CIMMYT wheat gene bank and selected from a larger collection for drought tolerance in 1991-92 were screened for four diseases with encouraging results (Table 10).

Table 10. List of resistant accessions of emmer wheat (*T. dicoccon*) screened for four diseases at Tel Hadya during 1992/93

Yellow rust	Leaf rust	Stem rust	Common bunt
500362	500345	500345	500367
500372	500346	500346	500368
500375	500349	500351	500371
	500352	500352	500372
	500361		500373
	500362		500374
	500364		500375
	500365		
	500367		
	500364		
	500367		
	500372		
	500375		

Some of the accessions showed resistance to more than one disease and could be exploited for wheat improvement by broadening the genetic base through incorporation of alternate sources of resistance genes. The most promising are two accessions (500372 and 500375) which possess genes for resistance to three diseases, viz. yellow rust, leaf rust, and common bunt. Also, accession 500367 showed high resistance to leaf rust and common bunt.

Table 11. List of resistant accessions of rare species of wheat (Triticum) screened for four diseases at Tel Hadya during 1992/93

Species	Acc.No.	YR[a]	LR	SR	CB
T. monococcum	300104	X	X		
T. monococcum	300105	X	X		X
T. monococcum	300106	X	X	X	X
T. monococcum	300107	X	X	X	
T. monococcum	300109	X	X		
T. monococcum	500236	X	X	X	
T. monococcum	500237		X		X
T. monococcum	500238		X		X
T. monococcum	500239	X			X
T. monococcum	500240	X			X
T. monococcum	500241		X	X	
T. monococcum	500246	X	X		
T. monococcum	500249	X	X		X
T. dicoccon	500164	X	X		
T. dicoccon	500167	X	X		
T. carthlicum	500181				X
T. carthlicum	500187				X
T. carthlicum	500189				X
T. carthlicum	500191			X	X
T. carthlicum	500232				X
T. carthlicum	500233		X		
T. turgidum	500309		X	X	
T. turgidum	500310		X	X	
T. compactum	500222				X
T. compactum	500224				X
T. compactum	500233				X

a : YR=Yellow rust; LR=Leaf rust; SR=Stem rust; CB=Common bunt.

3. Accessions of rare wheat species resistant to four diseases

Under the continuing collaboration with CIMMYT in germplasm evaluation of rare (primitive/obsolete) species, a collection of 237 samples selected for drought tolerance the previous two seasons was evaluated for resistance to local races of the four above diseases.

Thirteen accessions of Triticum monococcum were found resistant to diseases. All except two of them were resistant to leaf rust. One accession (300106) had multiple resistance to all four diseases. Since this sample is also early, it could be successfully utilized in wheat improvement. The resistance found in T. monococcum and five other species of rare wheats is given in Table 11. Blank spaces in the table represent susceptibility. **A.B. Damania, O.F. Mamluk (CP), H. Altunji, N. Munzer (CP) and B. Skovmand (CIMMYT)**

1.3.1.2. Evaluation of Aegilops spp. for abiotic stress tolerance and maintenance of pure lines

West Asia is the primary center of diversity and origin of wheat. Despite this advantage, utilization of non-conventional germplasm, such as wild relatives and primitive forms, has been slow in the region due to a number of factors. These are as follows: (1) potential value of this germplasm was not fully understood; (2) insufficient pre-breeding and lack of pure lines; (3) genetic instability where one of the parents is a wild type; (4) loss of industrial quality due to genes from wild or primitive parents; (5) lack of documentation of desirable traits; (6) poor communication between genebanks and users; and (7) little or no feedback from evaluators. Pure lines from single plants from 239 accessions of Aegilops spp. selected the previous four seasons for drought stress tolerance were planted in a replicated experiment at Tel Hadya during 1992/93. Because of drought during the season, there was excellent screening for tolerance to water stress.

During 1992/93, 69 accessions of 12 Aegilops species were found resistant to drought and naturally prevalent diseases at

Tel Hadya: Ae. biuncialis (400591, 400560, 400553, 400074, 400035, 400031, 400030, 400007, 400001, 400844, 400848, 400859, 400984, and 400986); Ae. columnaris (401557, 401533, 401528, 401531, and HS0007); Ae. crassa (BR 0003); Ae. kotschyi (HS0013 and 400980); Ae. lorentii (401611, 401606, 401590, 401579, 401572, HS0015, and HS0010); Ae. ovata (401001, 401805, 401614, 401613, 401612, 401608, 401599, 401596, 401594, 401570, 401600, 401532, 401518, 401856, 400598, 400165, 400154, 400153, 400082, 400060, 400056, 400036, 400027, 400013, 400014, 400983, 400985, HS0006, and HS 0005); Ae. peregrina (401875 and 401063); Ae. speltoides (400010); Ae. triaristata (400535); Ae. triuncialis (401838, 401524, 401876 and 401849); Ae. umbellulata (400583); and Ae. vavilovii (401842 and 401982).

Species possessing the D genome are restricted to Ae. crassa because the other species with this genome were found susceptible to yellow rust at Tel Hadya and were eliminated earlier. The sample of Ae. crassa was collected at Breda where, since a number of years, plants of this species have been found to grow wild on the borders of the experimental fields. The vigor of the plants depended largely on the amount and distribution of rainfall at Breda. These Aegilops spp. were also resistant to naturally occurring diseases at Tel Hadya and demonstrated a high degree of early growth vigor. Morphological data on this germplasm which is maintained as separate individual pure lines are available.

A.B. Damania and H. Altunji

1.3.1.3. Agro-morphological evaluation of old varieties of bread wheat from Japan

One hundred and thirty-one old varieties of bread wheat received from Japan were evaluated for agro-morphological characters at Tel Hadya during 1992/93.

There was very high variation for days to heading and plant height (Table 12). The mean number of days to heading of the three varieties "Sakigake", "Shirowase", and "Fukuwase" of 138 days was significantly lower than the bread wheat checks, "Cham 2" and "Mexipak", which headed in 148 days. Their plant height, on an average, was only 3 cm less than that of the checks. The other morphological data on these three varieties is given in Table 13.

Table 12. Simple statistics for 131 old varieties of Triticum aestivum received from NARC, Japan.

Trait[a]	Min.	Max.	Mean	Var.	S.D.
DHE	137	176	150	34.43	5.86
TOTIL	5	18	9.5	7.74	2.78
F.TIL	3	17	8.3	6.45	2.54
PLH	65	120	87	130.4	11.40
PED	18	46	29.6	26.8	5.18
DMA	183	202	190	14.3	3.78

a : DHE = Days to heading; TOTIL = Total no. of tillers; F.TIL = Total no. of fertile tillers; PLH = Plant height (cm); PED = Peduncle length (cm); and DMA = Days to maturity.

Table 13. Quantitative traits for the three earliest heading varieties from Japan grown at Tel Hadya during 1992/93

Variety	DHE[a]	TOTIL	F.TIL	PLH	PED	DMA
Sakigake	140	6	6	82	29	186
Shirowase	138	8	8	71	25	187
Fukuwase	137	9	9	91	24	183
Check mean	154	10	9	85	34	195

a : Abbreviations same as in Table 12.

The history of the green revolution and the part played by "Norin 10", a semi-dwarf wheat variety from Japan, has been well documented. Among the 131 bread wheat varieties, there were 74 "Norin" types. At least two of these (IC 207459 and 207463) were very short (68.5 cm). However, their days to heading and days to maturity were 161 and 199, and 153 and 193, respectively. This material is interesting for crop improvement, since it possesses traits such as earliness not normally found in bread wheat germplasm.

A.B. Damania and H. Altunji

1.3.1.4. Agro-morphological evaluation of landraces of hexaploid and tetraploid wheats from Ethiopia

The background to the acquisition of this valuable germplasm from Ethiopia has been reported in GRU Annual Reports for 1991 and 1992. Evaluation of this material continued in 1992/93. Among the previously identified tetraploid wheats were some hexaploids and the final number of both types planted in 1992/93 were 32 tetraploids and 31 hexaploids, with Cham 1, Cham 2 and Haurani as checks. Simple statistics for both forms are given in Table 14.

Table 14. Simple statistics of 32 tetraploid and 31 hexaploid landraces from Ethiopia.

Trait[a]	Min.	Max.	Mean	Check mean	Var.	S.D.
Tetraploid wheat						
DHE	148	159	153	152	8.96	2.99
TOTIL	6	19	10.7	7.0	10.8	3.29
F.TIL	5	15	9.6	7.0	6.82	2.61
PLH	84	111	97.7	89.3	34.77	5.89
PED	27	44	34.0	39.3	17.09	4.13
DMA	180	200	186	192	16.7	4.09
Hexaploid wheat						
DHE	147	164	152	151	14.89	3.86
TOTIL	6	16	9.53	10.0	8.24	2.87
F.TIL	5	14	8.5	9.3	5.78	2.40
PLH	83	129	107	85.3	121.4	11.00
PED	29	45	36.0	34.0	19.69	4.43
DMA	183	197	190	193	13.99	3.74

a : Abbreviations same as in Table 12.

A.B. Damania and H. Altunji

1.3.1.5. Selection of pure lines of *Triticum dicoccoides* on the basis of high agronomic score, drought and disease tolerance

In recent years, diversity and desirable traits found in *T.*

dicoccoides have been reported. Diverse genetic polymorphisms for this species have been described from across the Fertile Crescent. Attempts at in-situ conservation of this wild progenitor and other wild cereals have begun in earnest in at least two regions within the Fertile Crescent, viz. Anatolia (Turkey) and Suweida (Syria). Results of evaluation in Syria and elsewhere have so far indicated that T. dicoccoides harbors a rich genetic resource appropriate for wheat improvement. However, variety release is a long and painstaking process and cultivar release with desirable genes from this wild progenitor may not be feasible in the immediate future. Nevertheless, breeders from the Fertile Crescent are increasingly confident that, in the foreseeable future, cultivars with genes for resistance to salinity, yellow rust, powdery mildew, as well as high protein content and improved baking quality will be released. Results of evaluation at Tel Hadya and Breda show that T. dicoccoides plays a major role in enhancing wheat productivity in stress environments

After more than five seasons of testing at Tel Hadya and Breda, the following 40 pure lines were isolated (600435, 600258, 600397, 600263, 600475, 600540, 600553, 600276, 600307, 600298, 600504, 600434, 600233, 600219, 600255, 600876, 600322, 600237, 600877, 600557, 600833, 600262, 600319, 600256, 600450, 600879, 600243, 600477, 600300, 600294, 600238, 600411, 600862, 600838, 600543, 600299, 600283, 600866, 600227, 600241). These lines were selected on the basis of high number of fertile tillers, resistance to diseases, and a high agronomic score (AGS) as defined by Damania et al. (1991) in the "Durum Wheat Catalog". The AGS was recorded at Breda shortly before maturity. A 9-level scale was used where "1" was defined as "very poor" and "9" as "excellent". For our selection purpose, only accessions scoring "8" ("very good") and "9" are reported. The AGS also took into consideration other important traits for survival in stressful environments, such as early growth vigor, earliness in heading and maturity, tillering capacity, plant height, duration of grain-filling period, and waxiness. Other results emanating from collaborating institutions in Canada also show a relation between agronomic score recorded at Breda and physiological traits used to assess drought tolerance, such as excised leaf water loss.

A.B. Damania

1.3.1.6. Pre-breeding and development of genetic stocks with genes from wild and rare forms

The wild progenitors of wheat are commonly sympatric with their cultivated forms. They differ, however, in phenotype and adaptation but remain sufficiently genetically related to cross and produce fertile hybrids with exchange of genes, particularly in the direction of the cultivated forms. Breeders are adverse to use of germplasm which may retard their improved lines or those which require years of back crossing to eliminate undesirable traits, which are inherited when wild or rare species material is used in the pedigree. Germplasm of wild and rare species is being utilized for a pre-breeding program which seeks to infuse desirable genes from the wild or rare species parent into the cultivated form through crossing and selection. This work has created stable lines which can be utilized by breeders without fear of non-desirable characteristics becoming linked to those which are sought from the wild or rare species parent.

During 1992/93, 131 crosses were made. A highly variable number of seeds were obtained from each cross. These crosses utilized F_3 lines obtained from crosses in previous years between the well-adapted durum landraces Haurani and Cham 1 x selected T. dicoccoides lines as the female parent. The male parents were selected T. dicoccon and durum landraces from Yemen, and tetraploid landraces from Ethiopia. ICARDA-developed bread wheat varieties Cham 2 and Cham 4 were also used as female parents in crosses with hexaploid landraces from Ethiopia. The number of seeds obtained from these crosses ranged from 1 to 29 and will be spaced-planted in 1993/94 for further selection.

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1.3.2. Screening for resistance to important wheat diseases in a selection of the ICARDA Aegilops collection

During the 1992/1993 season, a third part of the Aegilops collection was tested for important fungal wheat diseases, viz. yellow rust [Puccinia striiformis Westend. f.sp. tritici], and septoria tritici blotch [Mycosphaerella graminicola (Fuckel) Schr.; anamorph Septoria tritici Rob.]. In total, 739 accessions were screened. All species of Aegilops, as well as Amblyopyrum muticum were involved, although there were only a few accessions of some species. Results for the testing for resistance to septoria blotch are presented under "Durum Wheat Pathology: Studies of the Host-Pathogen System" in the Cereal Program Annual Report for 1993.

For yellow rust screening, the accessions were planted on 21 December, 1992, in a systematic trial. This, in general, prevented outcrossing species from being planted next to each other, while providing for randomization. Fourty entries did not germinate. Also included in the initial 739 were 270 retested entries that scored 15 MR, a CI of 6.0, or less, during the 1991/1992 screening (GRU Annual Report for 1992: Table 16). Of those 270, 11 did not germinate. Thus, resistance of a total of 739 - (270 + 40) = 429 new entries was scored.

Scoring of severity of the infection was again done with the modified COBB's scale, with trace infection scored as 1%. Field response, or reaction type, was classified with the categories R, MR, M, MS, and S. Severity and response were converted to a Coefficient of Infection, or CI (= severity x response), using a constant value for the field response: R = 0.2, MR = 0.4, M = 0.6, MS = 0.8, and S = 1. For each species, the Average Coefficient of Infection, or ACI, was calculated as the sum of individual CI's divided by the number of entries.

The results for the new entries tested for yellow rust both at the individual accession and at the species level are varied (Table 15). An ACI of 15 MR (CI = 6.0) or less was shown by only three Aegilops species: comosa, geniculata, and neglecta, with most of the accessions of the widespread Ae. triuncialis also in this range. The one sample of Amblyopyrum muticum was also resistant, but this does not predict the performance of this species as a whole.

Table 15. Performance of 429 tested accessions of 21 Aegilops spp. and of Amblyopyrum muticum, resulting from the yellow rust screening, Tel Hadya, Syria in 1992/1993

Species	Severity/Reaction range	ACI species	No. acc.
bicornis	20-30 / MS-S	38.0	3
biuncialis	1-70 / R-S	13.5	29
caudata	1-90 / R-S	52.4	10
columnaris	1-80 / R-S	30.7	6
comosa	1 / R	0.2	11
crassa	10-90 / MR-S	63.5	14
cylindrica	1-90 / R-S	49.0	74
geniculata[a]	1-80 / R-S	5.8	40
juvenalis	40-80 / S	60.0	5
kotschyi	10-90 / MR-S	58.2	14
longissima	10-90 / R-S	47.0	2
neglecta	1 / R	0.2	7
peregrina	1-90 / R-S	37.4	57
searsii	20 / S	20.0[a]	1[a]
sharonensis	90 / 1	90.0[a]	1[a]
speltoides	1-80 / R-S	11.6	11
tauschii	1-95 / R-S	53.5	57
triuncialis	1-70 / R-S	7.2	47
umbellulata	1-70 / R-S	18.6	4
vavilovii	80 / S	73.1	16
ventricosa	10-90 / MS-S	67.0	19
Ambl. muticum[b]	1 / R	0.2[a]	1[a]
Total			429

a : Data of one accession; only CI calculated.
b : Names are in accordance with the taxonomic revision of Aegilops, presented in this Report in Section 1.4.5. Thus, geniculata replaces the well-known name ovata and Aegilops mutica has been separated as Amblyopyrum muticum.

The widespread Ae. geniculata, Ae. neglecta and Ae. triuncialis may provide a rich source of resistance to yellow rust. The many retested accessions from these three species (102, 31 and 69, respectively) maintained, with few exceptions, their resistance (Table 16).

Table 16. Susceptibility of Aegilops species carrying the D- and S-genome to yellow rust, screenings 1991/1992 through 1992/1993, at Tel Hadya, Syria

Species	Genome formula[a]	ACI 90-91	ACI 91-92	ACI 92-93
D-genome				
crassa	DM / DDM	18.6	15.0	63.5
cylindrica	CD	28.6	6.8	49.0
juvenalis	DMU	-	48.0	60.0
tauschii	D	31.8	10.4	53.5
vavilovii	DMS	44.8	80.0	73.1
ventricosa	DUn	25.1	67.0	67.0
S-genome				
bicornis	S^b	10.8	-	38.0
longissima	S^l	7.7	-	47.0
searsii	S^s	27.1	85.0	20.0[b]
sharonensis	S^s	-	-	90.0[b]
speltoides	S	2.1	7.1	11.6

a : Genomic formula according to Kimber & Tsunewaki, Proc. 7th International Wheat Genetics Symposium, Cambridge, England: 1209-1210 (1988). A (-) indicates that entries were either not tested or died during retesting.
b : CI only.

Entries with good resistance were defined as showing a severity of infection between trace (1%) and 15%, and a response of R-MR, which is a CI range of 0.2 to 6.0. Out of the 429 new entries tested in this season, a total of 148 accessions, or 34%, fell in this range (Table 17), while the remaining 281 (66%) had a CI of over 6.0.

Retesting the 270 resistent accessions of the 1991/1992 screening gave the following results (referring to 259 entries, as 11 accessions did not germinate) in 1992/1993. Out of the 259, 162 (62%) gave the same CI score, 21 (8%) a lower CI score than the previous year, and 76 (29%) a higher CI score, of which 62 scored a CI of 6 or lower and 14 a CI higher than 6. Thus, most of the entries maintained their resistance to yellow rust during the second year, but 14 accessions (18%) showed an increased sensitivity to the disease. As a result of retesting 259 accessions, 245 were found to have good resistance to yellow rust for two years. Examples of striking differences between the two years are a biuncialis accession from Lebanon (CI = 30; last year 0.2), a peregrina accession from Syria (CI = 30; last year 0.4); one of the few tauschii accessions that appeared resistant (CI = 24; last year 0.2), and a triuncialis accession from Daghestan, Russia with a CI of no less than 80 (last year it was 0.4)!

Table 17. Number of resistant accessions to yellow rust in the Aegilops / Amblyopyrum collection, screened in 1992/1993

Severity and reaction type	No. Accessions
1* R	101
5 R	4
10 R	10
15 R	5
1* MR	-
5 MR	2
10 MR	26
15 MR	-
Total	**148**

* : Trace severity put at 1%.

The 1992/1993 season again showed generally higher ACI scores than the previous year (which, in turn, showed higher scores than in 1991). This may be due to a change in the pathogen virulence or differences in the environmental conditions.

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1.3.3. Characterization of Aegilops germplasm

A set of 133 entries from Afghanistan, Algeria, Greece, Iraq, Jordan, Lebanon, Palestine, Russia, Syria, and Turkey was planted in an unreplicated nursery with three systematically repeated checks (Aegilops searsii, ICAG 400061; Ae. triuncialis, 400021; Ae. vavilovii, 400067) and a fourth, randomized check (Ae. biuncialis, 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. Nine quantitative characters were evaluated on three single random plants. They included: number of tillers per plant, number of productive tillers per plant, plant height, spike length, 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 the first effective rain after planting (28 November, 1992). Data on three quantitative traits are presented in Table 18.

M. van Slageren and O. Obaji

1.3.4. Screening Aegilops species for resistance to barley yellow dwarf virus (BYDV)

Over the last three years, 1097 Aegilops accessions were evaluated for their reaction to the PAV type of BYDV. The tested accessions belong to the species bicornis, biuncialis, caudata, crassa, columnaris, comosa, cylindrica, kotschyi, longissima, mutica, neglecta (= triaristata 4x), ovata, peregrina, searsii, sharonensis, speltoides, tauschii, triuncialis, umbellulata, uniaristata, vavillovii, and ventricosa. The first evaluation of

Table 18. **Minimum, maximum, mean and standard deviation for three characters in *Aegilops* germplasm (1993 evaluation)**

Species	No. of acc.	Plant height (cm)				Days to flowering				Spikelets/spike			
		Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
biuncialis	10	39	56	47.4	3.36	152	173	160.9	7.26	2	3	2.6	0.32
caudata	2	35	52	44.5	9.19	167	167	167.0	0.00	5	6	5.3	0.35
columnaris	6	40	57	47.1	4.18	150	170	161.8	9.24	3	7	5.1	1.11
comosa	16	29	48	38.5	3.99	167	194	176.9	7.51	2	5	2.8	0.68
crassa	6	53	78	64.1	9.19	147	156	150.3	3.39	7	12	9.8	1.25
cylindrica	9	34	72	55.2	12.32	163	177	168.7	4.12	7	13	8.9	1.47
juvenalis	5	35	55	42.3	5.03	152	158	156.8	2.68	5	7	5.7	0.76
longissima	13	47	110	80.4	14.11	150	170	158.5	8.68	9	18	12.9	1.85
ovata	16	23	50	40.2	5.35	147	163	154.9	4.17	2	4	3.4	0.49
peregrina	15	36	62	52.8	4.43	147	167	158.4	6.57	3	6	4.0	0.92
searsii	5	53	87	65.8	8.97	150	156	152.8	3.03	9	14	12.2	1.60
speltoides	4	58	73	66.9	4.03	152	177	163.8	10.24	7	12	9.8	1.50
tauschii	5	43	56	49.6	2.41	152	173	164.6	9.10	8	15	10.1	1.88
triuncialis	13	41	67	53.7	7.13	150	177	166.2	10.03	3	7	5.0	1.25
vavilovii	4	39	72	49.6	7.93	150	163	155.3	5.74	7	12	9.0	0.58
Checks													
vavilovii	(I)[a]	56	84	64.3	4.78	150	152	151.6	0.89	7	12	9.3	0.67
triuncialis	(II)	45	70	54.5	6.19	152	158	156.0	2.45	5	7	5.9	0.42
searsii	(III)	53	81	66.9	8.71	147	156	152.2	3.90	11	15	13.3	0.76
biuncialis	(IV)	42	63	53.9	2.04	147	150	148.2	1.64	3	3	3.0	0.00

a : I-IV=check, 10 plots per check.

virus multiplication levels in the different accessions was conducted at ICARDA using ELISA. Accessions tested ranged from highly resistant to highly susceptible. Thirty-eight accessions classified as resistant at ICARDA were re-evaluated at Sainte-Foy, Canada, by the tissue-blot immunoassay. Seven accessions belonging to the species biuncialis, caudata, neglecta, and triuncialis were highly resistant to BYDV at both locations; five of these originated from Bulgaria (Table 19).

Table 19. Accessions of Aegilops resistant to BYDV-PAV

Germplasm	ICARDA accession number	Geographical origin	Average number of stained phloem bundles[a]
Aegilops			
caudata	400901	Syria	4.2
neglecta	401147	Turkey	4.8
	401791	Bulgaria	5.0
	401805	Bulgaria	2.8
biuncialis	401812	Bulgaria	4.6
	401816	Bulgaria	4.8
triuncialis	401815	Bulgaria	4.0
Check			
T. aestivum "Maringa"		Brazil	21.4

a : Each value represent average number of stained phloem bundles of four stem (including leaf sheath) sections made at 5, 7, 11, 21, and 60 days after inoculation. The stain deposit occurs specifically around virus particles adsorbed on the membrane, so that absence of stained bundles means resistance.

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1.3.5. Screening for barley yellow dwarf virus (BYDV) resistance in cereals

Over 700 new breeding lines were evaluated for their reaction to BYDV after inoculation with a PAV isolate. In addition, the most promising lines of the previous two years were re-evaluated. A number of traits, including yield loss in comparison with a healthy control, were monitored (Table 20). The best performing lines from this trial constitute the BYDV nursery which is available to national programs of the region.

Table 20. Cereal breeding lines tolerant to BYDV for three years

Cereal nursery	Lines with tolerance to infection
Durum wheat	
DKL-92	8[a], 36, 46, 53, 64, 92, 116, 125, 193, 197, 202, 213, 225
C-YD-DW-92	4, 7, 17, 27, 43, 47
Bread wheat	
WKL-92	13, 15, 25, 38, 56, 79, 141, 153, 161, 167, 187, 191, 202, 204, 207, 216, 222
C-YD-BW-92	61, 67, 91, 97, 106, 120, 130, 140, 146, 147, 150
Barley	
BKL-92	24, 26, 30, 34, 55, 59, 65, 71, 79, 82, 87, 93, 101, 102, 110
C-YD-BA-92	15, 16, 17, 23, 27, 31, 32, 34, 35, 37, 44, 53, 58, 60

a : Numbers refer to ICARDA nursery serial number, e.g. 8 is DKL-92-8.

K. M. Makkouk and W. Ghulam

1.3.6. Evaluation of Portugese chickpea

Sixty-four accessions of Portugese chickpea germplasm collected jointly with ENEA, Elvas, Portugal were evaluated for 15 descriptors at Tel Hadya, Syria in 1992/93. The test entries were evaluated in an augmented design with one systematic check

(ILC 482) and two random checks (ILC 2379 and ILC 5104). The 15 descriptors observed were as follows: days to flowering (DFLR), days to 90% maturity (DMAT), plant height (PTHT) in cm, growth habit (GRH), seed shape (SSH), seed surface roughness (SRO), seed color (SCO), pods per plant (POD), seeds per plant (SPP), seeds per pod (SPD), hundred seed weight (HSW) in g, seed yield (SYLD) in kg/ha, straw yield (STYLD) in kg/ha, biomass (BYLD) in kg/ha, and harvest index in % (HI).

The majority of the Portugese chickpea accessions evaluated were spreading and the remainder had a semi-spreading growth habit (Table 21). The seeds were all rough, almost entirely of kabuli type, and were mostly light brown or beige colored.

Table 21. Frequency distributions for GRH, SCO, SSH, and SRO for 64 Portugese chickpea germplasm accessions evaluated at Tel Hadya, Syria during 1992/93

Descriptor/Score[a]	Frequency (%)
GRH	
Semi-erect	0.0
Semi-spreading	43.7
Spreading	56.2
SCO	
Beige	35.9
White	1.6
Light brown	51.6
Brown	7.8
Black	1.6
Mixed	1.6
SSH	
Kabuli	98.4
Desi	1.6
SRO	
Rough	100.0
Smooth	0.0

a : Descriptor abbreviations as per text.

All Portugese accessions were as early or earlier than the mean of the checks (Table 22). Seed and straw yields of the germplasm accessions had a mean equal to the checks,

Table 22. Summary statistics for 64 Portugese chickpea germplasm accessions evaluated at Tel Hadya, Syria during 1992/93

Descriptor		Check mean	Mean	Min.	Max.	C.V. (%)
DFLR[a]	(days)	124.8	123.8	121	125	0.9
DMAT	(days)	171.4	172.1	168	175	1.1
PTHT	(days)	47.2	42.1	27	52	13.1
HTFP	(cm)	25.2	24.1	14	33	16.5
CAW	(cm)	31.7	29.6	16	48	21.1
POD		27.4	19.7	11	53	35.5
SPD		0.87	0.92	0.74	1.05	7.4
HI	(%)	46.4	51.4	43.8	59.2	5.2
HSW	(g)	59.1	41.2	20.8	56.4	13.1
SYLD	(kg/ha)	1412	1579	1157	2290	12.8
BYLD	(kg/ha)	3083	3007	2242	4741	12.6
STYLD	(kg/ha)	1671	1428	1004	2451	14.8

a : Descriptor abbreviations as per text.

with the highest values about 50% higher than the checks. The accessions were shorter and had a slightly smaller CAW. The number of POD was 30% less for the Portugese germplasm compared to the check means, though the SPD was slightly higher. The seed size was much smaller (30%) than the checks, with the largest value for the tested accessions smaller than the check mean. This germplasm was collected from a Mediterranean environment and is well adapted to the WANA region and should be of use to breeding programs in the region. The accessions will be tested for ascochyta blight and cold tolerance in the LP.

Larry D. Robertson and Ali Ismali

1.3.7. Joint evaluation of lentil germplasm with NBPGR

In 1992, an agreement was signed with the National Bureau of Plant Genetic Resources (NBPGR), New Delhi, India for the joint evaluation of lentil germplasm between NBPGR and the GRU, ICARDA.

The agreed procedure is that germplasm will be evaluated in Syria the first year and the seed produced sent to India the subsequent year for evaluation at four locations. An additional coastal site will be added in Syria for evaluation. This evaluation

Table 23. Frequency distributions for LOD, TCO, TPA, TPC, and COC for 300 lentil accessions evaluated at Tel Hadya, Syria in 1992/93

Descriptor/ Score[a]	AFG	CHL	EGY	ETH	IND	IRN	PAK	SYR	TUR	YEM
LOD										
None	26.7	3.3	6.7	13.3	13.3	0.0	36.7	0.0	0.0	0.0
Low	70.0	70.0	56.7	63.3	3.3	56.7	3.3	0.0	13.3	60.0
Medium	3.3	23.3	30.0	16.7	76.7	36.7	53.3	40.0	83.4	36.7
High	0.0	3.3	6.7	6.7	6.7	6.7	6.7	60.0	3.3	3.3
TCO										
Green	6.7	80.0	20.0	0.0	3.3	40.0	3.3	13.3	90.0	0.0
Grey	0.0	0.0	6.7	6.7	20.0	10.0	30.0	10.0	0.0	3.3
Brown	46.7	3.3	33.3	80.0	73.4	16.7	63.4	43.3	0.0	96.7
Black	6.7	0.0	26.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pink	26.7	13.3	3.3	0.0	3.3	30.0	0.0	33.3	3.3	0.0
Mixed	13.2	3.4	10.0	13.3	0.0	3.3	3.3	0.0	6.7	0.0
TPA										
Absent	10.0	66.7	26.7	0.0	3.3	83.3	0.0	16.7	93.4	0.0
Dotted	13.3	6.7	20.0	53.3	36.7	3.3	16.7	3.3	0.0	33.3
Spotted	16.7	6.7	30.0	0.0	3.3	6.7	6.7	30.0	0.0	6.7
Marbled	26.7	6.7	10.0	10.0	16.7	6.7	16.7	13.3	0.0	36.7
Complex	23.3	13.2	6.7	0.0	40.0	0.0	60.0	36.7	3.3	23.3
Mixed	10.0	0.0	6.7	6.7	0.0	0.0	0.0	0.0	3.3	0.0
TPC										
Absent	10.0	66.7	26.7	0.0	3.3	83.3	0.0	16.7	93.4	0.0
Olive	6.7	6.7	10.0	3.0	6.7	0.0	13.3	0.0	3.3	0.0
Grey	33.3	23.3	33.3	30.0	50.0	10.0	30.0	43.3	3.3	36.7
Brown	6.7	0.0	3.3	0.0	0.0	0.0	3.3	0.0	0.0	0.0
Black	43.3	3.3	26.7	60.0	40.0	6.7	53.3	40.0	0.0	63.3
Mixed	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0
COC										
Red	10.0	90.0	30.0	6.7	6.7	80.0	3.3	40.0	90.0	6.7
Yellow	86.7	6.7	56.7	93.3	93.3	20.0	96.7	60.0	3.3	93.3
Mixed	3.3	3.3	13.3	0.0	0.0	0.0	0.0	0.0	7.3	0.0

a : Descriptor abbreviations as per text.

should allow the Indian national program to select useful germplasm for further breeding research and provide a database to study multi-locational evaluation of germplasm of lentil.

A total of 300 lentil landraces from 10 countries (Afghanistan, Chile, Egypt, Ethiopia, India, Iran, Pakistan, Syria, Turkey, and Yemen) were selected for the first year of the joint project. These were evaluated in an unreplicated augmented design with one systematic check (ILL 4400, local check) and two random checks (ILL 2501 and ILL 5582, Indian and ICARDA checks, respectively).

The 16 descriptors observed were: days to 50% flowering (DFLR), days to 90% maturity (DMAT), plant height in cm (PTHT), height to the first pod in cm (HTFP), canopy width in cm (CAW), lodging susceptibility (LOD), seed yield in kg/ha (SYLD), biomass in kg/ha (BYLD), straw yield in kg/ha (STYLD), harvest index in % (HI), pods per plant (POD), seeds per pod (SPD), 100 seed weight in g (HSW), testa color (TCO), testa pattern (TPA), cotyledon color (COC), and testa pattern color (TPC).

Lodging was low for accessions from AFG, CHL, EGY, ETH, and YEM, and high for IND, SYR, and TUR (Table 23). COC was mostly yellow for AFG, ETH, IND, PAK, and YEM with red COC for CHL, IRN, and TUR. Accessions from EGY and SYR were mixed in COC. The testa color was mostly brown for AFG, ETH, IND, PAK, and YEM; these countries also had mostly grey and black TPC. TUR and CHL had almost entirely green TCO. CHL, IRN and TUR had few accessions with any TPA.

Large differences between countries of origin for the quantitative traits were measured (Table 24). The earliest accessions were from Yemen, Pakistan, Ethiopia, and India and the latest were from Afghanistan, Iran and Turkey. The smallest plants were with accessions from Ethiopia, India, Pakistan, and Yemen. The largest seeds were with Chile, Iran, Syria, and Turkey, however, these had the least SDP. Likewise, the largest SDP were with Afghanistan, Ethiopia, India, and Pakistan, which had low values for HSW. The lowest yields were with India, Eth-

Table 24. Means for DFLR, DMAT, PTHT, HTPF, CAW, POD, SPD, HI, HSW, SYLD, BYLD, and STYLD for countries of origin and checks and standard error of means for country of origins

Origin	Descriptor mean[a]											
	DFLR	DMAT	PTHT (cm)	HTFP (cm)	CAW (cm)	POD	SPD	HI (%)	HSW (g)	SYLD (kg/ha)	BYLD (kg/ha)	STYLD (kg/ha)
AFG	142.9	180.3	29.7	18.4	8.9	40.4	1.30	42.0	2.41	1289	3117	1828
CHL	132.2	176.6	33.3	23.6	12.2	23.8	0.87	35.7	6.43	1442	4066	2624
EGY	129.8	172.2	29.3	18.5	11.9	35.4	1.14	40.8	3.65	1478	3663	2185
ETH	119.1	158.5	25.1	13.5	10.5	25.5	1.23	50.1	2.95	1035	2100	1065
IND	123.2	162.7	22.0	11.0	10.1	23.3	1.40	47.2	2.29	904	1951	1047
IRN	135.9	177.1	29.2	20.4	10.3	27.7	1.05	38.5	4.30	1292	3384	2092
PAK	122.0	158.8	22.5	12.7	9.8	22.9	1.41	48.5	2.30	1002	2108	1106
SYR	129.1	168.0	32.3	22.3	11.7	25.4	1.02	37.5	4.79	1527	4109	2582
TUR	136.9	183.3	32.8	23.7	9.8	20.4	0.92	29.2	6.09	1111	3911	2800
YEM	114.8	154.4	22.7	10.3	10.0	25.0	1.16	50.0	3.03	1101	2218	1117
Mean	128.6	169.2	27.9	17.4	10.5	27.0	1.15	42.0	1218	1218	3063	1845
C.1[b]	128.6	171.6	32.1	24.7	13.3	23.0	0.87	35.9	6.72	1576	4404	2827
C.2	124.7	167.1	24.7	13.7	9.6	30.6	1.57	48.8	2.21	1098	2268	1170
C.3	127.0	163.4	31.7	19.9	11.1	35.4	0.87	42.9	5.01	1694	3967	2273
S.E.[c]	0.25	0.28	0.20	0.21	0.15	0.63	0.01	0.35	0.06	12.9	32.8	26.8

a : Descriptor abbreviations as per text.
b : C.1=ILL 4400, C.2=ILL 2501 (PANT L 406) and C.3=ILL 5582.
c : S.E.=Standard error of mean for origins.

iopia, Pakistan, Yemen, and Turkey and the highest with Syria, Chile and Egypt.

Canonical discriminant analysis for country of origin was performed with DFLR, DMAT, PTHT, HTFP, CAW, POD, SPD, HI, HSW, SYLD, STYLD, and LOD with seven functions found significant. The first two functions accounted for 83.9% of the variation among countries. Overall, there was a correct classification rate of 69.3%, indicating the clear distinctness of accessions based on country of origin. The countries with the highest correct classifications were Afghanistan, Chile, Syria, and Yemen with correct classifications over 80%. The lowest correct classification was with Iran (46.7%). All other correct classifications were over 50%.

Hierarchial cluster analysis was performed using the country of origins centroids of the seven significant canonical functions. The dendrogram from this analysis (Figure 2) reveals that Afghanistan (Cluster 3) is distinct from the other countries of origin. The other countries formed two major clusters. These were the India, Pakistan, Ethiopia, and Yemen southern latitude cluster (Cluster 1) and the remainder, more Mediterranean group

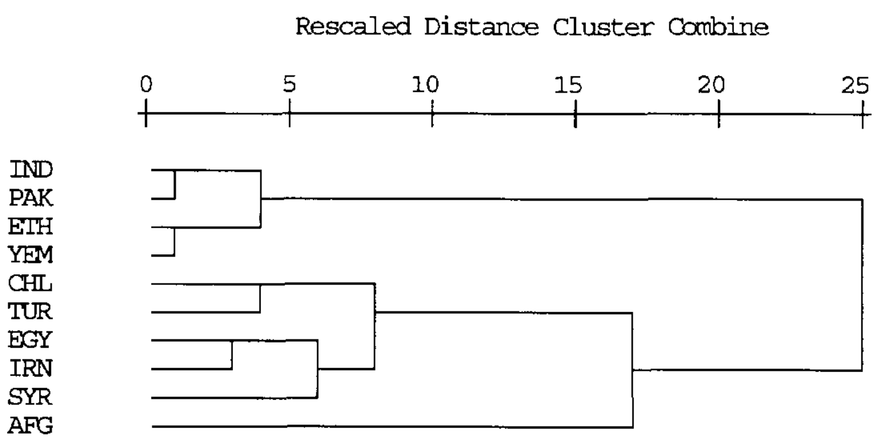

Figure 2. Dendrogram for country of origin for lentil from ten countries from hierarchial clustering of seven significant canonical functions

(Cluster 2). The similarities of the individual countries in the clusters can be seen in Tables 23 and 24. These results are similar to those reported in GRU Annual Report 1992 for a larger data set (though, this did not include Afghanistan).

Table 25. Means for the three major clusters of lentil for country of origin for DFLR, DMAT, PTHT, HTFP, CAW, POD, SPD, HI, HSW, SYLD, BYLD, and STYLD

Descriptor		Cluster 1	Cluster 2	Cluster 3
DFLR[a]	(days)	119.8	132.8	142.9
DMAT	(days)	158.6	175.4	180.3
PTHT	(days)	23.1	31.4	29.7
HTFP	(cm)	11.9	21.7	18.4
CAW	(cm)	10.1	11.2	8.9
POD		24.2	26.5	40.4
SPD		1.30	1.00	1.30
HI	(%)	49.0	36.3	42.0
HSW	(g)	2.64	5.05	2.41
SYLD	(kg/ha)	1010	1370	1289
BYLD	(kg/ha)	2094	3827	3117
STYLD	(kg/ha)	1084	2457	1828

a : Descriptor abbreviations as per text.

Examination of cluster means (Table 25) reveals that the southern latitude cluster is the earliest, shortest and lowest yielding cluster. Afghanistan is similar to the southern latitudes (Cluster 1) for HSW, SPD and HI, both of which have lower values for HSW and SPD and higher values for HI, compared to the Mediterranean cluster (Cluster 2). AFG is similar to cluster 2 for yield and plant size. However, Afghanistan is much later than either of the other two clusters and has the smallest CAW and the largest POD of the three clusters.

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1.3.8. Evaluation of Lathyrus germplasm

The entire Lathyrus germplasm (1082 accessions and 30 species) was evaluated in a series of augmented nurseries (one per species) using one systematic check (IFLA 347, L. sativus) and two random checks (IFLA 101, L. ochrus and IFLA 536, L. cicera).

The 21 descriptors observed were: Growth habit (GRH), flower color (FLCO), anthocyanin (ANTH), leaf shape (LFSH), days to 50% flowering (DFLR), days to 90% maturity (DMAT), days to 90% podding (DPOD), plant height in cm (PTHT), height to the first flower in cm (HTFF), leaf length in cm (LFL), leaf width in cm (LFW), pod length in cm (LPD), pod width in cm (WPD), peduncle length in cm (PEDL), internode length (LINT), seeds per pod (SPD), 1000 seed weight in g (W1000), seed yield in kg/ha (SYLD), biomass in kg/ha (BYLD), straw yield in kg/ha (STYLD), and harvest index in % (HI).

Results are presented for the three economically important species: L. cicera (n=96), L. ochrus (n=58) and L. sativus (n=272). Most accessions of L. cicera were from Greece, Syria and Turkey. The accessions of L. ochrus were mostly from Greece, Cyprus and Syria, and those of L. sativus from Ethiopia, Afghanistan, Cyprus, Pakistan, Iran, and Turkey.

L. ochrus and L. sativus had a mostly semi-erect GRH, while L. cicera also had erect and prostrate plant types (Table 26). Most

Table 26. Frequency distributions for GRH, FLCO, ANTH, and LFSH for L. cicera (n=96), L. ochrus (n=58) and L. sativus (n=272) germplasm evaluated at Tel Hadya, Syria during 1992/93

Descriptor/score[a]	L. cicera	L. ochrus	L. sativus
GRH			
Prostrate	24.0	3.4	0.7
Semi=erect	51.0	96.6	96.0
Erect	25.0	0.0	3.3
FLCO			
White	0.0	53.4	1.5
Cream	1.0	12.1	2.2
Brick	11.5	0.0	0.4
Pink	5.2	0.0	0.0
Violet	4.2	13.8	95.6
Yellow	2.1	0.0	0.0
Blue	0.0	0.0	0.0
Red	76.0	20.7	0.4

Table 26. Cont'd

Descriptor/score[a]	**L. cicera**	**L. ochrus**	**L. sativus**
ANTH			
Weak	83.3	100.0	83.8
Fair	8.3	0.0	9.9
Strong	7.3	0.0	6.2
V. strong	1.0	0.0	0.0
LFSH			
Narrow	99.0	8.6	99.6
Medium	1.0	91.4	0.0
Oval	0.0	0.0	0.4

a : Descriptor abbreviations as per text.

accessions of L. cicera had red FLCO while most L. ochrus accessions had white FLCO and almost all L. sativus accessions had violet FLCO. All accessions had weak anthocyanin pigmentation. L. cicera and L. sativus had mostly narrow LFSH and L. ochrus mostly medium LFSH. These descriptors are used for taxonomic identification in Lathyrus.

The accessions of L. cicera were earlier than the L. cicera check, IFLA 536, by up to 11 days (Table 27). The SPD was higher for the tested accessions, but the W1000 was smaller and the HI

Table 27. Summary statistics for 96 Lathyrus cicera germplasm accessions evaluated at Tel Hadya, Syria during 1992/93

Descriptor		**Check mean**[a]	**Mean**	**Min.**	**Max.**	**C.V. (%)**
DFLR[b]	(days)	126.2	123.9	115	136	3.3
DMAT	(days)	161.7	163.9	156	181	2.8
DPOD	(days)	133.7	128.3	122	148	4.5
PTHT	(cm)	36.7	35.4	24.1	49.8	12.5
HTFF	(cm)	10.7	8.1	2.4	13.2	18.5
SPD		3.61	3.83	2.32	9.62	24.2
HI	(%)	36.6	33.8	12.7	52.0	26.1
W1000	(g)	91.75	83.1	13.88	116.68	24.2
SYLD	(kg/ha)	1237	1120	117	2030	52.5
BYLD	(kg/ha)	3350	3101	635	4972	37.7
STYLD	(kg/ha)	2113	2578	488	3067	26.1

a : IFLA 536, L. cicera.
b : Descriptor abbreviations as per text.

was similar to the check. The BYLD was reduced, which resulted in a lower SYLD and STYLD for the tested accessions, although the maximum for the tested entries was as high as the check L. cicera. The L. ochrus accessions were also earlier than the L. ochrus check (Table 28). The vegetative descriptors were similar to the check for L. ochrus. The W1000 was smaller for the tested entries, as was the SPD. However, for L. ochrus, the mean of the tested accessions for BYLD was the same as the check, which resulted in similar values for STYLD and SYLD. The HI, BYLD,

Table 28. Summary statistics for 58 Lathyrus ochrus germplasm accessions evaluated at Tel Hadya, Syria during 1992/93

Descriptor		Check mean[a]	Mean	Min.	Max.	C.V. (%)
DFLR[b]	(days)	124.3	120.4	115	145	4.1
DMAT	(days)	160.0	157.0	149	184	3.2
DPOD	(days)	128.0	124.0	118	154	4.6
PTHT	(cm)	33.1	34.7	23.8	48.6	15.4
HTFF	(cm)	15.8	13.0	7.6	19.2	15.5
SPD		4.78	4.62	3.32	5.68	11.9
HI	(%)	38.5	36.2	12.7	48.6	20.1
W1000	(g)	130.20	121.30	57.16	156.28	17.7
SYLD	(kg/ha)	853	815	105	1454	38.0
BYLD	(kg/ha)	2214	2221	726	3741	32.0
STYLD	(kg/ha)	1362	1406	564	2499	32.5

a : IFLA 101, L. ochrus.
b : Descriptor abbreviations as per text.

SYLD, and STYLD were much lower for the tested L. sativus germplasm accessions than the L. sativus check (Table 29). Unlike the other two species, the tested accessions of L. sativus were later than the L. sativus check. Overall, the L. cicera germplasm was the best performing in this year, as indicated by the checks and the germplasm accessions.

Correlations among phenological traits (DFLR, DMAT and DPOD) were high and positive for all three species. All three species had significant postive correlations of HI and STYLD with SYLD (Table 30). L. cicera had significant negative correlations of phenological traits with SYLD (earlier accessions yielded

Table 29. Summary statistics for 272 Lathyrus sativus germplasm accessions evaluated at Tel Hadya, Syria during 1992/93

Descriptor		Check mean[a]	Mean	Min.	Max.	C.V. (%)
DFLR[b]	(days)	121.1	126.0	119	142	2.5
DMAT	(days)	163.3	173.8	145	189	3.9
DPOD	(days)	125.1	137.5	122	154	4.9
PTHT	(cm)	40.8	41.1	5.5	60.2	15.7
HTFF	(cm)	7.3	9.2	3.4	17.4	18.5
SPD		3.30	3.09	1.48	6.52	16.4
HI	(%)	26.6	19.54	1.9	54.7	43.8
W1000	(g)	104.05	86.75	34.54	225.96	34.3
SYLD	(kg/ha)	729	445	29	1406	65.9
BYLD	(kg/ha)	2682	2167	516	5200	38.2
STYLD	(kg/ha)	1953	1722	440	3861	36.2

a : IFLA 347, L. sativus.
b : Descriptor abbreviations as per text.

highest). Only L. sativus had significant correlations (positive) of plant size descriptors with SYLD.

Table 30. Correlations of SYLD with DFLR, DMAT, DPOD, PTHT, HTFF, SPD, HI, W1000, and STYLD for Lathyrus cicera (n=96), L. ochrus (n=58), and L. sativus (n=272)

Descriptor		L. cicera	L. ochrus	L. sativus
DFLR[a]	(days)	-0.45**	0.20	-0.06
DMAT	(days)	-0.26**	0.23	-0.01
DPOD	(days)	-0.45**	0.19	-0.07
PTHT	(cm)	0.21*	0.22	0.25**
HTFF	(cm)	0.03	0.07	0.14*
SPD		0.16	0.23	0.13*
HI	(%)	0.85**	0.60**	0.78**
W1000	(g)	0.50**	0.25	0.01
STYLD	(kg/ha)	0.85**	0.71**	0.58**

a : Descriptor abbreviations as per text.
*,** : Significant at P=0.05 and P=0.01, respectively.

Larry Robertson and Fawzi Sweid

1.3.9 Evaluation of Medicago polymorpha

Three hundred ninty-two accessions of the four botanical varieties (polymorpha, vulgaris, brevispina, and iraqi) of Medicago polymorpha were evaluated in an systematic design.

Eleven descriptors were recorded: growth habit (GRH), degree of spininess (SPN), hookness (HOOK), 50% flowering date (DFLR), plant height in cm (PTHT), 90 % maturity date (DMAT), pod width or diameter (PODW), pod height (PODH), spine length (SPNL), 1000 seed weight (S1000) and seeds per pod (SDP).

All four botanical varieties of M. polymorpha were mostly prostrate (Table 31). Brevispina had mostly hooks present, whereas the other varieties were without hooks on the spines of the pods. The SPN of vulgaris and brevispina were short. Polymorhpa had mostly long SPN and iraqi had mostly tuberculate SPN.

Table 31. Frequency distributions for Medicago polymorpha variety polymorpha (n=196), vulgaris (n=152), brevispina (n=12), and iraqi (n=13) for GRH, SPN and HOOK

Descriptor/ Score[a]	polymorpha	vulgaris	brevispina	iraqi
GRH				
Prostrate	67.3	65.1	66.7	53.8
Semi-erect	32.7	34.9	33.3	46.2
SPN				
Smooth	0.0	0.0	0.0	0.0
Tuberculate	0.0	0.0	8.3	61.5
Short	28.6	74.3	91.7	38.5
Long	71.4	25.7	0.0	0.0
HOOK				
Absent	99.5	79.6	16.7	84.6
Present	0.5	20.4	83.3	15.4

a : Descriptor abbreviations as per text.

All four varieties of polymorpha had similar PODW, DFLR and PTHT (Table 32). Polymorpha and iraqi had similar values for PODH, SPNL, S1000, and SDP. The values for vulgaris and brevispina were also similar for these traits, though distinct from those of polymorpha and iraqi. PODH and SPNL were long for the former group and shorter for the latter, indicating the larger pods of the former. SDP and S1000 was also higher for the polymorpha-iraqi group compared to the vulgaris-brevispina group.

Table 32. Means (X) and standard deviations (SD) for *Medicago polymorpha* variety *polymorpha* (n=196), *vulgaris* (n=152), *brevispina* (n=12), and *iraqi* (n=13) for DFLR, PTHT, DMAT, PODW, PODH, SPN, S1000, and SDP

Descriptor[a]	polymorpha		vulgaris		brevispina		iraqi	
	X	SD	X	SD	X	SD	X	SD
DFLR	142.7	4.9	144.9	5.0	145.3	5.2	146.0	7.9
PTHT	12.8	5.1	13.0	5.6	11.7	5.3	13.8	7.4
DMAT	175.6	6.4	175.6	6.8	174.3	5.7	179.1	6.0
PODW	6.64	0.66	5.53	0.72	4.83	0.72	6.85	0.55
PODH	6.32	0.96	3.84	1.08	3.17	1.03	6.46	1.05
SPNL	3.41	0.44	2.01	0.91	0.96	0.22	3.11	0.79
S1000	5.39	0.95	3.75	0.84	3.38	0.76	5.42	0.84
SDP	5.79	1.15	3.19	0.71	3.02	1.14	6.61	1.24

a : Descriptor abbreviations as per text.

From stepwise discriminant analysis using variety as the grouping variable; PTHT, HOOK, PODW, PODH, SPNL, S1000, and SDP were chosen for canonical discriminant analysis. Two canonical functions were found to be significant and explained 99.4% of the variation between variety. Understandably, the percent correct classification for variety was high (73%), with the lowest correct classification with *iraqi*, with a value of 69%.

Hierarchial cluster analysis was performed for variety using the two significant canonical functions. As follows from Tables 31 and 32, the dendrogram (Figure 3) shows a close relationship of *polymorpha* with *iraqi* and of *vulgaris* with *brevispina*. Though the varieties of *M. polymorpha* are distinct, that distinctness is based on taxonomic descriptors.

Stepwise discriminant analysis was performed for the *M. polymorpha* accessions (all varieties together) for 10 countries of origin (Italy, Morocco, Cyprus, Ethiopia, Jordan, Syria, Turkey, Algeria, Tunisia, Iraq, and Iran) and nine descriptors were found significant (SPNL, S1000, SDP, DFLR, HOOK, PODH, PTHT, PODW, and SPN). Canonical discriminant analysis resulted in six significant canonical functions, with the first three explaining 83% of the variation among countries of origin. The correct classification rate for country of origin was 45%.

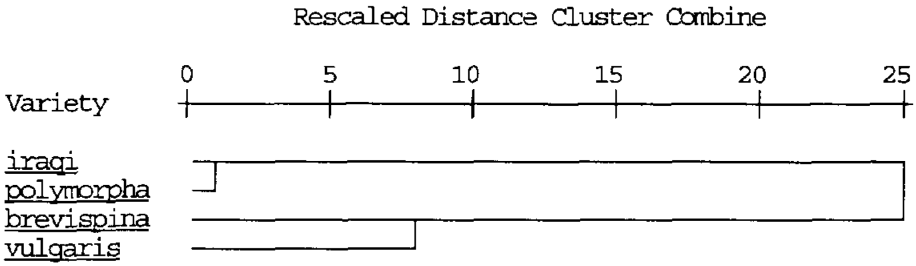

Figure 3. Dendrogram for botanical variety of M. polymorpha from hierarchial analysis based on two significant canonical functions from discriminant analysis

Hierarchial cluster analysis based on the six significant canonical functions from discriminant analysis was used to cluster the countries of origins. From the dendrogram (Figure 4) it can be seen that accessions from CYP, JOR, SYR, TUR, and ETH form a mostly Middle Eastern group. ITA-MAR and DZA-TUN form two western Mediterranean groups and IRQ and IRN are fairly distinct from the Middle Eastern and western Mediterranean goups.

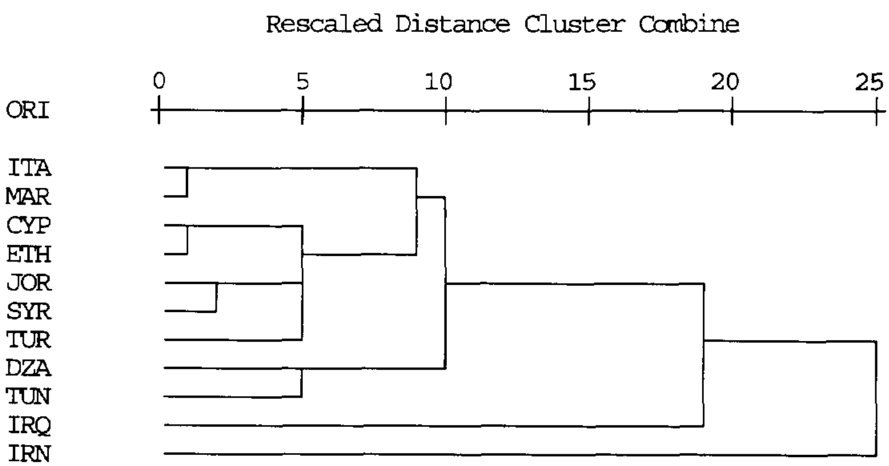

Figure 4. Dendrogram for country of origin for M. polymorpha (all varieties) using six significant canonical functions from discriminant analysis

Larry Robertson and Ali Shehadeh

1.4. Genetic resources support research

1.4.1. Study of variation in gliadins in landraces and varieties of Triticum aestivum from Iran

A collection of T. aestivum consisting of 74 varieties and 27 population samples of landraces was analyzed in the electrophoresis laboratory of the Genetic Resources Unit using PAGE. Since the seeds from the 74 varieties were from single spikes, only protein extracts from one seed per sample were used. In order for the banding profiles of two samples to be identical, the profiles should match each other band for band in relative mobility (Rm) as well as intensity of staining. The results showed each variety to be unique in its gliadin banding pattern as shown in Fig. 5, where the ten varieties are different from one another.

A.B. Damania and N.A. Sepahvand (SPII, Karaj, Iran) and H. Altunji

1.4.2. Alien gene transfer and assessment of alien genetic polymorphisms through the use of molecular markers

The following is a report of the collaborative research activity carried out at the Department of Agrobiology and Agrochemistry, University of Tuscia, Viterbo, Italy, under the framework of the special project "Enhancing wheat productivity in stress environments utilizing wild progenitors and primitive forms."

Alien gene transfer

a) Transferring Pm13 gene:

Several recombinants of bread wheat cv. Chinese Spring (CS)-Ae. longissima were obtained through ph1b mediated homeologous recombination. Eight of these have been characterized in detail. Five (R1A, R4A, R5A, R6A, and R1B) exhibited recombination on wheat chromosome 3B, and the remaining three (R2A, R2B and R1D) on chromosome 3D. Cytogenetic (observation of pairing in meta-phase I) and genetic (telocentric mapping) analyses allowed the

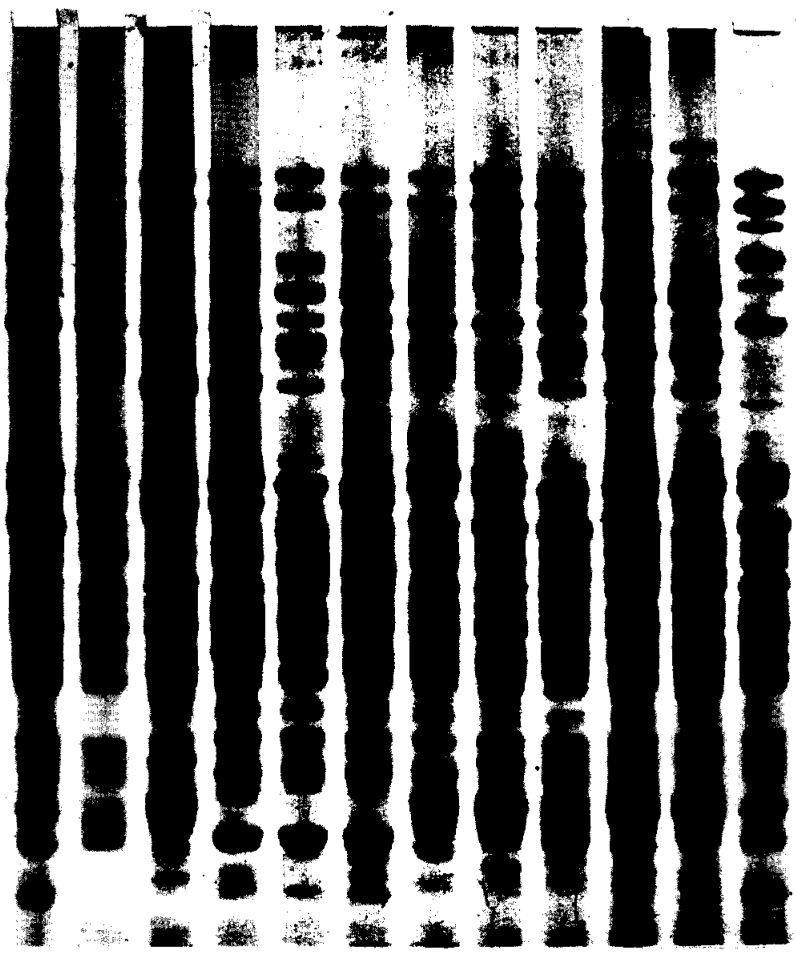

Figure 5. Variation for gliadin banding patterns in ten old varieties of bread wheat from Iran using Al-lactate PAGE. "Marquis" (reference) is in the lane on the extreme right and left

estimation of the amount of alien chromatin transferred to each recombinant. Among the 3B recombinants, R6A seemed to have a larger alien segment than the remaining ones. Among the 3D recombinants, R2A showed the most proximal wheat-alien chromatin breakpoint, R2B the most distal, and R1D was in-between. Restriction Fragment Length Polymorphism (RFLP) analyses have been carried out to obtain a more refined genetic mapping of the recombinant lines. RFLP also assists in selection of lines carrying the minimum possible amount of alien chromatin. Wheat homeologous group-3 RFLP probes mapped on the critical 3BS and 3DS arms, along with heterologous probes have been used. The mapping results generally agreed with the ones obtained through genetic and cytogenetic analyses. However, the former approach allowed further discrimination within the two groups, particularly, R4A and R1B, which were the 3B recombinants with the smallest alien introductions, resulting in R2B being included among the 3D ones. On the basis of these results, R1B has been employed for subsequent work aimed at introducing the Pm13 gene into durum wheat.

High yielding Italian durum wheat cultivars with desired industrial quality and possessing the powdery mildew resistance gene (Pm4a) of declining efficacy were chosen as Pm13 recipients. Gene pyramiding is expected to result in a more durable resistance than that associated with single major genes. Line R1B was initially crossed with durum cultivars and the resulting pentaploid progeny backcrossed to the recurrent durum parents. Backcross (BC_1) progenies were tested for resistance to powdery mildew and their chromosomal number assessed. Among the resistant individuals, some already exhibited an euploid 2n=28 chromosomal number. Further backcrossing and selfing will allow the recovery of the Pm13 + Pm4 homozygous condition into suitable genotypes for cultivation.

b) Transferring Lr19 and Yp

Chinese Spring-*Agropyron elongatum* transfer N°. 12, one of the lines produced by the late E.R. Sears to transfer the effective *Agropyron* Lr19 leaf rust resistance gene to bread wheat, has been used to introduce the alien chromosome segment into durum wheat. In addition to Lr19, the Yp gene for yellow flour pigmentation, whose effect is detrimental for bread wheat producers but is valuable for pasta products, is also found in the same segment.

The translocation in transfer N°. 12 involves the chromosome 7A, which permits traits to be transferred through homologous recombination to durum varieties. CS-Agropyron elongatum transfer N°. 12 was thus crossed to high industrial quality durum cultivars and the resulting pentaploid progenies have been backcrossed to the same durum cultivars. Selection for leaf rust resistance and somatic chromosome numbers was carried out in each generation. Individuals with 2n=28 have already been obtained among the BC_1 progeny. After repeated backcrosses and selfing, chromosomally stable and homozygous progenies were produced. These progenies are being tested for semolina "yellow index", an accurate indicator for industrial quality pasta flour.

Genomic in-situ hybridization experiments allowed physical determination of the CS-Agropyron elongatum chromatin breakpoint in the transfer line used. The translocated segment turned out to be longer than previously stated on the basis of meiotic pairing and N-banding analyses, since it includes the entire long arm, where the Lr19 and Yp genes are located, and part of the short arm of the same 7A chromosome.

So far, no apparent undesirable trait seems to be associated with the Agropyron chromatin of the Lr19 + Yp donor line. However, ph1 mediated chromosome engineering might eventually be used to reduce alien chromatin transferred with the selected genes.

Assessment of alien genetic polymorphism through the use of molecular markers

In continuation of the research mentioned in the GRU Annual report for 1992, work was conducted on the use of molecular markers to assess genetic variability in diploid, tetraploid and hexaploid Triticum species. To increase the number of useful RFLP clones, Pstl genomic libraries from T. urartu and Aegilops squarrosa were screened. Two-hundred recombinant clones were analyzed and 20 out of these were found useful in detecting polymorphism between Triticum species. In particular, the analysis was carried out on genomic DNA from T. urartu, T. dicoccoides, T. dicoccon, T. durum cv. Trinakria and T. aestivum cv. Chinese Spring. Among the RFLP clones which were polymorphic, some were particularly interesting for species identification and genotype/cultivar fingerprinting. Two of them were specific for the D genome of Ae. squarrosa and gave an hybridization pattern with several distinct bands useful for fingerprinting analysis.

To evaluate the genetic polymorphism of each specific chromosome, the hybridizing bands obtained with the selected clones were assigned to specific chromosomes and chromosome arms using genomic DNA of nulli-tetrasomic and ditelocentric lines of T. aestivum cv. CS, respectively. The majority of such clones were localized on chromosomes of homoeologous groups 1, 3 and 7. However, representative clones of the other homoeologous groups were also obtained.

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1.4.3. Biodiversity studies in wild progenitors of wheat

As a result of recent exploration activities of ICARDA conducted in cooperation with NARSs of Syria, Jordan and Lebanon, knowledge of the distribution of wild progenitors of wheat in the southern regions of the Fertile Crescent has been substantially increased. Comparison of new maps for geographical distribution of the wild Triticum spp. with previous ones in publications by Witcombe et al. (1982) and van Slageren et al. (1989) reveals considerable differences, especially with diploid species. These differences are partly caused by reclassification of the wild diploid accessions.

Existence of T. boeoticum in Syria was questioned by Witcombe et al. (1982). Now, this species is well documented in two, relatively small areas; the northern part of the Jebel Sa'aman in Aleppo Province and the Anti-Lebanon mountains close to the Lebanese border. Distribution of this species extends to Lebanon, north of Mount Hermon; where it was discovered for the first time this year in a joint ICARDA/ARI Lebanon expedition.

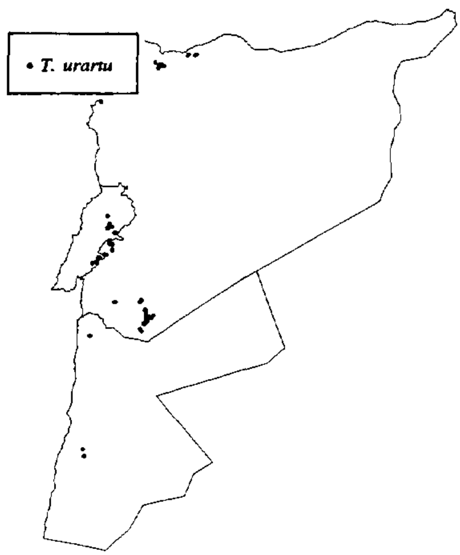

Figure 6. Geographical distribution of Triticum urartu in Lebanon, Jordan and Syria

The other wild diploid wheat, T. urartu, is more abundant and more common for Syria and Lebanon than T. boeoticum. Its distribution extends to the south of Jordan (Fig. 6). At most sites it is sympatric with wild emmer, Triticum dicoccoides; however, T. urartu is better adapted to marginal and/ or diverse environments. It is found at elevations above 1800 m asl, at a high-rainfall site (1000 mm) in northwest Syria, low-rainfall sites in the Beka'a valley in Lebanon, in the northeast of Aleppo Province, Syria, and in the drier eastern part of the Jebel Al-Arab, Sweida Province, Syria, where it dominates over T. dicoccoides in sympatric populations, especially in dry years. Witcombe et al. (1982) reported the presence of wild diploid wheats in northeastern Syria, Hassake Province. This, however, could not be confirmed by a mission to that area in 1991 and there is concern that those populations are now extinct.

The distribution of T. dicoccoides is concentrated in three major areas: (i) Mount Hermon (Lebanon) and Zabadani regions (Syria) in the Anti-Lebanon mountains; (ii) Jebel Al-Arab high plateau in Sweida Province, Syria; and (iii) northwest Jordan (Fig. 7). This species is also common in the more fertile parts of the Hauran in southern Syria, where its presence depends on grazing intensity. In that region, small- or medium-size populations are confined to roadsides, field borders, and near heaps of stones removed with some soil from fields.

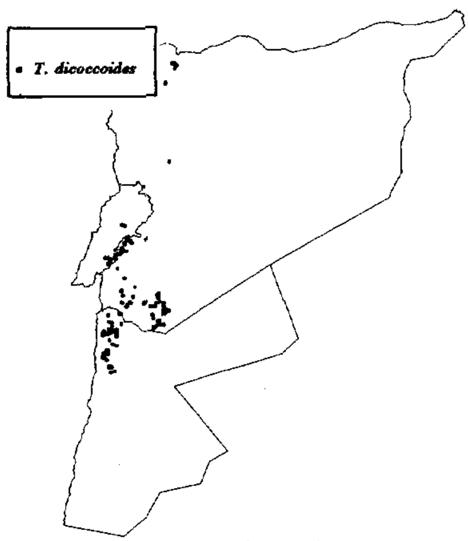

Figure 7. Geographical distribution of Triticum dicoccoides in Lebanon, Jordan and Syria

In general, the major factors affecting biodiversity in wild wheat progenitors in Syria, Lebanon and Jordan are overgrazing by small ruminants and the change of stony, long-term fallow or uncultivated land into fields. Large populations of T. urartu and T. dicoccoides still exist in the Jebel Al-Arab high plateau in southern Syria on stony uncultivated or rarely cultivated private land surrounded by fields, where sheep grazing during the vegetative period of field crops is controlled by farmers.

Relatively undisturbed populations of wild Triticum spp. can also be found in remote and/or less populated mountain areas. Grazing by sheep is usually less intensive in such locations.

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1.4.4. Diversity in T. urartu and T. dicoccoides populations from Syria and Jordan

A total of 1256 and 219 single-plant progenies, derived from 23 T. dicoccoides and nine T. urartu populations collected recently in Jordan and Syria (see GRU AR 1992), were planted in the postquarantine area of the ICARDA main experimental station, Tel Hadya, on November 19, 1992, in an unreplicated nursery with three durum wheat systematic checks (Cham 1, Omrabi and Haurani).

Phenotypical diversity of the populations was analyzed by means of discriminant analysis using the following six descriptors: time to heading, time to maturity, spike length, awn length, number of spikelets per spike, and plant height.

The first two canonical discriminant functions accounted for 95.9% of the variance (80.4 and 15.5%, respectively) in the nine T. urartu populations. The first function was associated with time to heading, its standardized coefficient for the first canonical discriminant function (SC1) = 0.87, and the second function was associated with awn length (SC2 = 0.88).

Plotting function 1 with function 2 separated three major groups: (i) populations from southern Syria which were early and short-awned; (ii) Jordanian populations - early and long-awned; and (iii) populations from northern Syria - late and short-awned.

Hierarchical cluster analysis based on group centroids of the three significant canonical discriminant functions indicated higher similarity of the Jordanian and southern Syrian populations, whereas the populations from northern Syria were grouped in a distinct cluster (Fig. 8). This grouping probably reflects the difference in ecological characteristics of the respective habitats.

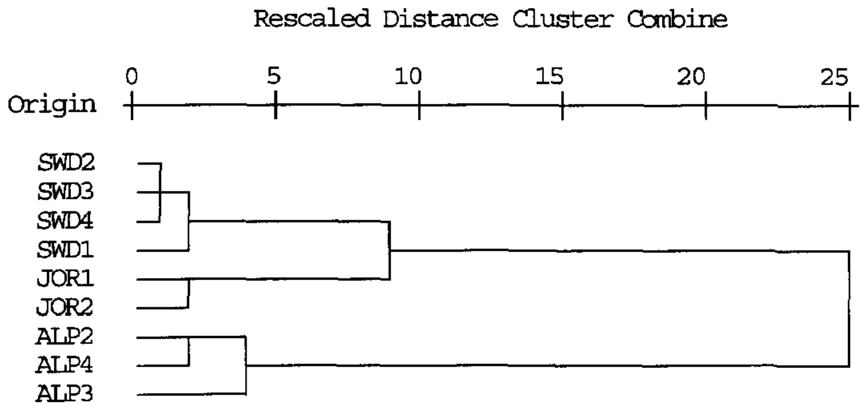

Figure 8. Dendrogram of nine T. urartu populations from Syrian provinces (ALP=Aleppo, SWD=Sweida) and Jordan (JOR) based on six quantitative descriptors

Two populations from the vicinity of Sha'af village in the eastern part of Sweida province displayed the highest percentages of misclassifications with other populations from southern Syria. This indicates a high intrapopulational diversity, which was also found in a previous study based on seed protein polymorphism analysis of one of the two populations (see GRU Annual Report 1991).

Discriminant analysis of 16 Jordanian and seven Syrian populations of T. dicoccoides revealed six significant canonical discriminant functions and showed a considerable difference between two major groups: (i) populations from Sweida and Aleppo Provinces of Syria; and (ii) Jordanian populations and a population from Damascus Province, Syria (Figs. 9 and 10).

The most significant characters associated with the first two canonical discriminant functions, which accounted for 65.8% and 17.6% of the total variation, respectively, were number of spikelets per spike (SC1 = -0.78) and awn length (SC1 = 0.64) in function 1 and plant height (SC2 = 0.72) and time to heading (SC2 = 0.61) in function 2 (Fig. 9).

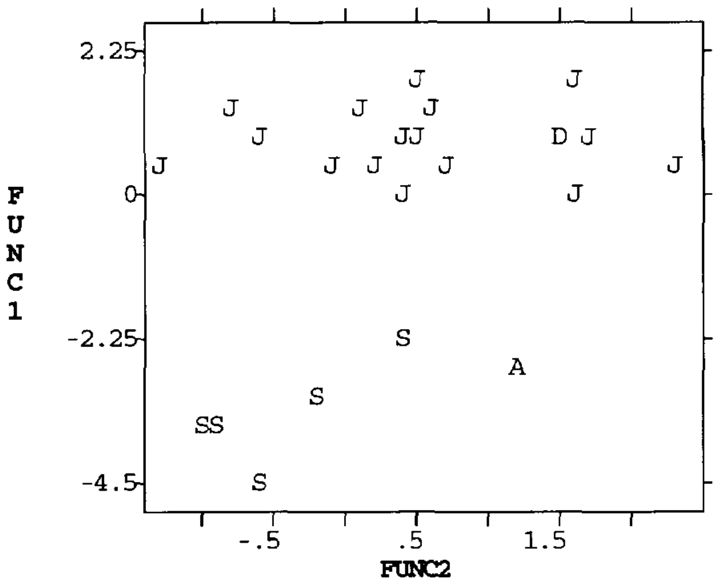

Figure 9. Plot of canonical discriminant function group centroids for 23 T. dicoccoides populations from Syrian provinces (A = Aleppo, D = Damascus, S = Sweida) and Jordan (J)

The dendrogram in Fig. 10 reveals two major subgroups within the Jordanian cluster, which are also discriminated by function 2 in Fig. 9. These subgroups are discriminated by plant height and heading date. One Syrian population from the Zabadani Valley in the Anti-Lebanon Mountains, Damascus Province, belongs to one of the Jordanian subgroups.

The seven Syrian populations were analyzed separately by the same type of multivariate statistical analyses, with six additional descriptors: growth habit, growth class, waxiness, glume color, glume hairiness, and awn color. The primary factors for discrimination were time to heading (association with function 1, SC1 = 0.70) and spike length (association with function 2, SC2 = 0.97). Populations SWD2, SWD5 and SWD4 form a 'core' of the 'Sweida' morphotype, which possibly is an ecotype. The population SWD1 is located close to Jordan and, as the mis-

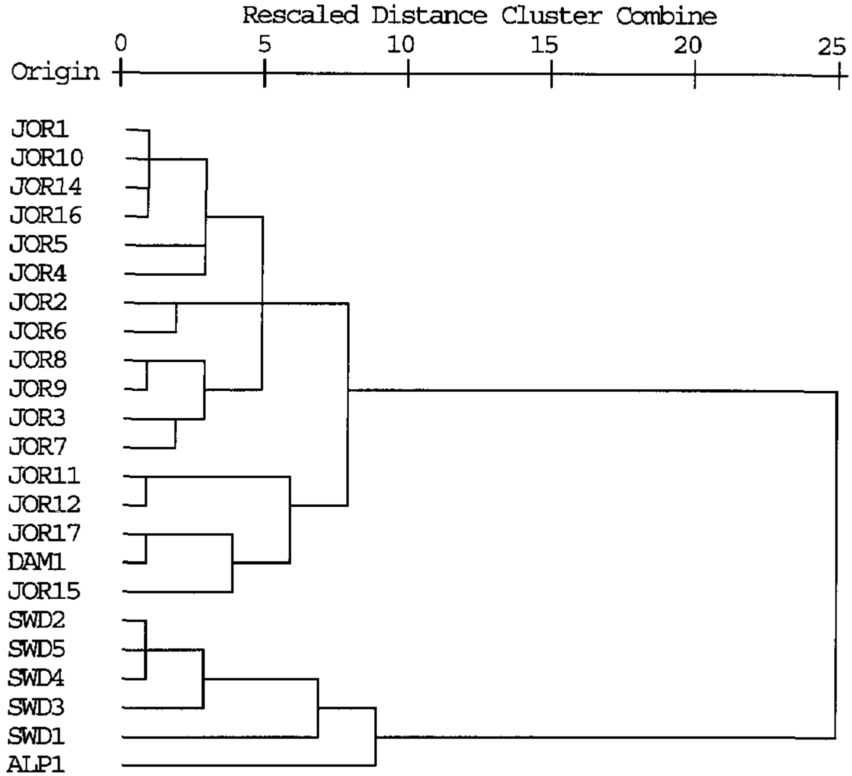

Figure 10. Dendrogram of 23 _T. dicoccoides_ populations from Syrian provinces (ALP=Aleppo, DAM=Damascus, SWD=Sweida) and Jordan (JOR) based on six quantitative descriptors

classification data showed (15.0% with Jordanian populations), there is similarity with the Jordanian subgroup. The populations from Aleppo and Damascus provinces are separated from each other, as well as from the Sweida populations. This indicates that in Syria there are at least three major distinct morphotypes, which perhaps are ecotypes, since the different groups occupy diverse environments: (i) highlands >1300 m asl, basalt, low rainfall, Sweida; (ii) highlands >1100 asl, limestone, medium rainfall, Damascus; and (iii) lowlands 400-500 m asl, basalt, medium rainfall, Aleppo.

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1.4.5. Taxonomic study of Aegilops

In the frame work of the taxonomic revision of Aegilops and the wild species of Triticum; herbaria of Berlin (435), Genève (8), Lund (157), and Vienna (369) were studied in the Netherlands and the U.K. Material studied in the Netherlands was received on loan by the Laboratory for Plant Taxonomy of the Agricultural University at Wageningen.

During 1993, the general part of the taxonomic revision of Aegilops was completed. This includes an analysis of the distribution patterns, which was presented in the 1992 Genetic Resources Unit Annual Report. Other chapters are devoted to the history, morphology, ecology, and phylogeny of the group. It is advocated that Aegilops remains a separate genus from Triticum (thus seen sensu stricto), with, in addition, separate generic status for Aegilops mutica as Amblyopyrum muticum. An enumeration of the generic characters is presented in the "Proceedings of the International Symposium on Biodiversity and Wheat Improvement," held in October, 1992.

Though only one character consistently separates Aegilops from Triticum - the absence (Aegilops) or presence (Triticum) of a distince keel on the glumes - many can be drawn to separate Amblyopyrum muticum from Aegilops (characters listed for Amblyopyrum muticum only, and according to Eig, 1929): (1) total absence of awns; (2) glumes widest at apex; (3) glume venation divergent; (4) glume apex truncate but irregularly gnawed; (5) plants "...either completely glabrous or beset with long, spreading, stiff hairs appearing like bristles..." [This is imprecise: only glumes and upper parts of lemmas are hispid; rachis segments, as well as stems and leaves are glabrous], and (6) apex of lower paleas rounded.

With the separation of Aegilops L. and Triticum L., the genus which accomodates the intergeneric hybrids, x Aegilotriticum P. Fourn., now remains in place. In the case of merger of the two genera it would have been dissolved, becoming just a group of interspecific hybrids instead.

The complicated nomenclature of all taxa involved has been solved. This involved the correct names of the 27 accepted taxa, 175 so-called heterotypic synonyms (taxonomically the same as any of the accepted taxa, but based on other type specimens), 27 nomina nuda (undescribed but published names), and 30 taxa that had to be excluded from Aegilops but were originally published in the genus. The total amount of names, coined for any of the taxa in any combination, however, is over 800! All these have now been checked for their validity to establish the one and only, correct name for any accepted taxon in the proposed generic and sectional configuration.

Three ways of disarticulation of the spike exist in Aegilops: (1) at the base of the rachilla: "wedge-type" (e.g., in Ae. speltoides var. ligustica); (2) at the top of the rachilla: "barrel-type" (e.g., in Ae. crassa), and (3) at the base of the lowest fertile spikelet: "whole-spike type" (the whole spike, including the rachis segment that supports the lowest fertile spikelet, which falls as one unit: e.g., in Ae. longissima). These disarticulation types almost completely coincide with the five sections of Aegilops as defined here. Aegilops now consists of 22 species and five non-typical varieties, grouped in five sections. The generic and sectional nomenclature of Aegilops, Amblyopyrum, and x Aegilotriticum is now as follows:

Aegilops L.; *Linnaeus*, Species plantarum (ed. 1) 2: 1050 (1753), (ed. 2) 2: 1489 (1763), Genera plantarum (ed. 5) 470 (1754).

Type species: Aegilops triuncialis L. Designated by Hammer (1980).

Section **Aegilops**:

Basionym: Aegilops L. sect. Surculosa Zhuk.; Zhukovsky, Bull. Appl. Bot., Gen. & Pl. Breeding 18(1): 449 (1928). - Note: although this is the oldest name for this taxon as it is based on the same type species, it has to be replaced by Aegilops following the autonym rule of Art. 22.1 of the ICBN.

Type species: Ae. triuncialis L.

Disarticulation: whole-spike type.

Genome types (see Table 33): U, and modified forms of C, M, N, S, and U. As follows: diploid U; tetraploid UC, UM, UN, US; hexaploid UMN.

Species: Ae. biuncialis Vis., Ae. columnaris Zhuk., Ae. kotschyi Boiss., Ae. neglecta Req. ex Bertol., Ae. ovata L., Ae. peregrina (Hack.) Maire & Weiller, Ae. triuncialis L., Ae. umbellulata Zhuk.

Section **Comopyrum** (Jaub. & Spach) Zhuk.; Zhukovsky, Bull. Appl. Bot., Gen. & Pl. Breeding 18(1): 451 (1928).

Basionym: Aegilops L. subg. Comopyrum Jaub. & Spach; Jaubert & Spach, Illustrationes plantarum orientalium 4: 19 (1851).

Type species: Ae. comosa Sm. in Sibth. & Sm.

Disarticulation: whole-spike type.

Genome types: diploid M and N.

Species: Ae. comosa Sm. in Sibth. & Sm., Ae. uniaristata Vis.

Section **Cylindropyrum** (Jaub. & Spach) Zhuk.; Zhukovsky, Bull. Appl. Bot., Gen. & Pl. Breeding 18(1): 449 (1928).

Basionym: Aegilops L. subg. Cylindropyrum Jaub. & Spach; Jaubert & Spach, Illustrationes plantarum orientalium 4: 12 (1850).

Type species: Aegilops cylindrica Host.

Disarticulation: whole-spike type.

Genome types: C and D, as follows: diploid C; tetraploid CD.

Species: Ae. caudata L., Ae. cylindrica Host

Section **Sitopsis** (Jaub. & Spach) Zhuk.; Zhukovsky, Bull. Appl. Bot., Gen. & Pl. Breeding 18(1): 454 (1928).

Table 33. Genomic formula and synonyms (at species level, and when available) when Aegilops, Amblyopyrum and x Aegilotriticum are placed within Triticum emend

Species of Aegilops	Genome[a]	Species of Triticum
1. Aegilops bicornis (Forssk.) Jaub. & Spach	S^b	Triticum bicorne Forssk.
2. Aegilops biuncialis Vis.	UM	Triticum macrochaetum (Shuttlew. & A. Huet ex Duval-Jouve) K. Richt. (note 1)
3. Aegilops caudata L.	C	Triticum dichasians Bowden
4. Aegilops columnaris Zhuk.	UM	(note 2)
5. Aegilops comosa Sm. in Sibth.	M	Triticum comosum (Sm. in Sibth. & Sm.& Sm.) K. Richt.
6. Aegilops crassa Boiss. (Boiss.) Aitch.	DM DDM	Triticum crassum & Helmsl.
7. Aegilops cylindrica Host	CD	Triticum cylindricum (Host) Ces., Pass. & Gibelli
8. Aegilops geniculata Roth	UM	(note 3)
9. Aegilops juvenalis (Thell.) Eig	DMU	Triticum juvenale Thell.
10. Aegilops kotschyi Boiss.	US	Triticum kotschyi (Boiss.) Bowden
11. Aegilops longissima Schweinf.	S^l	Triticum longissimum (Schweinf. & Muschl.& Muschl.) Bowden
12. Aegilops neglecta Req. ex Bertol.	UM UMN	Triticum neglectum (Req. ex Bertol.) Greuter Triticum recta (Zhuk.) Chennav.
13. Aegilops peregrina (Hack.) Maire & Weiller	US	Triticum peregrinum Hack.

Table 33. Continued

Species of Aegilops	Genome[a]	Species of Triticum
14. Aegilops searsii Feldman & Kislev ex Hammer	S^s	(note 2)
15. Aegilops sharonensis Eig	S^l	Triticum longissimum (Schweinf. & Muschl.) Bowden ssp. sharonense (Eig) Chennav. (note 4)
16. Aegilops speltoides Tausch	S	Triticum speltoides (Tausch) Gren. ex K. Richt.
17. Aegilops tauschii Coss.	D	Triticum tauschii (Coss.) Schmahlh.
18. Aegilops triuncialis L.	UC	Triticum triunciale (L.) Rasp.
19. Aegilops umbellulata Zhuk.	U	Triticum umbellulatum (Zhuk.) Bowden
20. Aegilops uniaristata Vis.	N	Triticum uniaristatum (Vis.) K. Richt.
21. Aegilops vavilovii (Zhuk.) Chennav.	DMS	Triticum syriacum Bowden
22. Aegilops ventricosa Tausch	DN	Triticum ventricosum (Tausch) Ces., Pass. & Gibelli
Species of **Amblyopyrum**		
1. Amblyopyrum muticum (Boiss.) Eig	T	Triticum tripsacoides (Jaub. & Spach) Bowden (note 1)
Species of **x Aegilotriticum**		
1. (combination not made)	AD	Triticum erebunii Gandilyan (note 5)

a : Genomic formula according to Kimber & Tsunewaki (1988). Underlining indicates substantial modification from the same genome types, present in the diploid species.

Basionym: Aegilops subg. Sitopsis Jaub. & Spach; Jaubert & Spach, Illustrationes plantarum orientalium 4: 10 (1850).

Lectotype species: Aegilops speltoides Tausch. Designated by Hammer (1980) and including both varieties.

Disarticulation: wedge-type and whole-spike type (Ae. longissima, Ae. searsii, Ae. speltoides var. speltoides only).

Genome type: S.

Species: Ae. bicornis (Forssk.) Jaub. & Spach, Ae. longissima Schweinf. & Muschl., Ae. searsii Feldman & Kislev ex Hammer, Ae. sharonensis Eig, Ae. speltoides Tausch.

Section **Vertebrata** Zhuk. emend. Kihara; Kihara, Züchter 12: 61, Tab. 12 (1940), Cytologia 19: 342, Tab. 3 (1954; further emendation).

Based on: section Vertebrata Zhuk.; Zhukovsky, Bull. Appl. Bot., Gen. & Pl. Breeding 18(1): 450 (1928).

Disarticulation: barrel-type.

Genome types: D, N, and modified D, M, S and U, as follows: diploid D; tetraploid DM, DN; hexaploid DDM, DMS, DMU.

Species: Ae. crassa Boiss., Ae. juvenalis (Thell.) Eig, Ae. tauschii Coss., Ae. vavilovii (Zhuk.) Chennav., Ae. ventricosa Tausch.

Amblyopyrum (Jaub. & Spach) Eig; Eig, P.Z.E. Inst. Agric. Nat. Hist., Agric. Rec. 2: 199 (1929b).

Basionym: Aegilops L. subg. Amblyopyrum Jaub. & Spach; Jaubert & Spach, Illustrationes plantarum orientalium 4: 23 (1851).

Type (and only) species: Amblyopyrum muticum (Boiss.) Eig.

Disarticulation: wedge-type.

Genome type: T.

x Aegilotriticum P. Fourn.; Fournier, Les quatre flores de la France 89 (1935).

Table 34 presents the accepted names in Aegilops, Amblyopyrum

Table 34. Taxa recognized in the genera Aegilops, Amblyopyrum, and x Aegilotriticum and their basionyms or most widely known synonyms

Taxon	**Basionym (B:) and/or most common synonym (S:) Genus**
Genus **Aegilops** L.	S: Triticum L. pro parte
Sections of **Aegilops**	
1. Sect. Aegilops	S: Aegilops L. sect. Surculosa Zhuk.
2. Sect. Comopyrum (Jaub. & Spach) Zhuk.	B: Aegilops L. subg. Comopyrum Jaub. & Spach.
3. Sect. Cylindropyrum (Jaub. & Spach Zhuk.	B:Aegilops L. subg. Cylindropyrum Jaub. & Spach
4. Sect. Sitopsis (Jaub. & Spach) Zhuk.	B: Aegilops subg. Sitopsis Jaub. & Spach
5. Sect. Vertebrata Zhuk. emend. Kihara	(no basionym. Emendation of sect. Vertebrata Zhuk.)
Species of **Aegilops**	
1. Aegilops bicornis (Forssk.) Jaub. & Spach	
var. bicornis	B: Triticum bicorne Forssk.
var. mutica (Asch.) Eig	B: Triticum bicorne Forssk. var. β muticum Asch.
2. Aegilops biuncialis Vis.	S: Aegilops lorentii Hochst.
3. Aegilops caudata L.	S: Aegilops markgrafii (Greuter) Hammer S: Aegilops dichasians (Bowden) Humphries
4. Aegilops columnaris Zhuk.	-

Table 34. (continued)

Taxon	Basionym (B:) and/or most common synonym (S:) Genus
5. Aegilops comosa Sm. in Sibth. & Sm.	-
var. comosa	-
var. subventricosa Boiss.	S: var. heldreichii (Holzm. ex Boiss.) Eig
6. Aegilops crassa Boiss.	-
7. Aegilops cylindrica Host	-
8. Aegilops geniculata Roth	S: Aegilops ovata L. pro parte
9. Aegilops juvenalis (Thell.) Eig	B: Triticum juvenale Thell.
10. Aegilops kotschyi Boiss.	-
11. Aegilops longissima Schweinf. & Muschl.	-
12. Aegilops neglecta Req. ex Bertol.	S: Aegilops triaristata Willd. S: Aegilops recta (Zhuk.) Chennav. S: Aegilops ovata L. emend. Roth
13. Aegilops peregrina (Hack.) Maire & Weiller	
var. peregrina	B: Triticum peregrinum Hack. S: Aegilops variabilis Eig
var. brachyathera (Boiss.) Eig	B: Aegilops triuncialis L. var. brachyathera Boiss.
14. Aegilops searsii Feldman & Kislev ex Hammer	-
15. Aegilops sharonensis Eig	-

Table 34. (continued)

Taxon	**Basionym (B:) and/or most common synonym (S:) Genus**
16. *Aegilops speltoides* Tausch	
var. *speltoides*	S: *Aegilops aucheri* Boiss.
var. *ligustica* (Savign.) Fiori	B: *Agropyrum ligusticum* Savign.
17. *Aegilops tauschii* Coss.	S: *Aegilops squarrosa* L.
18. *Aegilops triuncialis* L.	
var. *triuncialis*	-
var. *persica* (Boiss.) Eig	B: *Aegilops persica* Boiss.
19. *Aegilops umbellulata* Zhuk.	-
20. *Aegilops uniaristata* Vis.	-
21. *Aegilops vavilovii* (Zhuk.) Chennav.	B: *Aegilops crassa* Boiss. ssp. *vavilovii* Zhuk.
22. *Aegilops ventricosa* Tausch	-
Genus **Amblyopyrum** (Jaub. & Spach) Eig	B: *Aegilops* subg. *Amblyopyrum* Jaub. & Spach
Species of **Amblyopyrum**	
1. *Amblyopyrum muticum* (Boiss.) Eig	
var. *muticum*	B: *Aegilops mutica* Boiss.
	S: *Aegilops tripsacoides* Jaub. & Spach
var. *loliaceum* (Jaub. & Spach) Eig	B: *Aegilops loliacea* Jaub. & Spach
Genus **x Aegilotriticum** P. Fourn.	S: x *Aegilotricum* R. Wagner ex Tscherm.-Seys. *nom. inval*.
	S: x *Aegilotrichum* (E.G. Camus ex?) A. Camus *nom. inval*.

Table 34. (continued)

Taxon	Basionym (B:) and/or most common synonym (S:) Genus
Species of **x Aegilotriticum**	
1. (combination not made)	B: Triticum erebunii Gandilyan
2. x Aegilotriticum grenieri (K. Richt.) P. Fourn.	B: x Triticum grenieri K. Richt. S: Triticum vulgari-triaristatum Godr. & Gren. nom. inval.
3. (combination not made)	B: Aegilops caudata L. var. α langeana Amo S: Aegilops vulgari-triuncialis Lange nom. inval.
4. (combination not made)	B: x Triticum rodetii Trab.
5. x Aegilotriticum sancti-andreae (Degen) Soó	B: Aegilops sancti-andreae Degen S: x Aegilotriticum cylindrare Cif. & Giacom. nom. inval. S: x Aegilotriticum cylindroaesti-vum Gandilyan nom. inval.
6. (combination not made)	B: Aegilops speltaeformis Jord. S: Triticum speltaeforme (Jord.) Asch. & Graebn.
7. (combination not made)	B: Aegilops triticoides Req. ex. Bertol. S: Triticum vulgari-ovatum Godr. & Gren. nom. inval.

and the hybrid genus x Aegilotriticum with their so-called basionyms (the first name given to the taxon) and the most widely known synonyms. Table 33 presents the names of Aegilops taxa when located under Triticum, showing that a valid combination under the latter genus has not been published, nor will be published, for three taxa. (Notes 1-5 are dealing with some complications). For reasons of nomenclature, the new combinations resulting from the study are not published here. Principle IV of the International Code of Botanical Nomenclature (1988) states in this respect: "Each taxonomic group...can bear only one correct name, the earliest that is in accordance with the Rules...". As the forthcoming Aegilops monograph should be the earliest place of publication of new combinations, publication in this Annual Report, which may appear earlier than the monograph, has to be avoided.

Michiel van Slageren

1.4.6. Biodiversity in Lens

Lens culinaris (cultigen, 100 accessions), L. orientalis (174 accessions), L. odemensis (40 accessions), L. ervoides (104 accessions), and L. nigricans (36 accessions) were evaluated for eight izozyme systems (PGI, LAP, AAT, ME, PGM, PGD, SKDH, and ACP) with 12 polymorphic isozyme loci to study relationships among species and genetic diversity of the four wild species. Also, the genetic relationships among L. orientalis from six eco-geographic areas (EturNEsyr=eastern Turkey and northeastern Syria, 18 accessions; SturNWsyr=southern Turkey and northwestern Syria, 73 accessons; Ssyr=southern Syria and Lebanon, 26 accessions; Ntur=northern Turkey, 7 accessions; Wtur=western Turkey, 11 accessions; and the USSR=former Soviet Central Asian Republics, 10 accessions) were studied.

Using the 12 isozyme loci, Nei's genetic distance was calculated among the combinations of Lens species. The dendrogram based on these distances is given in Figure 11. L. culinaris and L. orientalis are the closest related species, as would be expected (cultigen and progenitor). Also, odemensis is closely related to this group, supporting the classification system of Lens culinaris with three subspecies proposed by several taxonomists. However, the contention that there is just one other species of Lens, L. nigricans, with two subspecies, nigricans and ervoides, is not supported by these data. Lens nigricans is distinct from the other Lens species including L. ervoides. L. ervoides clusters with the other three species and not with L. nigricans.

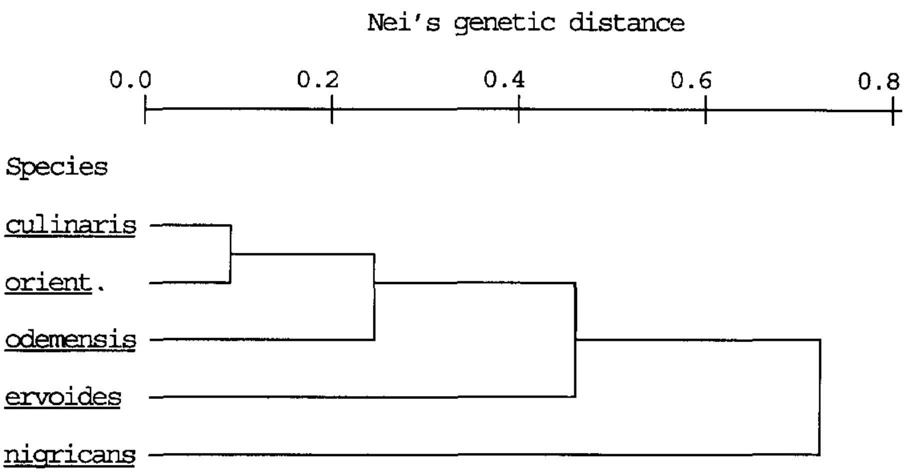

Figure 11. Relationship of species of Lens based on Nei's genetic distance calculated using 12 isozyme loci

For L. orientalis, the 145 accessions with site data were analyzed for genetic distance between eco-geographical regions as defined above. The regions of Wtur, EturNEsyr, and SturNWsyr formed a tighly linked cluster (Figure 12), with Ntur and Ssyrlbn less tightly linked with this group. The accessions from the former Soviet Central Asian Republics are quite distinct from the rest of the orientalis germplasm, indicating that this germplasm pool of L. orientalis is distinct from the Near East germplasm of the rest of L. orientalis. This germplasm pool might be useful in crosses with the cultigen because of its genetic distance from the rest of the L. orientalis.

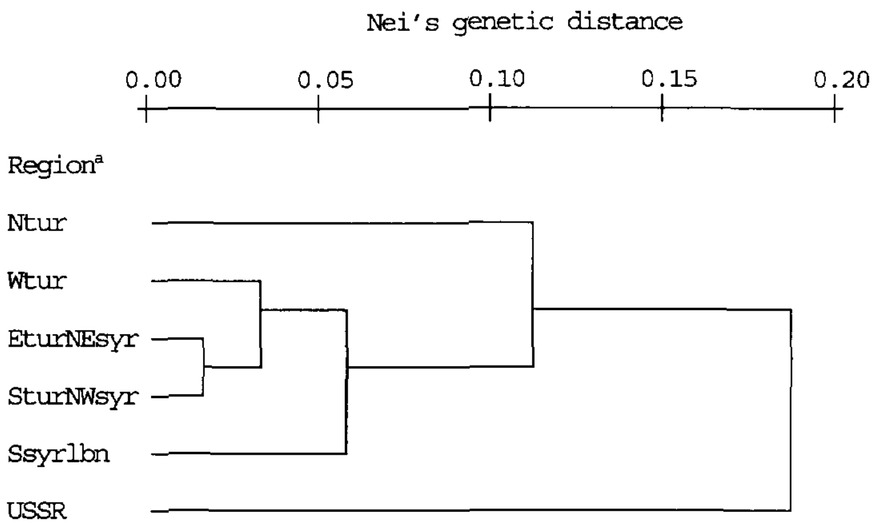

Figure 12. Dendrogram of six sub-regions ([a] see text for description) for Lens orientalis for Nei's genetic distance based on 12 isozyme loci

Data from the 12 isozyme loci were used to calculate genetic diversity for the four wild species of Lens and for the six sub-regions for L. orientalis based on Nei's heterozygosity index and the Shannon Weaver information index (Table 35). The species diversity was highest for L. nigricans and lowest for L. ervoides. The region with the lowest genetic diversity for L. orientalis was the central Asian Republics of the former Soviet Union and the highest was with northern Turkey.

This information indicates that there would be three possible areas for in-situ conservation for L. orientalis: (a) northern Turkey because of its distinctness (Figure 12) and because this is the area with the highest diversity (Table 35), (b) the former Soviet Central Asian Republics because this region is the most distinct germplasm of the L. orientalis gene pool, and (c) a site from Syria or southern Turkey, as this area is similar and could be represented by a common site.

Table 35. Genetic diversity for the five Lens species and for the six eco-geographical subregions for L. orientalis using Nei's heterozygosity index (N) and the Shannon-Weaver information index (SW) averaged over 12 isozyme loci

Group/class	No. accs.	SW	N
Species			
orientalis	174	0.509	0.255
odemensis	40	0.510	0.270
nigricans	36	0.739	0.381
ervoides	104	0.288	0.165
culinaris	100	0.552	0.343
Region[a] (orientalis)			
Ntur	7	0.815	0.516
Wtur	11	0.563	0.314
EturNEsyr	18	0.571	0.306
Ssyrlbn	26	0.591	0.402
SturNWsyr	73	0.538	0.283
USSR	10	0.413	0.250

a : As defined in text.

Morag Ferguson and Larry Robertson

1.4.7. Relationship of varieties of Medicago polymorpha and eco-geographical genetic diversity within M. polymorpha

The four botanical varieties of Medicago polymorpha (brevispina, 8 accessions; iraqi, 5 accessions; polymorpha, 120 accessions; and vulgaris, 65 accessions) were studied for four isozyme sytems with nine polymorphic isozyme loci. The accessions were selected from six eco-geographical regions based on geographical region (West Asia and North Africa) and altitude of collection site (high>650 m, 300 m<middle<600 m, and low<300 m). These formed six eco-geographical regions: West Asia, low altitude (LowWA, 45 accessions); West Asia, middle altitude (MidWA, 40 accessions); West Asia, high altitude (HiWA, 18 accessions); North Africa, low altitude (LowNA, 43 accessions); North Africa, middle altitude (MidNA, 19 accessions); and North Africa high altitude (33 accessions).

Unlike with morphological characters (See Section 1.3.9.), polymorpha and vulgaris were the two most closely related varieties of M. polymorpha (Figure 13). Brevispina was the most distinct variety of M. polymorpha.

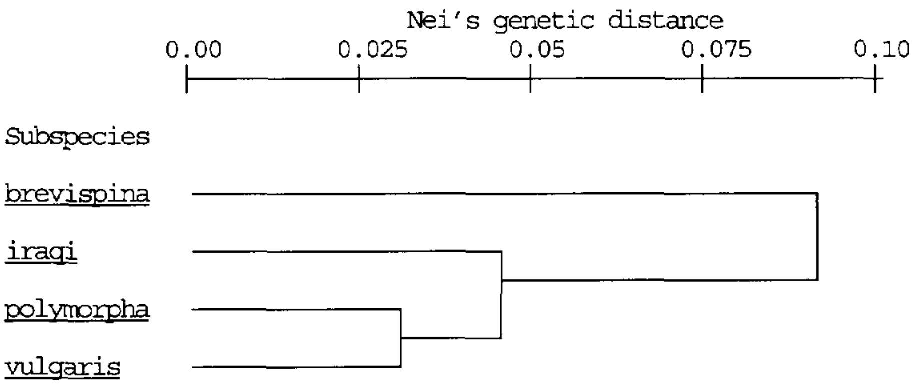

Figure 13. Relationship of M. polymorpha varieties based on Nei's genetic distance calculated using four isozyme loci

When ecogeographical regions were clustered based on Nei's genetic distance, three clusters were formed (Figure 14). The lowlands of West Asia and North Africa clustered together. How-

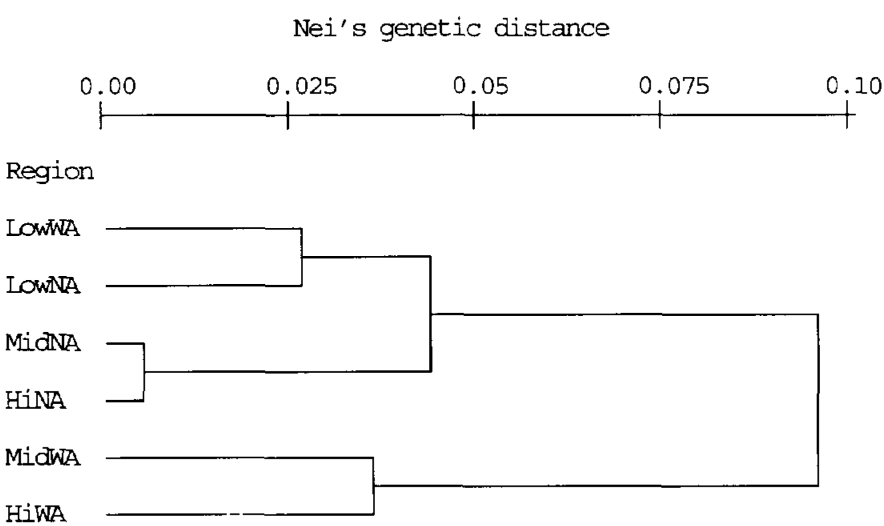

Figure 14. Genetic distance (Nei's) between different eco-geographical regions for M. polymorpha (four botanical varieties)

ever, the highlands or the middle altitudes of the two regions did not cluster together, rather the regions themselves clustered. The middle and high altitude ecologies of North Africa were closer to the low altitude ecologies of both West Asia and North Africa, whereas the middle and high altitude areas of West Asia were distinct from the other four ecologies. This could be explained by the fact that the West Asia continental middle and high alitude regions are under much more abiotic stress (temperature and drought) than the coastal high and middle ecologies of North Africa and the coastal areas of West Asia.

Simonetta Bullita (CNR, ITALY), Larry D. Robertson and Scott Christiansen (PFLP)

1.5. Documentation of genetic resources

Three major developments occurred in documentation of ICARDA's genetic resources collections during 1993.

First, there was implementation of the germplasm database on the center-wide network. This significantly improved access to all germplasm data by GRU staff and thus, provides a more efficient use of the available information to plan and carry out the Unit's work. All ICARDA scientists can readily consult this database. The ICARDA network consists of a cluster of two VAX 4000/500 computers and about 200 PCs. This database operates on the DOS platform through menu-driven software developed using the Clipper development system. The system caters for flexible data retrieval, including step-wise selection of accessions, data editing, and reporting. Work has begun to move the germplasm database to the VAX/VMS platform running under ORACLE RDBMS and to integrate it with the other center-wide databases: Trial Management System and Meteorological Database.

Second, high priority was assigned to development of a seed stock control system. Appropriate descriptors and data tables were finalized and incorporated into the database and software was developed to handle the stock data. The system has been extensively used. For the majority of GRU's collections, the actual seed weight of each accession in the active collections was established (electronic balance connected to the computer was used) and bottles with seeds were labeled. All subsequent seed movement is controlled throught this system, which monitors seed availability at two levels:

1. low stock level - accession should be regenerated immediately;
2. stop distribution - distribution is stopped until the stock is replenished with fresh seed.

The implementation of the seed stock control system had to be in parallel with the introduction of guidelines/procedures for handling seeds and documenting seed movement.

Lastly, GRU changed the accession numbering system in 1993. Sequential, crop-independent numbers bearing the prefix **IG** (**I**CARDA **G**enebank) were introduced and assigned to all accessions. The existing crop numbers (crop prefix plus number) are retained in the database as identifiers similar to variety or line names, accession numbers in other collection(s), collectors' numbers, etc.; thus the samples can still be selected through these numbers. The change of the accession numbering system will facilitate handling of the germplasm database and eliminate delay, and potential confusion in assigning 'crop numbers' to primitive and wild germplasm. IG numbers are assigned, and minimum passport data computerized, on receipt of new material (after checking for obvious duplicates). Continued assignment of crop numbers was left to the discretion of curators and for some collections they will be used for another two years to allow adjustment to the new system.

Completeness and accuracy of data on accessions is needed to properly select material from the collections. To meet data quality demands, the GRU's documentation section continues perusal of records for accessions collected by ICARDA and those obtained through seed exchange. Availability of computerized databases from cooperating genebanks greatly facilitates such an exercise. Comparison in 1993 of the ICARDA and USDA databases for wheat, chickpea, lentil and *Vicia* allowed improvement in accuracy of passport data of these crops.

Jan Konopka and A. Antypas

1.6. Germplasm management

1.6.1. Viability testing of cereal germplasm

Eighty percent of the barley germplasm (17056 accessions) has been tested for viability, including 6777 viability tests conducted in 1992/1993. Results of viability testing indicated that 99% of the tested barley germplasm (16834 accessions) had good germination (between 85% and 88%) while 93% had a high viability percentage (>90%).

All barley and durum wheat germplasm which showed low viability in 1991/1992 and which were planted for rejuvenation in 1992/1993 were retested for viability after harvest. In total, fresh seed of 668 accessions (359 barley and 309 durum wheat) has been retested for viability and stored in the medium term store (Active collection).

B. Humeid & GRU Staff

1.6.2. Viability testing of chickpea germplasm

During 1993 (97%) of the total ICARDA holdings of chickpea germplasm were tested for viability (8386 accessions). Results of viability testing indicated that 98% (8211 accessions) of tested chickpea germplasm showed good germination (>92%), while 95% (7973 accessions) had a high viability percentage (>96%).

B. Humeid and GRU staff

1.6.3. Viability testing of lentil germplasm

A set of 1121 accessions of lentil germplasm was tested for viability. The results of viability testing indicated that 95% (1063 accessions) had a high viability percentage (>94%).

B. Humeid & GRU Staff

1.6.4. Cleaning gene bank accessions from seed-borne viruses

Efforts to clean gene bank accessions from seed-borne infections continued and 1300 barley accessions and 810 lentil accessions were tested for seed-borne virus infections. Accessions found clean were labeled as such and those that were found with seed-borne infections will be cleaned when these accessions will be regenerated in the near future.

K. M. Makkouk and W. Radwan

2. SEED HEALTH ACTIVITIES 1992/93

As a result of an increased number of wheat plots contaminated with flag smut last season, and to reduce its occurrance at Tel Hadya station, the Seed Health Labratory (SHL) has strengthened its measures for control of this pathogen. Without exception, all wheat seeds were treated before planting. The SHL continues testing imported and exported seed lots to ensure freedom from seed-borne pathogens and pests. As a result of these measures, no flag smut was detected in Tel Hadya fields in the 1992/93 season.

2.1. Activities on incoming seeds

The SHL recieved 65 seed consignments from 26 countries during 1992/93, compared to 110 consignments the previous year. All consignments were fumigated or treated at -18° C for 7 days for insect control.

2.1.1. Laboratory testing

After visual inspection, seeds were tested for seed-borne pathogens using various techniques. The total number of tested samples (Tables 36 and 37) was 8153, which represents about a 30% decrease compared to last year.

Only 7.5% of the samples were contaminated by seed-borne pathogens, compared to 42% in 1991/92. The most frequent pathogens detected in the incoming material were Tilletia caries/ T. foetida in wheat and Fusarium spp. in barley seed lots. T. indica, T. contraversa and Urocystis agropyri were infrequent contaminants in some samples of wheat and wild wheat. All contaminated samples with the last three pathogens were destroyed.

Faba bean, chickpea, pea and medic imported seeds were free from seed-borne pathogens. Lentil seeds showed a low contamination with Fusarium spp. and Ascochyta spp.

Table 36. Seed health tests conducted on cereal seeds newly introduced to ICARDA in 1992/93

Crop	Number of lines: Tested	Found Clean	Found Infected	Tests carried out	Pathogens observed
Durum wheat	948	929	19	Karnal bunt test or centrifuge wash test	*Tilletia caries* and/or *T. foetida* (18)[a] *Urocystis agropyri* (1)
Bread wheat	5595	5084	511	Karnal bunt test Centrifuge wash test	*Tilletia caries* and/or *T. foetida* (499), *Urocystis agropyri* (1); *T. contraversa* (1), *T. indica* (10)
Barley	908	858	50	Centrifuge wash test Freezing blotter test	*Helminthosporium* spp. (5), *Fusarium* spp. (37), *Urocystis agropyri* (1), *T. indica* (1), *Tilletia* spp. (5)
Triticale	347	347	-	Centrifuge wash test	-----
Wild wheat	221	186	35	Centrifuge wash test	*Tilletia caries* and/or *T. foetida* (26), *T. indica* (5), *U. agropyri* (4)
Wild barley	5	5	-	Centrifuge wash test	-----
Total	**8024**	**7409**	**615**		

a : Numbers in parenthesis refer to infested entries.

Table 37. Seed health tests conducted on food and forage legumes and oil seeds newly introduced to ICARDA in 1992/93

	Number of lines				
Crop	**Tested**	**Found Clean**	**Found Infected**	**Tests carried out**	**Pathogens observed**
Lentil	21	17	4	Freezing blotter test	_Fusarium_ spp. (2)[a] _Ascochyta_ spp. (2)
Faba bean	7	7	-	Agar media test	-----
Chickpea	42	42	-	Agar media test	-----
Pea	32	32	-	Test on king's B agar	-----
Oil seeds	26	26	-	Freezing blotter test	-----
Medic	1	1	-	Test for stem Nematode	-----
Total	**129**	**125**	**4**		

a : Numbers in paranthesis refer to infested entries.

2.1.2 Field inspection

As per ICARDA policy, all imported seeds free of quarantine pathogens are planted at the post-entry quarantine area for one generation. Field inspection carried out in this area showed the absence of quarantine pathogens in cereal and legume plots.

2.2. Activities on seed dispatched internationally

The total number of consignments dispatched internationally was 473 (232 of regular international nurseries and 241 of specific trait germplasm), distributed to cooperators in 70 countries. This number represents a 7% increase in seed dispatch compared to 1991/92.

2.2.1. Laboratory testing

Seed samples from harvested plots were tested with special attention to samples harvested from plots shown contaminated by seed-borne pathogens during field inspection, and where special declaration is requested to indicate the absence of a specific pathogen. Table 38 summarizes detected pathogens.

The SHL has tested, in total, 2652 samples; with about 45% found contaminated. *T. caries*/ *T. foetida* (wheat), and *Fusarium* spp. and *Helmithosporium* spp. (barley) were the most frequent pathogens. Although field inspection revealed the absence of flag smut, a light contamination (1 teliospore/sample) by *U. agropyri* was detected in some cereal seed samples. Infected samples with this pathogen were discarded. *Fusarium* spp. were detected in 63% and 27% of tested seed lots of chickpea and lentil, respectively.

2.2.2. Field inspection

All inspected wheat plots were free from flag smut disease. Some seed-borne diseases were frequent in the field, such as common bunt of wheat, scald of barley, barley stripe disease, barley stripe mosaic virus and wilt of lentil.

Table 38. Seed health tests conducted on seeds dispatched internationally from ICARDA in 1992/93

	Number of lines				
Crop	**Tested**	**Found Clean**	**Found Infected**	**Tests carried out**	**Pathogens observed**
Durum wheat	189	176	13	Centrifuge wash test	Tilletia caries and/or T. foetida (13)[a]
Bread wheat	1204	642	562	Centrifuge wash test	Tilletia caries and/or T. foetida (547), Urocystis agropyri (15)
Barley	746	351	395	Centrifuge wash test Freezing blotter test and XT s Test	Helminthosporium spp. (93), Fusarium spp. (235), Fusarium spp. and Helminthosporium spp. (56); Urocytis agropyri (16)
Lentil	137	100	37	Freezing blotter test	Fusarium spp. (37)
Chickpea	277	100	177	Freezing blotter test Agar media test	Fusarium spp. (177)
Pea	99	70	29	Test on King's B agar	Pseudomonas spp. (29)
Total	**2652**	**1439**	**1213**		

a : Numbers in parenthesis refer to infested entries.

Orobanche spp. was found in some lentil, vetch and chickpea plots. Infected plants were rouged and burned.

A. El-Ahmed and S. Assad

3. VIROLOGY LABORATORY

In 1993, the Virology Laboratory continued its research on legume and cereal viruses; which included virus surveys, evaluating germplasm for resistance, improving screening and detection methods, monitoring seed-borne viruses in incoming and outgoing seed shipments, and providing national programs with virus detection kits. In addition, a number of colleagues from national programs received training in using sensitive methods for virus detection.

3.1. Legume viruses

3.1.1. Survey of lentil virus diseases in Lebanon and Syria

Twenty-seven fields in the Bekaa region of Lebanon and 57 fields from different lentil growing areas in Syria were inspected and samples were collected for virus testing in the laboratory. Two hundred leaf samples were collected at random from each field and were tested for the presence of broad bean stain virus (BBSV) and pea seed-borne mosaic virus (PSbMV) by using the ELISA test. Eight of the 27 fields in Lebanon had a 1% BBSV infection, whereas no infection with PSbMV was detected. In Syria, 19 out of 57 fields surveyed had a BBSV infection level of 1%, and three fields, all located in southern Syria, had a 0.3% infection with PSbMV. As the survey was conducted in May when lentil fields were approaching maturity, the low virus incidence suggested that in 1993, losses due to virus infection were most likely negligible.

In addition to the above randomly collected samples, 252 samples from Lebanon and 269 samples from Syria with symptoms suggestive of virus infection were collected and assayed. Faba bean necrotic yellows virus (FBNYV) was the most frequently encountered virus, followed by luteoviruses and BBSV. BYMV, PSbMV, and BBWV were detected in samples from Syria but not in those from Lebanon.

K. M. Makkouk and S. G. Kumari

3.1.2 Survey of faba bean viruses in Egypt

Virology Laboratory personnel, in collaboration with their Egyptian counterparts, conducted two surveys during 1992/1993, in early February (flowering stage) and mid-March (podding stage). In each survey, around 80 fields distributed throughout the faba bean growing area of Egypt were visually evaluated. Survey results showed that ca. 16% of the fields inspected had a virus incidence of 20% or higher, mostly with faba bean necrotic yellows virus (FBNYV). More than 3000 faba bean diseased samples were collected and tested for the presence of any of the nine viruses known to occur on faba bean in Egypt. Laboratory tests showed that ca. 50% of the tested samples were infected with FBNYV. Another two viruses, bean yellow mosaic virus (BYMV) and broad bean wilt virus (BBWV), were identified and found second in importance after FBNYV. The survey produced evidence that FBNYV was most likely the cause of the serious virus disease epidemic in Middle Egypt during 1991/1992.

K. M. Makkouk and S. G. Kumari

3.1.3. Evaluation of yield loss and seed-transmission rates in lentil infected with broad bean stain virus (BBSV) or pea seed-borne mosaic virus (PSbMV)

Yield loss and seed transmission rate were assessed in the lentil genotypes ILL 4400 and Red Chief after infection (flowering stage) with two isolates of BBSV and two isolates of PSbMV. No differences among the BBSV isolates were noticed, whereas a significant difference was noticed among the PSbMV isolates in their effect on yield and on seed transmission rates. The PSbMV isolate SL1-92, isolated earlier from lentil, was more severe than the isolate SP9-88, isolated earlier from pea. These two isolates induced a yield loss of 88 and 29%, respectively, in ILL 4400. Yield loss and seed transmission rates were less for the two viruses in Red Chief. Thus, Red Chief seems to be more tolerant to these two viruses (Fig. 15) with a significant reduction in seed transmission.

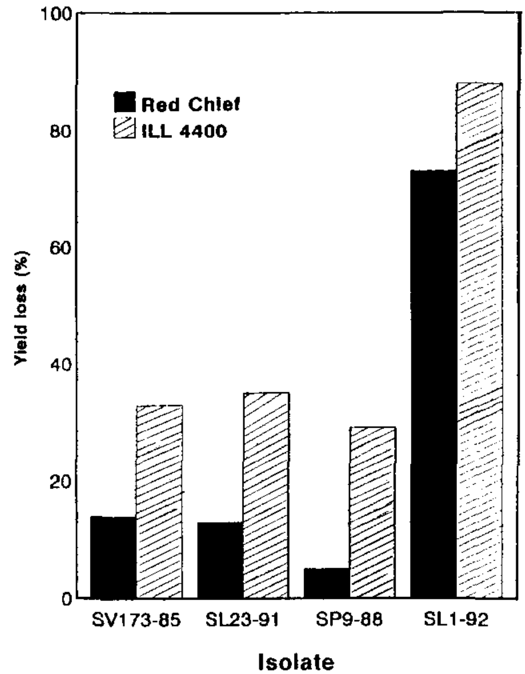

Figure 15. Yield loss in two lentil cultivars in response to infection with two isolates (SV173-85 and SL23-91) of BBSV and two isolates (SP9-88 and SL1-92) of PSbMV

K. Makkouk and S.G. Kumari

3.1.4. Effect of heat treatment on elimination of seed-borne broad bean stain virus (BBSV)

Treatments that could successfully eliminate seed-borne infection are useful for safe movement of germplasm. Accordingly, we evaluated the possibility of eliminating broad bean stain virus (BBSV) from lentil germplasm by dry heat treatment. Treatment of lentil seeds (ILL 4400) with 70°C for 20 days reduced the rate of seed-borne infection ten fold from 14.8% to 1.4%, however, seed germination dropped from 99% to 75%. Treatment at 70°C for 28 days reduced the seed transmission rate to zero, but seed germination was reduced to 28% (Fig. 16). Thus, heat treatment

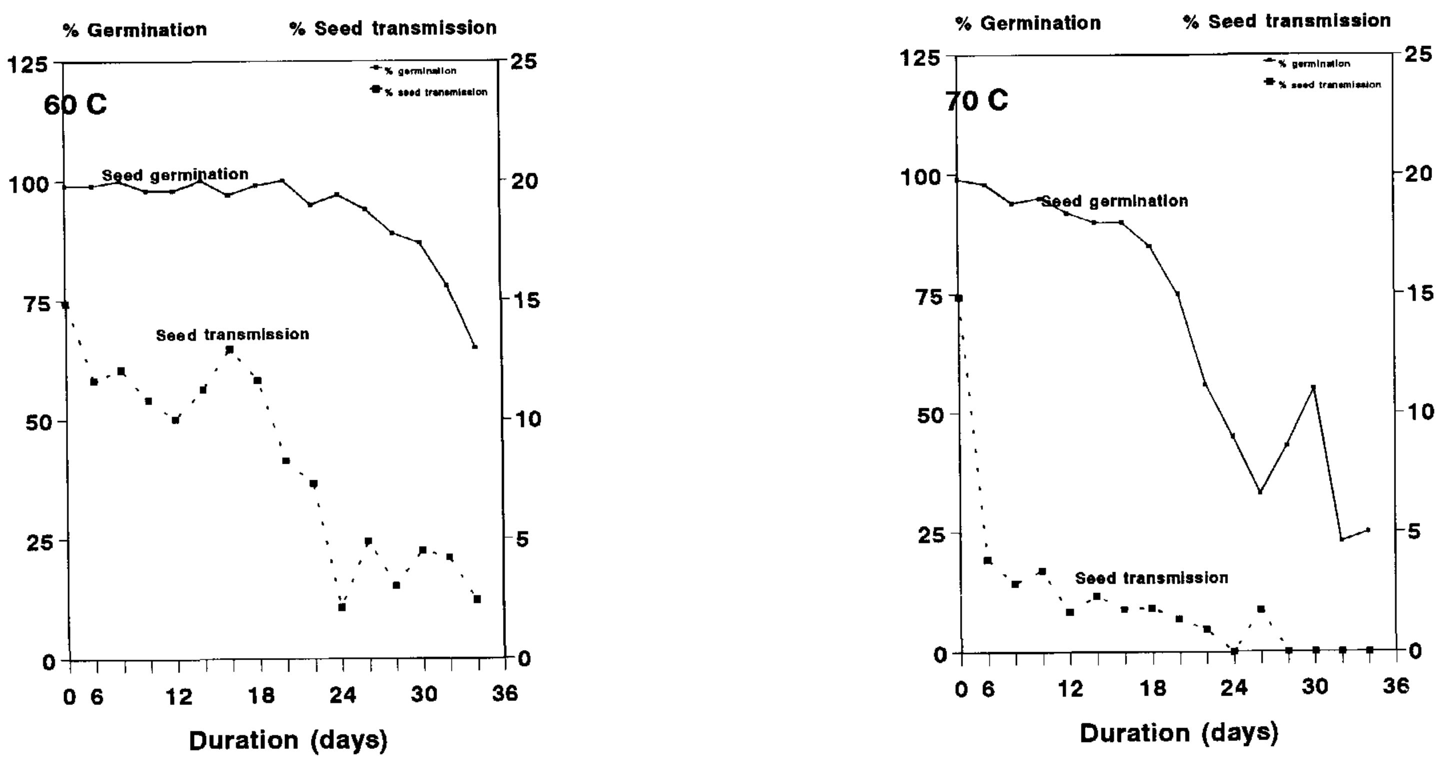

Figure 16. Effect of heat treatment of seed germination and seed transmission rates of BBSV in lentil seed

could be used to eliminate BBSV from lentil seed, inspite of its deleterious effect on seed germination.

K. M. Makkouk and S. G. Kumari

3.2. Cereal viruses

3.2.1. An improved method for screening for barley yellow dwarf virus (BYDV) resistance in barley

A screening method for barley yellow dwarf virus (BYDV) resistance in barley based on virus movement was developed. Movement of BYDV was evaluated in barley genotypes with the Yd2 gene (resistant) and without the Yd2 gene (susceptible). After leaf inoculation, the virus reached the root system and the growing point of susceptible genotypes earlier than with resistant genotypes. It was possible to reliably differentiate susceptible from resistant genotypes when root extracts of 41 genotypes were tested by ELISA four days after inoculation at the one-leaf stage. Results obtained suggested that screening for BYDV resistance in barley could be done quickly (within 2 weeks) and cheaply. Thus, slow virus movement was found to be a reliable marker for the Yd2 resistance gene in barley.

K. M. Makkouk, A. Comeau and W. Ghulam

3.3. Testing for seed-borne viruses

Four hundred and fifty lentil seed lots and 305 barley seed lots destined for international nurseries were tested for the presence of seed-borne infections. Around 10% of the lentil lots and 3% of barley lots had seed infections at the rate of 1 per 400 seeds or higher and those were considered not to meet the health standards set by ICARDA and/or by the importing countries and were therefore discarded.

K.M. Makkouk and S.G. Kumari

3.4. Production of ELISA kits

During 1993, antisera to bean yellow mosaic virus (faba bean isolate), broad bean stain virus (lentil isolate) and pea seed-borne mosaic virus (a pea and lentil isolates) and to a wheat soil-borne virus from Turkey, which is not fully characterized yet, were produced. Accordingly, ELISA kits for the following viruses are now available:

Legume viruses

- Alfalfa mosaic virus
- Bean yellow mosaic virus
- Broad bean mottle virus
- Broad bean stain virus
- Broad bean wilt virus
- Chickpea luteovirus
- Cucumber mosaic virus
- Pea seed-borne mosaic virus

Cereal viruses

- Barley yellow dwarf virus
- Barley stripe mosaic virus
- Wheat soil-borne mosaic virus from Turkey (virus not fully characterized yet)

K. M. Makkouk and S. G. Kumari

4. Training

4.1. Training in genetic resources activities

On request of the NARSs in WANA, a number of trainees received individual training in the Genetic Resources Unit at ICARDA Headquarters, Tel Hadya, Syria, in activities relating to plant taxonomy, species identification, germplasm evaluation, electrophoresis, and documentation. A summary of the training is presented in Table 39.

Table 39. Trainees in genetic resources activities in 1992/93

Topic	Type of course	No. of trainees	Country	Course duration
Germplasm documentation	short	10	North African countries	2 weeks
Use of electrophoresis in germplasm evaluation	short	10	Syria, Lebanon, Morocco, Tunisia, Bulgaria	2 weeks
Cereal identification	individual	3	Morocco, Algeria, Ethiopia	1 week
Forage legume identification	individual	1	Morocco	2 weeks
Germplasm documentation	individual	1	Syria	5 weeks
Food legume isozymes	individual	1	Portugal	4 weeks
Genetic resources activities	individual	3	Egypt, Iran	2 weeks
Evaluation of cereal germplasm	individual	2	Ethiopia	1-2 weeks

A sub-regional Training Course on Documentation of Plant Genetic Resources was held at the Institute Agronomy et Vétérinaire (IAV) Hassan II, Rabat, from 20 September to 1 October, 1993. The course was organized jointly by IAV Hassan II, IBPGR and ICARDA and attended by 10 participants from Algeria (2), Libya (1), Tunisia (2) and Morocco (5), who were already involved in (or would be in the near future) handling and documenting genetic resources collections. The program covered the principles of classification and gathering of data, management of databases and analysis of genetic resources data. Extensive hands-on practical sessions were conducted and several 'case studies' performed using databases of ICARDA, IBPGR and the Moroccan National Program.

4.2. Training in seed health activities

The seed health personnel have participated in implementing two in-country training courses (Egypt and Ethiopia) on "Seed Health Testing in Seed Production". The two courses were organized by the seed production unit of ICARDA.

4.3. Training in virology

During 1993, the virology laboratory received four visiting colleagues from Syria and Egypt for a period of 2-4 weeks. In addition, a M.Sc. student from Syria completed his thesis research on legume viruses.

GRU Staff

5. PUBLICATIONS

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Acknowledgments

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My particular thanks belong to Dr. Larry D. Robertson who accepted the burden of compiling and editing the report and conducted this additional duty in excellent way.

Table A1. Monthly precipitation (in mm) for the 1992/93 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Total
1992/93 season	0.2	0.0	49.7	48.3	58.3	42.9	41.8	0.9	40.3	0.8	0.0	12.8	**296**
Long term aver. (13 s.)	0.5	26.1	47.1	54.7	60.8	51.4	41.9	24.7	16.6	2.9	0.0	0.9	**328**
% of long term average	68	0	106	88	96	83	99	4	242	27	-	1422	**90**

Table A2. Monthly air temperature (°C) for the 1992/93 season at Tel Hadya

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Mean maximum	33.6	30.7	17.8	8.9	11.5	11.8	16.8	24.0	27.0	34.4	37.2	37.7
Mean minimum	16.1	11.5	5.6	2.2	-0.3	0.1	2.4	7.3	11.4	15.3	20.1	21.3
Average	24.9	21.1	11.7	5.6	5.6	6.0	9.6	15.6	19.2	24.9	28.7	29.5
Absolute maximum	41.0	35.2	29.0	15.6	16.5	18.2	27.2	33.2	36.6	41.0	41.3	42.6
Absolute minimum	5.7	7.8	-4.5	-7.2	-8.7	-7.5	-2.4	0.4	4.8	10.6	13.1	16.0

Table A3. Frost events during the 1992/93 season at Tel Hadya

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Season
Number of frost days	4	7	15	15	9	-	-	48
Absolute minimum (°C)	-4.5	-7.2	-8.7	-7.5	-2.4	-	-	-8.7
Number of frost events at 5 cm above ground	7	9	15	16	13	2	-	62
Absolute minimum (°) at 5 cm above ground	-6.5	-8.6	-9.2	-8.9	-4.4	-1.5	-	-9.2

Table A4. Status of ICARDA cereal collections by origin (December 1993)

	Barley	Wild Barley	Durum Wheat	Bread Wheat	Other Cult Wheat	Wild Wheat	Aeg.	Total
WANA	**9510**	**1441**	**12543**	**6977**	**142**	**1131**	**1994**	**33738**
Afghanistan	200	7	82	4	-	-	6	299
Algeria	127	12	1081	457	-	-	71	1748
Cyprus	7	4	102	1	-	-	51	165
Egypt	195	8	204	70	-	-	20	497
Ethiopia	2690	-	4896	2110	-	-	-	9696
Iran	209	64	98	95	8	5	304	783
Iraq	141	19	131	132	-	1	35	459
Jordan	134	127	270	17	1	508	198	1255
Lebanon	4	20	30	2	-	28	198	282
Libya	85	7	5	1	-	-	32	130
Morocco	743	4	237	208	-	-	62	1254
Oman	44	-	-	60	9	-	-	113
Pakistan	246	3	16	745	3	-	49	1062
Palestine	5	929	32	-	-	40	18	1024
Saudi Arabia	3	-	5	-	-	-	-	8
Syria	449	222	382	87	3	288	366	1797
Tunisia	601	-	1270	374	-	-	9	2254
Turkey	1186	15	1872	983	118	261	575	5010
UAE	6	-	-	-	-	-	-	6
Yemen	99	-	58	-	-	-	-	157
ICARDA lines	2336	-	1772	1631	-	-	-	5739
EUROPE	**3891**	**41**	**3347**	**468**	**58**	**35**	**627**	**8467**
ASIA	**4285**	**92**	**202**	**241**	**3**	**4**	**121**	**4948**
AFRICA	**156**	-	**53**	**5**	-	-	-	**214**
AMERICA	**3189**	**21**	**634**	**25**	-	-	-	**3869**
OCEANIA	**84**	-	**44**	**5**	-	-	-	**133**
Unknown	**288**	**13**	**979**	**50**	**260**	**38**	**41**	**1669**
TOTAL	**21403**	**1608**	**17802**	**7771**	**463**	**1208**	**2783**	**53038**

Table A5. Status of ICARDA food legume collections by origin (December 1993)

	Chickpea	Wild Cicer	Lentil	Wild Lentil	Faba Bean	Faba BPL	Total
WANA	6734	276	4142	349	2290	2176	15967
Afghanistan	888	22	133	-	94	104	1241
Algeria	50	-	34	-	41	41	166
Cyprus	46	-	28	3	104	251	432
Egypt	54	-	93	-	74	126	347
Ethiopia	67	9	376	-	378	682	1512
Iran	1752	-	904	7	15	17	2695
Iraq	30	-	22	-	64	114	230
Jordan	143	8	373	12	23	33	592
Lebanon	28	19	70	16	36	88	257
Libya	2	-	1	1	11	-	15
Morocco	223	-	69	-	313	181	786
Oman	-	-	-	-	4	-	4
Pakistan	255	1	222	-	24	50	552
Palestine	33	17	2	2	4	10	68
Syria	494	43	529	180	330	176	1752
Tunisia	264	-	21	-	31	65	381
Turkey	801	157	382	128	146	211	1825
Yemen	-	-	60	-	13	27	100
ICARDA lines	1604	-	823	-	585	-	3012
EUROPE	887	6	619	58	891	1248	3709
ASIA	435	1	2152	6	184	370	3148
AFRICA	15	-	4	-	115	47	181
AMERICA	590	-	432	-	362	419	1803
OCEANIA	4	-	3	-	9	30	46
Unknown	135	1	35	7	541	617	1336
TOTAL	8800	284	7387	420	4392	4907	26190

Table A6. Status of ICARDA forage collections by origin (December 1993)

	Medics	Vicia	Pisum	Lath.	Trif.	Alfa.	Other forage	Total
WANA	5970	2642	567	1217	3059	364	2506	16340
Afghanistan	18	25	70	20	40	34	-	207
Algeria	729	226	15	36	271	2	427	1706
Bahrain	-	-	-	-	-	2	-	2
Cyprus	263	96	8	36	-	-	-	405
Egypt	52	15	2	2	20	11	69	171
Ethiopia	46	-	215	110	-	-	-	371
Iran	300	59	5	21	90	51	-	526
Iraq	137	11	2	7	72	4	-	234
Jordan	666	109	26	35	547	-	691	2074
Lebanon	219	43	1	-	2	101	1	367
Libya	173	1	-	-	-	-	-	174
Morocco	534	348	11	111	242	-	275	1522
Oman	-	-	-	-	-	-	21	21
Pakistan	5	31	15	25	7	7	13	103
Palestine	37	1	-	2	5	17	-	62
Saudi Arabia	-	1	-	-	-	3	-	4
Syria	1767	942	87	474	1275	26	763	5335
Tunisia	256	22	-	7	12	1	230	528
Turkey	768	712	109	331	476	105	16	2527
Yemen	-	-	1	-	-	-	-	1
EUROPE	960	1146	1269	261	37	252	123	4048
ASIA	2	49	265	9	9	12	-	346
AFRICA	2	3	31	-	8	8	-	52
AMERICA	53	17	174	8	6	80	393	731
OCEANIA	107	33	26	10	3	17	-	196
Unknown	354	1209	1117	8	68	53	-	2809
TOTAL	7448	5099	3449	1513	3190	786	2506	24522

المركز الدولي للبحوث الزراعية في المناطق الجافة

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