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GERMPLASM EVALUATION IN ARID HIGHLANDS OF BALOCHISTAN: ANNUAL REPORT OF THE AZRI GERMPLASM RESEARCH GROUP, 1989/90.

by

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GERMPLASM EVALUATION IN ARID HIGHLANDS OF BALOCHISTAN:

ANNUAL REPORT OF THE AZRI GERMPLASM EVALUATION GROUP, 1989/90.

BY

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GERMPLASM EVALUATION IN THE ARID HIGHLANDS OF BALOCHISTAN

INTRODUCTION

Almost 60% of the cultivated area of Balochistan depends wholly on the winter and monsoon rains, which are scanty and erratic. Crop yields are severely limited in most years by water deficits, but low winter temperatures can also be a severe constraint. The local crop varieties have rather limited genetic potentials for yield, disease resistance, and performance stability in this very variable, harsh environment.

Improvements in yield and production can be attained by practices which improve the moisture supply, such as water harvesting, and by the selection and evaluation of improved varieties better adapted to drought and cold stresses and other environmental fluctuations. Due to the rapid increase in population, and the decreasing opportunities for intensive cropping in the limited irrigated areas, a well planned research strategy is essential for the best utilization of these rainfed areas. Aware of the vital importance to Balochistan of rainfed agriculture, the Arid Zone Research Institute (AZRI),based at Quetta has been conducting a wheat, barley, lentil and forage legume improvement program for the rainfed highlands of this area. Progress made during the last five years of germplasm evaluation work is summarised in Germplasm Evaluation Highlights from 1984-89 (Ali *et al*., 1989). Details of the progress made in the 1989/90 growing season are presented here.

OBJECTIVES

The objectives of the AZRI germplasm program are:

1. To select superior, disease-free/resistant crop species/lines/genotypes suitable for growth under non-irrigated conditions (better genotypes of crops other than wheat would help farmers to diversify away from the wheat monocropping system which most cultivators in highland Balochistan currently follow).

2. To investigate the potential for additional livestock feed production in the highlands from the introduction of forage crops, or from additional crop residues from food crops grown under rainfed conditions.

MATERIALS AND METHODS

The crops currently being evaluated are bread wheat, barley, lentils and annual forage legumes (mainly vetches). Experiments on these crops were planted at the four sites shown below which were chosen to represent cropping areas typical of highland Balochistan.

Site	Altitude (m)	Latitude	Longitude
1. ARI, Quetta	1690	30° 07' N	66° 58' E
2. Loralai	1340	30° 24' N	68° 36' E
3. Kan Mehtarzai	2250	31° 00' N	67° 45' E
4. Kalat	1850	29° 07' N	66° 24' E

The experiments were planted at two times, winter and spring, following the practices of local farmers. The winter planting time (late September to end of October) was used to expose the material to low temperatures to help select cold-tolerant, longer maturity genotypes. Spring planting (late January to end of February) was used to select material with short maturity period without the need for enhanced cold tolerance.

An initial irrigation was used at Quetta, Loralai and Kan Mehtarzai for winter planting to permit pre-winter emergence of the crop, because there was insufficient summer rainfall; for the spring planting, the conserved moisture from the late winter rains was adequate to ensure emergence. Fertilizer was used at the rate of 60 kg/ha N and 60 kg/ha P_2O_5 for cereal crops, and 60 kg/ha P_2O_5 plus *Rhizobium* inoculum was used for food and forage legumes.

The yield trials were planted in randomized complete block design, each entry having 6 rows per plot. Row length for these trials was 5m and row spacing was 25cm. The observation nurseries were of single 5m row per entry.

The harvesting of the trials at all sites was done between the end of May and the end of June. Only the central four rows were harvested from each six row plot, to eliminate border effects; the biological and seed yields were taken from these four rows. The crops were harvested manually and small threshing machines were used for grain separation

CLIMATIC CONDITIONS

Table 1 summarises the climatic conditions at three of the sites. The meteorological data from the fourth site, Loralai, has not been included because the data obtained were of poor quality. The 1989/90 cropping season was a good agricultural year, with more than 300 mm of well-distributed rains having been received during the crop growth period at Quetta and Kan Mehtarzai. The 1988/89 cropping season was also very favourable for spring planted crops, with more than 250 mm rain during the growth period of the spring planted crops at Quetta and Kalat. At Kan Mehtarzai heavy snow occurred during the winter and the crops remained under snow cover for two months. This retarded vegetative growth and delayed the maturation period of crops there.

The absolute minimum air temperature in the winter months at Quetta and Kan Mehtarzai was -7 and -10 °C respectively. No severe cold damage was experienced at Quetta, but dessicating winds at this site during the grain formation process severely affected the grain setting of wheat, lentil and forage legumes, and as a result the seed of these crops was shrivelled and yields were low.

TABLE 1: Climatic data for three sites in highland Balochistan during 1989/90.

	Quetta			Kalat			Kan Mehtarzai		
Month	Total rain-fall (mm)	Mean max. temp* (°C)	Mean min. temp (°C)	Total rain-fall (mm)	Mean max. temp (°C)	Mean min. temp (°C)	Total rain-fall (mm)	Mean max. temp (°C)	Mean min. temp (°C)
Jul	6.0	33.2	18.4	38.0	30.3	18.3	14.8	28.8	16.4
Aug	1.6	33.2	16.1	0.3	32.8	15.3	0.0	29.5	14.2
Sep	0.0	31.1	10.1	0.0	29.3	9.5	0.0	28.8	10.0
Oct	0.0	25.4	3.8	0.3	25.4	3.9	0.0	23.9	2.5
Nov	4.6	18.8	1.5	2.8	18.1	0.8	0.0	17.1	-4.5
Dec	36.0	12.6	0.0	22.5	13.1	-3.0	31.6	9.8	-12.0
Jan	110.7	10.3	1.2	57.4	12.7	0.2	177.6	10.1	-3.0
Feb	110.6	11.6	1.2	126.7	11.8	-1.0	145.2	11.2	-2.0
Mar	30.8	17.6	2.0	59.9	16.4	0.0	65.6	13.2	1.5
Apr	1.1	24.4	7.6	14.8	23.0	7.0	56.0	23.2	7.3
May	0.0	31.8	12.1	4.4	31.0	12.0	0.0	30.3	10.0
Total	301.4			327.1			490.8		
Irrg.	50** mm						30** mm		
Abs.Min.Temp. in season (°C)			-7.0			-7.2			-10.0
No.days below 0°C in season			82			77			99

* Screened air temperature at 1.5 m.
** Applied as one supplemental irrigation before sowing.

RESULTS

1. CEREALS

A. BARLEY

i) Barley Yield Trial Selection (Winter 1988/89)

Selected barley lines from the 1988/89 trials were planted at Quetta, Loralai and Kan Mehtarzai to evaluate desirable longer duration genotypes suitable for winter planting. There were great genotypic variability among genotypes and across locations. All the genotypes performed differently at the various sites and no one genotype had wide genetic adaptibility. Scald disease Rhynchosporium secalis was observed on lines WOL87 92 and BOC87 34 but the disease intensity was low and there was no major reduction in grain yield.

Dry matter production and grain yields are shown in Table 2. Dry matter production was significantly different ($p<0.05$) among the genotypes at Loralai and Kan Mehtarzai. At Quetta the dry matter production of exotic barley lines was generally equal to the local check, or better in a few entries. At Loralai, lines BOC87 92, Tokak, BOC87 34 and BYL88 11 outyielded the local check in dry matter production, whereas at Kan Mehtarzai Tokak (a Turkish line) produced the highest dry matter of all entries.

Grain yield differences were significant ($p<0.05$) at all the sites. At Quetta lines BYL88 6 and BKL88 187 gave the highest grain yield of 3259 and 3268 Kg/ha respectively, compared with 2293 Kg/ha from the local check. At Loralai lines BOC87 92 and BYL88 11 gave significantly ($p<0.05$) higher grain yields than the local check, whereas at Kan Mehtarzai line BKL88 114 significantly outyielded the local barley (Table 2). From these results it seems that for the Loralai area, facultative type materials are more suitable, with a low cold tolerance and without a vernalization requirement. However, for Quetta and Kan Mehtarzai, cold tolerance and a vernalization requirement is mandatory, so that this type of material can pass the vegetative stage in winter in a dormant condition, and start the reproductive phase after the winter is over.

The Turkish barley line Tokak has a high measure of winter hardiness but it matures later than local barley. Further large-scale evaluation and agronomic testing is required to confirm its adaptibility in the highlands of Balochistan. After two years of testing these genotypes, it has been found that some exotic entries are better adapted to the harsh environments of Balochistan than local types (Ali *et al.*, 1989). Two more years of testing will enable final conclusions to be drawn.

TABLE 2. Dry matter producation and grain yield (kg/ha) of selected barley genotypes (1988-89) for winter planting in 1989/90.

E.No.	Seed Source	Dry Matter			Grain Yield		
		Que.	Lor.	K.Meh.	Que.	Lor.	K.Meh
1	BOC87 92	11533	5516	1700	1977	2072	384
2	BOC87 34	10166	5333	1500	1558	1685	240
3	BYL88 11	12700	5183	2466	2448	2224	580
4	BYL88 6	11133	4133	1533	3259	1553	248
5	TOKAK	9466	5383	4933	893	617	1136
6	IWFBSN 20	11933	3833	3333	2471	1396	722
7	ABU88 129	12266	4883	3500	2572	1754	907
8	ABU88 134	12066	4200	1833	2788	1615	580
9	ABU88 150	12400	4916	2800	2411	1654	737
10	BKL88 49	12266	3916	2866	2698	1191	818
11	BKL88 114	10466	3616	4266	1848	1126	1446
12	BKL88 116	10200	4233	3866	1990	1218	1321
13	BKL88 187	12133	3600	1966	3268	1373	622
14	BKL88 197	11133	4083	3866	2708	1211	1178
15	BKL88 208	12200	2583	3266	2922	459	902
16	BKL88 266	11400	4566	1933	2560	1500	627
17	BKL88 271	10466	3716	1433	2298	1475	584
18	BKL88 294	13866	4333	3000	2590	1063	870
19	BKL88 372	9466	2700	3033	2953	913	418
20	ARABI ABIAD	12933	3133	1900	2670	1093	625
21	FRONTIER 87	11266	3983	2800	2836	1774	745
22	Local check	11466	4316	3500	2293	1332	856
Coeff. of Var.		15	22	36	28	28	40
SEM		369	198	211	145	83	64
LSD (5%)		-	1533	1631	1124	645	493

ii) Barley Yield Trial Selection (Spring 1988/89)

During 1988/89, 13 short duration barley lines were selected from ICARDA observation nurseries and yield trials for further testing under a wide range of environmental conditions. In 1989/90, these selected lines were sown in spring at Quetta and Kalat. The 1989/90 season was favourable for spring sown crops with the rainfall being more than 250 mm at Quetta and Kalat during the growing period.

Dry matter production and grain yield differences were significant ($p<0.05$) at both sites (Table 3). The local barley landrace produced most dry matter at both sites and the highest grain yield at Quetta. At Kalat, line BYL88 18 significantly outyielded ($p<0.05$) the local check in grain yield. Entries 6, 11 and 12 also gave higher grain yields at Kalat and these lines seem to be more heat and drought tolerant than the local barley. At Quetta line ABU88 152 was best for grain production. No diseases were observed on the exotic lines.

Thus, local barley was the outstanding genotype in the 1989/90 season when the average rainfall was high during the crop growth and development. However, under terminal moisture stress at Kalat the local check did not perform better than the exotic genotypes. Spring planted crops generally suffer from the combined effects of drought and heat during grain filling and this reduces the number of grains per spike and the seed size. These combined environmental stresses reduce the final grain yield considerably (Nicolas *et al*., 1984 and Wardlaw 1971). Therefore, selection under drought and heat stress conditions is a more successful method for identifying drought tolerant genotypes than selection under high moisture conditions (Ceccarelli and Mekni 1985). The promising entries 6, 8, 11 and 12 mature earlier than the local check and thus should have a better chance of escaping terminal drought at the reproductive stage. These selected lines will be further tested for the next two years in order to check their genetic stability.

TABLE 3. Dry matter producation and grain yield (kg/ha) of selected barley genotypes (1988-89) for spring planting in 1989/90.

E.No.	Seed Source	Dry Matter		Grain Yield	
		Quetta	Kalat	Quetta	Kalat
1	BYC88 7	2933	2066	696	264
2	BYC88 22	2766	1866	303	88
3	BYL88 1	3400	2433	616	304
4	BYL88 15	2700	2266	626	274
5	BYL88 16	3600	2000	890	266
6	BYL88 6	3400	2233	791	444
7	BYL88 12	3933	2133	695	152
8	BYL88 18	3133	2433	878	572
9	BOL87 95	3600	2266	818	216
10	ABU88 134	3533	2000	831	310
11	ABU88 151	4000	2333	856	422
12	ABU88 162	3200	2033	851	420
13	ABU88 152	3666	2066	1004	182
14	FRONTIER 87	3200	1266	295	64
15	Local check	4866	2566	1312	322
Coeff. of Var.		14	16	26	43
SEM		122	89	51	32
LSD (5%)		790	580	332	207

iii) Barley Yield Trial Selection (1986/87)

Four Syrian barley landraces have been tested for three years (1986-1989) with spring planting at multiple sites where varying environmental stresses were experienced by the tested landraces. The first three years of testing showed that Wadi Hassa, Arabi Abiad and Arabi Aswad were well adapted to spring planting in the highlands of Balochistan.

Table 4 shows the results for 1989/90. The dry matter production differences were significant ($p<0.05$) at Kalat, while grain yield differences were significant ($p<0.05$) at both sites. Wadi Hassa, Tadmor and Arabi Aswad gave higher grain yields at both sites than local barley. Among these landraces Arabi Abiad has already been selected for winter planting in the highlands of Balochistan due to its better performance under moisture stresses (Rees _et al_., 1989 and Ahmad _et al_., 1989). This trial shows that it is equally suitable for spring planting in this area. Considering the different combinations of site and season, it can be concluded that the selected lines Wadi Hassa, Arabi Aswad and Arabi Abiad have the genetic potential to perform well in poor moisture conditions. These lines are now receiving further agronomic testing.

Table 4. Dry matter production and grain yield (kg/ha) of selected Syrian barley landraces for spring planting in 1989/90.

		Dry Matter		Grain Yield	
E.No.	Name	Quetta	Kalat	Quetta	Kalat
1	Wadi Hassa	5600	2733	1315	542
2	Tadmor	4633	2333	1023	466
3	Arabi Aswad	4466	2433	1060	432
4	Arabi Abiad	4766	2100	578	128
5	Local check	4800	2566	666	362
Coeff. of Var.		13	5	25	28
SEM		288	55	104	49
LSD (5%)		-	232	437	207

iv) Barley Yield Trial (HA 1989/90 New Material)

This trial included 23 new genotypes from ICARDA which were planted in winter at Quetta. Observations were made on cold and drought tolerance, disease resistance and yield potential. During the 1989/90 winter, no severe cold damage was experienced.

Dry matter production and grain yield differences were not significant (Table 5). However, five high yielding lines BYC88 1, BYC89 16, BYC89 17, BYC89 19 and BOC89 53 have been selected for further multi-location testing. The grain yields of these selected lines were 2586-3446 kg/ha compared with 1949 Kg/ha from the local barley. All the selected lines will be promoted to advanced yield trial during the 1990/91 for testing at Quetta, Loralai and Kan Mehtarzai.

TABLE 5. Performance (kg/ha) of barley yield trial (HA 1989-90) at Quetta.

E.NO.	Seed Source	Dry Matter	Grain Yield
1	BYC88 1	13333	2586
2	BYC89 8	10666	2188
3	BYC89 10	12800	2260
4	BYC89 11	13000	2601
5	BYC89 13	10800	2642
6	BYC89 6	10533	2413
7	BYC89 14	13333	1620
8	BYC89 15	13866	2720
9	BYC89 16	13133	3165
10	BYC89 17	13866	3446
11	BYC89 19	12600	3165
12	BYC89 12	11333	2508
13	BYC89 21	12666	2269
14	BOM89 22	13333	2240
15	BOM89 31	13333	2625
16	BOM89 34	14266	2710
17	BOC89 53	14266	3378
18	BYC89 18	12933	2521
19	BOC89 51	10933	1068
20	BOC89 52	10000	1356
21	BOC89 4	12733	2917
22	BOC89 6	10800	2652
23	BOC89 31	10400	2574
24	Local check	12666	1949
Coeff. of Var.		18	31
SEM		450	156

v) Barley Yield Trial (Low Rainfall 1989/90 New Material)

New material, including 23 exotic genotypes, was planted in spring at Quetta and Kalat for initial screening for short duration and heat and drought tolerant genotypes. Observations were made on growth habit, maturity period, drought tolerance and yield potential.

Grain yield differences were significant ($p<0.05$) at both sites, but the dry matter production differences were not significant (Table 6). Local barley produced the highest dry matter and grain yield at Quetta. Line INBR89 12 gave significantly ($p<0.05$) higher grain yield at Kalat when compared to the local check. Entries BYL89 6, BYL89 15, BYL89 18, BOL89 13 and INBR89 12 have been selected for further testing due to their superior performance under moisture stress conditions at Kalat.

TABLE 6. Dry matter production and grain yield (kg/ha) of barley lines (low rainfall 1989-90)) in spring planting at different sites.

E.NO.	Seed Source	Dry Matter		Grain Yield	
		Quetta	Kalat	Quetta	Kalat
1	BYL88 1	5333	2266	1525	521
2	BYL89 10	4133	2733	872	424
3	BYL89 11	5333	2400	553	356
4	BYL89 13	5200	2466	1241	626
5	BYL89 14	6533	2800	1346	466
6	BYL89 6	5333	2600	1516	846
7	BYL89 15	5733	2733	1650	828
8	BYL89 16	5333	2666	645	262
9	BYL89 17	5866	2400	1425	557
10	BYL89 20	5400	2466	1176	150
11	BYL89 21	5466	2400	753	208
12	BYL89 12	5600	3200	1372	398
13	BYL89 22	5466	3066	1077	328
14	BYL89 23	5600	3000	1508	280
15	BOL89 2	5333	2866	1402	380
16	BOL89 6	6000	2866	1241	613
17	BOL89 9	5600	2600	1329	342
18	BYL89 18	5866	2800	1716	774
19	BOL89 13	5200	2933	1364	829
20	INBR89 12	5333	3466	1816	958
21	BOL89 17	5866	3466	1544	634
22	BOL89 18	6000	2866	1426	561
23	BOL89 19	6000	2333	1712	606
24	Local check	6200	2333	1941	612
Coeff. of Var.		12	23	19	36
SEM		140	126	53	39
LSD (5%)		-	-	425	310

B. BREAD WHEAT

i) Bread Wheat Yield Trial Selection (Winter 1988-89)

This trial included 26 genotypes of different origin and was planted in winter 1989/90 at Quetta, Loralai and Kan Mehtarzai. The results are shown in Table 7. Due to severe bird damage at Kan Mehtarzai, statistical analysis of grain yield was not possible and only cold tolerance and disease resistance were recorded from this site. No severe cold damage was experienced at any site. However, dessicating winds at Quetta during anthesis and grain formation affected grain setting the seed of most entries was shrivelled and the 1000 kernel weights were reduced.

Dry matter production differences were significant ($p<0.05$) at Loralai, while the grain yield differences were significant ($p<0.05$) at both sites. Entries WPT87 1511, WBWON84 111 and Gerek had higher grain yields at Quetta than the local check while at Loralai entries WBON84 111 and ICW81 1471 had higher grain yields than the local check.

In 1989/90, Yellow Rust *Puccinia striiformis*, occurred in epidemic form and the local wheat landrace experienced 50-75% infection at different locations depending upon the moisture conditions during the disease cycle. Thus, the 1989/90 season provided good natural screening conditions for selecting yellow rust resistant genotypes. Most of the exotic wheat lines in this trial were completely resistant to Yellow Rust.

The Turkish wheat line Gerek has a high measure of winter hardiness and resistance to Yellow Rust, and its performance was encouraging during 1989/90 at various sites. However, further testing is required in a number of environments to determine its drought tolerance/resistance characteristics under moisture stresses. The testing of all these selected lines will be continued in future.

TABLE 7. Dry matter production and grain yield (kg/ha) of selected bread wheat lines in 1989/90.

E.NO.	Seed Source	Dry Matter		Grain Yield	
		Quetta	Loralai	Quetta	Loralai
1	PWT288 22	10666	3666	1306	939
2	PWSN88 79	10200	6000	1336	1693
3	WOL87 50	10000	6400	1432	1749
4	WAT87 209	9533	5133	1637	1626
5	WAT87 607	9866	4600	1616	1313
6	WAT87 608	10933	2933	1992	826
7	WPT87 621	11013	3866	1589	1124
8	WPT87 1511	10533	3933	2138	857
9	IWON87 209	12466	5200	1784	1386
10	PWSN87 335	11266	3866	1714	1185
11	PWSN87 419	8533	5200	1378	1621
12	PWSN87 701	9733	4466	1274	1180
13	PWSN87 711	10266	4800	1600	1276
14	WBWON84 111	10844	6466	1997	1859
15	MEXIPAK 65	8400	3133	1650	860
16	W3918A/JUP	9600	5066	1432	1055
17	ICW81 1471	10800	6533	1621	1878
18	ICW81 1504	10200	6533	1690	1591
19	ICW81 1636	9066	4000	949	814
20	ICW81 1673	9733	6066	1344	1529
21	ICW81 1673	11200	3800	1154	641
22	ICW81 1673	10133	5666	1338	1503
23	ICW81 1683	10400	5800	1400	1631
24	GEREK	13333	5600	2130	1385
25	ZARGHOON	10866	5600	1362	1456
26	Local check	12000	6000	1768	1836
Coeff. of Var.		17	27	23	30
SEM		340	264	70	79
LSD (5%)		-	2209	588	663

ii) Bread Wheat Yield Trail Selection (Spring 1988/89)

Genotypes of bread wheat selected during 1988/89 were planted in spring at Quetta and Kalat. Dry matter production and grain yield differences were significant ($p<0.05$) at Quetta and Kalat respectively (Table 8).

Although the grain yield of exotic wheat lines was not significantly higher than the check varieties, these lines performed better in 1988/89, a less favourable year for spring planted crops, compared with 1989/90. Therefore, it seems that some of the exotic genotypes have enough drought tolerance/resistance to perform moderately well under moisture stress conditions. These selected lines will be further tested in widely contrasting environments to evaluate their genetic stability.

TABLE 8. Dry matter production and grain yield (kg/ha) of selected bread wheat genotypes after spring planting at different sites.

E.No.	Seed Source	Dry Matter		Grain yield	
		Quetta	Kalat	Quetta	Kalat
1	PWT188 14	3866	1400	153	55
2	PWT188 17	3300	1766	730	198
3	PWT188 23	3266	1833	577	91
4	PWSN88 73	3033	1466	563	100
5	MEXIPAK 65	3066	2066	644	99
6	WOL87 25	2933	1700	455	74
7	WOL87 32	3500	1933	682	263
8	WOL87 33	2866	1800	514	80
9	NESSER	3933	2066	690	244
10	WOL87 53	3200	2066	547	211
11	WOL87 75	3433	1966	699	140
12	WOL87 91	3100	2166	512	143
13	WOL87 99	3400	2200	494	221
14	Local white	3900	1733	789	270
15	ZAMINDAR	4033	2166	751	294
16	SONALIKA	3000	2100	578	260
17	KAHANI	3400	2100	622	223
18	SHAM-4	3000	1733	491	108
Coeff. of Var.		12	19	32	35
SEM		100	86	44	14
LSD (5%)		700	-	-	99

iii) Bread Wheat Yield Trial (HA 1989/90 New Material)

The trial included 23 different genotypes of bread wheat for high elevation areas received from ICARDA/CIMMYT. It was planted at Quetta, and observations were made on cold and drought tolerance, growth habit, disease resistance, maturity period and yield potential. There was no severe cold damage, but dessicating winds at the grain filling stage badly affected the grain setting and so the seed sizes and seed weights were low.

Dry matter production and grain yield differences were not significant (Table 9). Line PWT189 5 gave the highest grain yield and it has been selected for further testing. The exotic wheat lines in this trial were resistant to Yellow Rust, but their grain yields level were not significantly higher than the local check. Therefore in future, more emphasis will be given to identifying a disease resistant genotype with a high yield potential which is at least as good as the local check.

iv) Bread Wheat Yield Trial (Low Rainfall 1989/90 New Material)

Twenty-three new genotypes were planted in spring at Quetta and Kalat to select short duration and heat and drought tolerant genotypes suitable for spring planting.

Dry matter production differences were not significant, at either site, while grain yield differences were significant ($p<0.05$) at Quetta (Table 10). Lines WOL88 14, WOL88 83 and WOL88 110 have been selected for further testing. These lines have an erect growth habit and mature early, which are desirable characters in genotypes for spring planting.

TABLE 9. Performance (kg/ha) of bread wheat yield trial (HA/1989/90) at Quetta.

E.No.	Seed Source	Dry Matter	Grain Yield
1	BEZOSTAYA	7600	1188
2	PWT189 4	9866	1798
3	PWT189 5	11600	2017
4	PWT189 7	9933	1918
5	PWT189 8	10666	1661
6	PWT189 9	9733	1482
7	PWT189 16	8000	1449
8	PWT189 18	9600	1626
9	PWT189 21	10000	1401
10	PWT289 5	10000	1598
11	PWT289 6	9866	1329
12	ZERGOON	10400	1282
13	PWT289 7	9600	1868
14	PWT289 10	8200	1162
15	PWT289 13	9066	1732
16	PWT289 18	12333	1940
17	RWYT89 2	12666	1842
18	RWYT89 4	9066	1013
19	RWYT89 13	8800	1361
20	RWYT89 14	9600	1478
21	RWYT89 19	10400	1769
22	RWYT89 21	10200	1813
23	RWYT89 23	8266	1764
24	Local check	11000	1565
Coeff. of Var.		20	34
SEM		402	110

TABLE 10. Dry matter production and grain yield (kg/ha) of bread wheat yield trial (low rainfall) with spring planting.

E.No.	Seed Source	Dry Matter		Grain Yield	
		Quetta	Kalat	Quetta	Kalat
1	MEXIPAK 65	4733	2266	1036	593
2	WYL88 10	4466	2266	866	384
3	WYL88 21	5000	2133	762	284
4	WOL88 12	4800	2066	1178	472
5	WOL88 14	4333	2000	817	157
6	WOL88 41	3733	3000	764	206
7	WOL88 47	4266	2000	666	269
8	WOL88 57	5066	2066	629	372
9	WOL88 62	4600	2000	825	256
10	WOL88 67	4600	2266	644	308
11	WOL88 70	4666	2266	981	454
12	NESSER	4466	2266	957	438
13	WOL88 71	4800	2066	661	376
14	WOL88 72	5000	2466	1014	282
15	WOL88 74	4866	2466	957	568
16	WOL88 78	4666	2000	757	244
17	WOL88 83	4733	2800	1058	642
18	WOL88 92	4333	1933	581	298
19	WOL88 94	4400	1933	732	318
20	WOL88 99	4266	2133	870	372
21	WOL88 102	4733	2133	690	304
22	WOL88 110	4266	3066	993	652
23	BELIKH	4333	2133	594	205
24	Local check	4600	2466	1125	506
Coeff. of Var.		13	29	19	49
SEM		116	135	32	37
LSD (5%)		-	-	261	-

2. FOOD AND FORAGE LEGUMES

A. FOOD LEGUMES (Lentils)

i) Lentil Yield Trials (Selection 1988/89):

Twenty-three untried exotic, extra large seeded lines were planted in winter at Quetta, Loralai and Kan Mehtarzai during 1988/89. On the basis of overall performance, nine lines were selected for further testing during winter 1989/90 at all three sites. The results are shown in Table 11.

Total dry matter (TDM) production differences among the genotypes at Quetta and Loralai were non-significant (P>0.05) while at Kan Mehtarzai, the differences were significant (P<0.05). Only two lines, ILL 5816 and 5842 could compete with the local landrace (Entry 10) and gave almost the same TDM production.

Seed yield differences among the lentil lines were significant (P<0.05) at all three sites. The seed yield differences of three lines ILL 5668, 5699, 5988 at Quetta and three lines, ILL 5668, 5816, 5817 at Loralai, were not significantly different when compared with local control at both sites. The yield level of these lines were similar to local control. All the other entries could not compete with the local check. However, two lines, ILL 5816 and 5842 gave significantly (P<0.05) higher seed yields than the local landrace at Kan Mehtarzai (Table 11).

In the 1989/90 season there was good, above-normal rainfall. All the lines were selected in the previous season on the basis of their better performance, but the 1988/89 rainfall was poorer than in 1989/90. As dry years occur frequently in the highlands of Bąlochistan (Kidd _et al_., 1989), selection during dry seasons is more appropriate for identifying drought tolerant genotypes. Emphasis is being given to selecting versatile genotypes with wide genetic adaptability. The 1989/90 results indicate that those genotypes which performed similarly to the best adapted local landrace in a comparatively good year also did significantly better in a poorer year. At the same time two genotypes ILL 5816 and 5842, appear to be suitable for poor and good environments. Bold seeded genotypes with similar yield to the local landrace are desirable due to their high market price and disease resistance (Keatinge _et_. _al_., 1990).

The low productivity at Loralai was due to heavy attacks of Army-worm, _Spodoptera_ spp., near crop maturity. Such damage varies from year-to-year depending upon the occurrence of conditions favourable for these pests.

TABLE 11: Total dry matter and seed yield (kg/ha) of large seeded lentil lines (selection 1988/89) at different sites in winter planting during 1989/90.

S.No.	ILL No.	Origin	TOTAL DRY MATTER			SEED YIELD		
			Que.	Lor.	K.Meh.	Que.	Lor.	K.Meh.
1	5582	JORDAN	4700	3700	667	350	514	31
2	5668	SYRIA	5000	3300	800	720	761	42
3	5699	ICARDA	5300	2850	367	591	348	8
4	5751	ICARDA	5767	2800	500	337	351	26
5	5816	ICARDA	4733	4317	1633	296	541	123
6	5817	ICARDA	5500	3967	867	258	601	59
7	5842	ICARDA	4633	3633	1400	250	505	136
8	5876	ICARDA	4467	3433	433	450	238	13
9	5988	ICARDA	4467	3617	433	523	339	16
10	Local	check	5200	3433	1500	649	780	48
Coeff. of Var.(%)			26	26	58	23	35	99
SEM			741	521	288	59	100	29
LSD (5%)			---	---	855	176	297	85

ii) Lentil Yield Trials-Winter & Spring Selection (1988/89):

Three different sets of observation nurseries were received from ICARDA, with a total of 89 test entries of different origin. The trials were planted at all three sites in winter and spring 1988/89.

On the basis of cold tolerance, longer maturity period, disease resistance and higher yield potential, nine superior lines were selected for winter planting (Table 12) and six superior lines were isolated for their shorter maturity period (Table 13). The shorter maturity lines complete their life cycle within 130 days. All the selected lines were promoted to yield trials for further testing during 1989/90 at Quetta only, due to shortage of seed for the other sites.

ii, a) Lentil Yield Trial-Winter

Total dry matter and seed yield differences among the genotypes were not significant (P>0.05). Most of the selected lines are from the same origin, have the same genetic background and performed similarly (Table 12). All the selected lines performed better than the local check in 1989/90, but this material has not yet been exposed to a wide enough range of environments in upland Balochistan. During 1990/91, the material will be planted at all the experimental sites used for germplasm evaluation and then it will face several different kinds of environments in this area. This will facilitate the selection of improved genotypes. The two main desirable characteristics of the selected material, greater seed size and disease resistance, gives it an advantage over the local landrace.

TABLE 12: Total dry matter (TDM) and seed yield (kg/ha) of selected (1988/89) winter type lentil lines at Quetta during 1989/90 season.

Ent.No.	Selection	ILL No.	Origin	TDM	SEED YIELD
1	PANT. L 538	2500	INDIA	5267	596
2	PANT. L 639	2573	INDIA	5500	501
3	L 1282	2581	INDIA	5333	610
4	B 77	3493	INDIA	5533	448
5	LG 46	3517	INDIA	5933	532
6	LL 57	3614	INDIA	5467	651
7	162	4403	PAKISTAN	5833	574
8	---	590	TURKEY	4267	254
9	---	857	ALGERIA	5200	605
10	---	---	Local	4867	580
Coeff. of Var. (%)				12	28
SEM				369	86

ii, b) Lentil Yield Trial-Spring:

Total dry matter and seed yield differences among the genotypes were significant ($P<0.05$). Only one line, ILL 4354 (Jordanian Local), could not compete with all the other lines, including local check, and yielded significantly less TDM and seed than the others (Table 13). With the exception of line ILL 4354, all the other lines have similar productivity, (Table 13).

These lines have not yet been exposed to a wide range of environments because of a shortage of seed but they will be planted at all three germplasm testing sites in the coming season (1990/91). After they have been grown under different conditions, those lines which performed best for Balochistan will be selected.

TABLE 13: Total dry matter (TDM) and seed yield (kg/ha) of selected (1988/89) Spring type lentil lines at Quetta during 1989/90.

Ent. No.	Selection	ILL No.	Origin	TDM	SEED YIELD
1	FLIP 86-41L	6027	ICARDA	633	110
2	FLIP 87-64L	6254	ICARDA	433	160
3	FLIP 87-66L	6256	ICARDA	633	176
4	FLIP 87-70L	6260	ICARDA	800	227
5	FLIP 87-73L	6263	ICARDA	567	124
6	JORD. Local	4354	JORDAN	233	79
7	---	---	Local	600	191
Coeff. of Var. (%)				30	34
SEM				97	30
LSD (5%)				299	93

B. FORAGE LEGUMES

i) Yield Trials (Selections 1987/88):

During 1987/88, eight lines of Vicia sativa were selected for further testing with two check entries Vicia villosa ssp. dasycarpa (improved check) and Lens culinaris (Local check) in a wide range of environments at three sites with two planting times. This was repeated during 1989/90, with winter planting at Quetta, Loralai and Kan Mehtarzai. This was the third year of testing the material and it was exposed to almost every kind of environment. This trial will not be repeated; the final conclusions will be made on the overall performance of the genotypes at different locations during different years.

Total dry matter and seed yield among the genotypes at Quetta and Loralai during 1989/90 were significantly different ($P<0.05$), but the differences were not significant ($P>0.05$) at Kan Mehtarzai (Table 14).

Vicia sativa (Acc. 713, 715, 490 and V. villosa ssp. dasycarpa (Acc. 683) had a significantly ($P<0.05$) higher total dry matter yield than the local control at Quetta. At Loralai, no V. sativa line could compete with improved or local checks and both checks were not significantly different from each other.

No line could compete with the local check in seed yield at Quetta or Loralai. The local check was significantly ($P<0.05$) better than all the other entries at Quetta and Loralai (Table 14). One of the main reasons for the higher seed yield of the local control was that it matured 15 days earlier than the other lines which enabled it to escape from Army-worm attack at Loralai and dessicating winds at Quetta near crop maturity. These problems badly affected the seed production of the other genotypes which matured later.

TABLE 14: Total dry matter and seed yield (kg/ha) of forage legume lines/genotypes (selection 1987/88) at different sites during winter 1989/90.

S.No.	Name of Genotype	Acc.No.	TOTAL DRY MATTER			SEED YIELD		
			Que.	Lor.	K.Meh.	Que.	Lor.	K.Meh.
1	V. SATIVA	713	8700	300	1167	322	1	222
2	V. SATIVA	715	7833	383	933	385	0	212
3	V. SATIVA	308	5433	250	1167	200	1	271
4	V. SATIVA	490	8467	383	1867	188	0	525
5	V. SATIVA	709	6600	333	1167	262	5	260
6	V. SATIVA	1459	6200	350	1767	59	1	329
7	V. SATIVA	1485	6267	467	1167	20	0	219
8	V. SATIVA	2	6933	483	567	83	0	59
9	V. DASYCARPA	683	7600	1667	2433	173	19	445
10	L. CULINARIS	Local	4533	1800	767	673	476	86
Coeff. of Var.(%)			20	48	52	20	181	65
SEM			810	178	391	27	52	98
LSD (5%)			2406	530	---	79	156	---

ii) Yield Trials (Selection 1988/89):

After previously testing the performance of this *Vicia villosa* genotype eight improved lines of the genotype were received from ICARDA for testing at different locations. Two check entries (local lentil and *Vicia villosa* ssp. *dasycarpa* Acc. 683) were included in the trials for comparison. During 1989/90, the trial was carried out at Quetta, Loralai and Kan Mehtarzai, in winter only.

Total dry matter production was not significantly different (P>0.05) among the lines at all three sites but seed yields were significantly different at all three sites (Table 15). At Quetta, *Vicia villosa* ssp. *dasycarpa* Acc. 596, 800, 2558 and 683 outyielded the local check, but the seed yield was not significantly different within these genotypes. At Kan Mehtarzai all the lines except two, Acc. 801 and 956, had significantly ($P<0.05$) higher seed yield than the local control. At Loralai, almost no seed yield was obtained from the lines being tested or from the improved check of Acc. 683 because of heavy Army-worm attack at the later stages of crop maturity and so no valid comparisons were possible (Table 15). The local check escaped attack as it matured 15 days earlier at this site than the other lines. This material will be tested once more at all three sites during 1990/91 so that the lines best suited to a wide range of highland areas of Balochistan can be selected.

TABLE 15: Total dry matter and seed yield (kg/ha) of forage legume lines/genotypes (Selection 1988/89) planted at different sites during winter 1989/90.

S.No.	Name of Genotype	Acc.No.	TOTAL DRY MATTER			SEED YIELD		
			Que.	Lor.	K.Meh.	Que.	Lor.	K.Meh.
1	V. VILLOSA	596	7600	2633	1867	301	0	362
2	V. VILLOSA	717	8267	1667	2000	147	10	365
3	V. VILLOSA	800	8800	2383	2033	173	1	393
4	V. VILLOSA	801	8067	1450	1133	64	1	240
5	V. VILLOSA	956	6533	1833	1100	92	0	210
6	V. VILLOSA	958	7200	1833	1833	101	1	348
7	V. VILLOSA	966	6667	1633	2567	52	1	448
8	V. VILLOSA	2558	6200	1233	1200	192	0	328
9	V. VILLOSA	683	5533	2233	2033	160	1	390
10	L. CULINARIS	Local	4800	1300	1233	329	228	28
Coeff. of Var.(%)			29	46	39	65	130	41
SEM			1164	487	384	61	18	74
LSD (5%)			---	---	---	181	54	221

iii) **Yield Trial Selection (1988/89):**

Eighteen different lines of *Vicia* spp. were received from Iran. The single row observation nursery was planted in winter at Quetta, for initial cold screening during 1988/89. Due to very limited seed, the trial was planted at only one site. On the basis of cold tolerance and other desirable characters, 11 lines were selected for promotion into the yield trial for further testing in 1989/90.

Total dry matter and seed yield differences among the entries were significantly ($P<0.05$) different (Table 16). Only two lines, Acc. 225006 and 225014, could compete with the local control in total dry matter production, but the differences were not significant (Table 16). Eight lines gave significantly ($P<0.05$) higher seed yields than the local control (Table 16).

The selected material matures earlier than the local check , so it can escape terminal stresses and insect problems, which occur in some years at the later stages of crop maturity. These problems can badly affect the overall productivity of later genotypes at high altitudes in Balochistan.

TABLE 16: Total dry matter (TDM) and seed yield of selected forage legumes (*Vicia* ssp), selected in 1988/89, planted at Quetta during winter 1989/90.

Ent. No.	Genotype Name	Acc. No.	Origin	TDM	SEED YIELD
1	*VICIA* SPP.	225001	IRAN	3000	1257
2	*VICIA* SPP.	225004	IRAN	3133	1201
3	*VICIA* SPP.	225006	IRAN	4067	1838
4	*VICIA* SPP.	225007	IRAN	3600	1424
5	*VICIA* SPP.	225008	IRAN	3400	1467
6	*VICIA* SPP.	225010	IRAN	1600	908
7	*VICIA* SPP.	225011	IRAN	900	374
8	*VICIA* SPP.	225012	IRAN	3167	1343
9	*VICIA* SPP.	225014	IRAN	4267	1649
10	*VICIA* SPP.	225015	IRAN	3767	1449
11	*VICIA* SPP.	225016	IRAN	3133	909
12	*L.CULINARIS*	----	Local	5033	476
Coeff. of Var. (%)				21	24
SEM				403	168
LSD (5%)				1183	493

iv) Observation Nurseries:

During 1989/90, 118 different lines of *Vicia* ssp. of different origin were received from Italy. Single row observation nurseries were planted in winter and spring at Quetta to select desirable genotypes for different planting times. Keeping in view all the desirable characteristics, 17 genotypes for winter and 12 for spring sowing were selected (Tables 17 & 18). These selected genotypes will be promoted into the yield trials during 1990/91. Due to limited seed, the trials will be planted initially at Quetta with two planting times. After multiplying enough seed, these trials will be extended to other germplasm testing sites for further study.

TABLE 17: Selected forage legume genotypes/lines for winter planting at Quetta during 1989/90.

Ent. No.	M.G. No.	Name of Genotype/line	Origin
1	106483	*Vicia sativa*	Tunisia
2	106716/3	*Vicia sativa*	Tunisia
3	106916/2	*Vicia sativa*	Italy
4	107074/2	*Vicia sativa*	Italy
5	107174	*Vicia sativa*	Spain
6	107200/1	*Vicia sativa*	Spain
7	107200/2	*Vicia ervilia*	Spain
8	108839	*Vicia ervilia*	Greece
9	110431/2	*Vicia sativa*	Italy
10	112100	*Vicia sativa*	Morocco
11	112108	*Vicia ervilia*	Morocco
12	112173	*Vicia ervilia*	Morocco
13	112181	*Vicia bithynica*	Morocco
14	112189	*Vicia narbonensis*	Italy
15	112190	*Vicia narbonensis*	Italy
16	113092	*Vicia sativa*	Italy
17	113093	*Vicia narbonensis*	Italy

TABLE 18: Selected forage legume genotypes/lines for spring planting at Quetta during 1989/90.

Ent. No.	M.G. No.	Name of genotype/line	Origin
1	107200/2	*Vicia ervilia*	Spain
2	107207/1	*Vicia ervilia*	Spain
3	107221/2	*Vicia ervilia*	Spain
4	107222	*Vicia ervilia*	Spain
5	107225	*Vicia sativa*	Spain
6	107270/1	*Vicia sativa*	Spain
7	108839	*Vicia ervilia*	Greece
8	110319	*Vicia ervilia*	Greece
9	110431/2	*Vicia sativa*	Italy
10	112101	*Vicia ervilia*	Morocco
11	112108	*Vicia ervilia*	Morocco
12	112190	*Vicia narbonensis*	Italy

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