DEVELOPMENT AND HIGHLIGHTS OF FABA BEAN RESEARCH IN MOROCCO UNDER INRA/ICARDA COLLABORATIVE PROGRAM

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INTRODUCTION

The International Center for Agricultural Research in the Dry Areas (ICARDA) had a world mandate for the improvement of faba bean since its inception in 1977. The faba bean improvement work was mainly carried out at ICARDA ; principal research station at Tel Hadya near Aleppo, and a subsite on the Mediterranean coast near Lattakia. However, because of the shifts in commodity priorities within the Consultative Group on International Agriculture (CGIAR), a decision was made to phase-out ICARDA'S CORE Budget research on faba bean improvement by December, 1991, although collection, conservation, evaluation, documentation and distribution of germplasm will be

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continued in the Genetic Resources Unit, and dissemination of information through the Communication, Documentation and Information Unit of ICARDA. Also, to ensure that success achieved so far in the improvement of the crop is fully utilized, it was decided that the Center should transfer the crop improvement activity along with the generated breeding material to a national research program in North Africa where the crop is important.

1. 1. Faba Bean in North Africa

Faba bean is the major food legume in North Africa and accounts for half the total production of pulses in the region (Table 1). Faba bean yield levels in North Africa are low and unstable compared to those elsewhere in the world (Table2). Algerian mean yields from 1981 to 1987 have been only 455 kg/ha versus the world average of 1294 kg/ha. Faba bean yields have varied from 300 to 1260 kg/ha in Morocco and 500 to 1000 kg/ha in Tunisia.

Morocco accounts for 75% of the production of faba bean in North Africa. The actual total production may be even higher as much is in the form of green vegetable for which production statistic are not available. Faba bean is predominantly grown in wheat-based farming systems in the region, mainly in the medium rainfall environments (above 450 mm). For these reasons, Douyet Research Station of INRA (Institut National de la Recherche Agronomique), neat Fes, Morocco, was chosen as the site for the transfer of faba bean improvement research from ICARDA.

1. 2. Constraints to Faba Bean Production in North Africa

The major constraints to bean production in North Africa are biotic that include diseases and pests. The important diseases are chocolate spot, Ascochyta blight, rust, and stem nematodes. However, the most important biotic constaint is the flowering plant parasite, the broomrape (**Orobanche crenata** Forsk). Additionally, the indeterminate growth habit of the commercial cultivars is the major contraint to modern agricultural production because of lodging, excessive vegetative growth, and low harvest index. The partially outcrossing nature of faba bean makes breeding difficult and inefficient, and hinders seed production of cultivars by national programs. ICARDA has developed methodology and screening techniques to identify useful germplasm for most of the above contraints. Work needs to continue to place these resistant sources in backgrounds useful to national programs, and with the shift of research from the ICARDA base in Syria to North Africa, the material coming out of the program should be better adapted to the conditions of the region.

Table I : **Faba bean area and production in the countries of North Africa, 1987.**

Country	Area ('000 ha)			Production ('000 t)		
	Faba bean	Total pulse	Faba bean	Faba bean	Total pulse	Faba bean
Algeria	77	161	47.8	40	70	57.1
Libya	9	10	90.0	9	12	75.0
Morocco	207	486	42.6	232	450	51.6
Tunisia	31	86	36.0	14	49	28.6
Total	324	743	43.6	295	581	50.8

Source : FAO 1988 Production Yearbook.

Table II : **Faba bean grain yields (kg/ha) in the countries of North Africa, 1981-1986.**

Country	1981	1982	1983	1984	1985	1986	1987	Mean
Algeria	578	458	423	404	357	449	455	519
Libya	1000	1027	1026	1026	1012	1024	1017	1006
Morocco	300	892	834	641	916	1264	852	1123
Tunisia	670	593	858	1000	512	604	671	463
World	1126	1327	1198	1313	1303	1349	1294	1443

Source : FAO Production Yearbooks ; 1982-1988.

1. 3. Transfer of ICARDA'S Faba Program to Morocco

In accordance with the decision of the CGIAR to phase-out crop improvement research on faba bean at ICARDA headquarters and to transfer this to a North African national research program, the ICARDA faba bean improvement team consisting of a breeder and a pathologist was transferred to Douyet Research Station near Fes, Morocco as of September 1, 1989. The team arrived with all the breeding material and essential research supplied and equipment to enable continuation of the improvement work in the style in which it was being done at ICARDA headquarters.

The major objectives of this transfer of an international breeding program of faba bean at ICARDA to the national program of INRA Morocco based at Douyet have been :

1. Etablisment and development of a strong faba bean improvement team at INRA, and linking it with similar research teams in other North Africa countries,

2. Developement of a strong research program for Orobanche control and Orobanche-resistant faba bean varieties,

3. Consolidation of national germplasm collection and its evaluation for identification of potentially useful accessions,

4. Development of a breeding program on faba bean for identification of high and stable yielding varieties, not only for Morocco but also for other North African countries.

5. Development of a disease screening program for ascochyta blight, chocolate spot, rust and stem nematode, and

6. Development of agronomic research.

Highlights of these will be discussed in the following sections.

DEVELOPMENT ACTIVITES

1.2 Development of National Faba Bean Improvement Team

Development of a strong faba bean research team in INRA, Morocco was essential to effectively to assume the responsibility of ICARDA's faba bean crop improvement research. Therefore, special efforts were made to establish a strong

foundation and set the stage for special funding to guarantee the continuity of the research beyond 1991, when ICARDA's core funding on faba bean will terminate. Breeder and agronomist counterparts from INRA were identified and stationed at Douyet in February, 1990 and they worked closely with the ICARDA faba bean team to enhance skills to assume their future roles. A counterpart pathologist has been identified who should be in place by September 1, 1991.

Specific accomplishments in establishing a faba bean national program at Douyet are as follows :

a. Two offices with two computers and a pathology laboratory with basic equipment were established.

b. Screenhouse facilities (21 field screens) for pure line breeding were transfered and facilities for disease screening work were established.

c. Faba bean improved germplasm, including inbred and advanced lines with disease resistance, closed-flower character, determinate growth habit and IVS (independant vascular system) trait were transferred from ICARDA to Douyet.

d. North African regional Yield Trials (Large and Small Seeded) and Regional Orobanche nursery were initiated and distributed.

e. Systematic screening under artificial inoculation for resistance to Orobanche at Douyet, chocolate spot and Ascochyta blight at Meknes, and stem nematodes at Guich (Rabat) was initiated in 1989.

f. Verification trials Orobanche-resistant lines on farmers, fields were initiated in close collaboration with extension personnel in Morocco.

g. Two, 2-week faba bean improvement courses were conducted in collaboration with INRA and ENA-Meknes. These courses hosted 14 participants from six countries in 1990 and 20 participants from seven countries in 1991.

A bilateral grant proposal to support a faba bean project in Morocco was developed for donor support.

2.2 Establishment of National Germplasm Collection

Efforts were made to establish a collection of Moroccan faba bean

germplasm at Douyet. As a first step, the collection of 269 accessions which was maintained at Guich was brought to Douyet Station in 1990. The collection was raised in a field screenhouse in the 1990/91 season to increase seed. The collection is now being maintained at room temperature till suitable facilities are developed at Douyet for long term storage.

RESEARCH HIGHLIGHTS

3.1 Evaluation of National Germplasm Collection

In 1990/91 the Moroccan germplasm collection of 269 accessions was evaluated for 37 descriptors of the IBPGR/ICARDA faba bean desciptor list. These were grown in a field trial at Douyet with a randomized complete block design (10 trials of 30 entries each, with 3 checks) with two replications. Plot size was one, 4-m row 0.5 m apart with 3 m harvested for yield. Observations were recorded on different descriptors as per the IPBGR/ICARDA descriptor list. Distributions for grain yield, days to flowering, plant height, pods per plant, pod length, seeds per pod and 100-seed weight are given in Figure 1.

There were 55 accessions with grain yields of 5 t/ha or greater which will be further evaluated for their yield performance in breeding trials (Fig. 1.1). The mean flowering date was 95 days with most accessions flowering between 92 to 96 days (Fig. 1.2). There were six unifoliate lines. Mean plant height was 105 cm with most accessions between 100 to 110 cm tall (Fig. 1.3). The height of the lowest podbearing node varied from 14-42 cm with an average of 25 cm and most accessions between 18-30 cm. Pods per plant averaged 3.5 with a range from 6 to 15 cm (Fig. 1.5). Seeds per pod averaged 3.1 with most accessions between 2.5 and 3.5 seeds per pod (Fig. 1.6). There were three peaks for 100-seed weight, one at 80 g, one at 130 g and one at 260 g per hundred seeds (Fig. 1.7).

Correlations among grain yield, date of flowering, plant height, pods/plant, pod length, 100-seed weight, pod per node and seeds per pod are given in Table 3. The highest correlation with grain yield was with 100-seed weight ($r = 0.50^{**}$)

However, pods per plant and seeds per pod had negative correlations with grain yield ($r = -0.48^{**}$ and -0.40^{**} respectively). This is because of compensatory relations of 100-seed weight with pods per plant and seeds per pod, ($r = -0.48^{**}$ and -0.50^{**} respectively).

3.2. Orobanche Research

Broomrape (**O. crenata**) is the most important flowering plant parasite which attacks faba bean in the dry and hot areas of the Mediterranean region. **O. crenata** is difficult to manage and all commercial faba bean cultivars grown by farmers today are susceptible. The wide prevelence and severity of **O. crenata** in certain areas in North Africa has either forced farmers to drop or reduce faba bean cultivation. The use of chemicals to control **O. crenata** is expensive and breeding for resistance to this plant parasitic weed has long been hampered by the lack of useful sources of resistance.

3. 2. 1. Screening for Resistance

Screening for Orbanche resistance was done in Orobanche-infested fields under screen cages at Lattakia, Syria and Douyet, Morocco in the 1989/1990 season using a single, 3-m row plot per test entry 0.5 m apart alternated with a susceptible line (Aquadulce in Morocco; Lattakia local in Syria) after every two test lines. In 1990 many resistant lines were identified (47 from previous years and 144 new lines). Results from 1989/90 and 1990/91 showed that these lines had a lower number of **Orobanche** shoots per faba bean plant compared to the local susceptible check, Aquadulce (Fig. 2).

3. 2. 2. Integrated Control

Realizing that **Orobanche** control by individual methods, was not adequate, an integrated control strategy employing resistant varieties, chemical control and sowing date was tested in an **Orobanche**-infested field at Douyet station in RCB with four replications. Three faba bean varieties, two resistant (18105 and 18035) and a susceptible (Aquadulce), were each sown on three different dates (24 Oct 1990, 18 Nov 1990 and 10 Jan 1991) in 5,4-m rows 40 cm apart (plot size of 10 m^2). Each of the three varieties was sprayed twice, either with water or with glyphosate (184 mh/ha) on 11 and 26 March for 24 Oct sowing, on 24 March and 11 April for 18 Nov sowing and on 18 April and 2 May for 10 Jan sowing. Observations were recorded on grain yield (based on 2.5 m^2 area harvested) and yield attributes biological yield, and number and dry weight of **Orobanche** shoots.

Faba bean grain yield was significantly affected by the three varieties. On an average, line 18105 yielded highest (2741 kg/ha) followed by line 18035 (2488 kg/ha) and Aquadulce (1496 kg/ha). Thus, the two resistant varieties gave nearly 40% increase in yield over Aquadulce. Faba bean grain yield was also affected

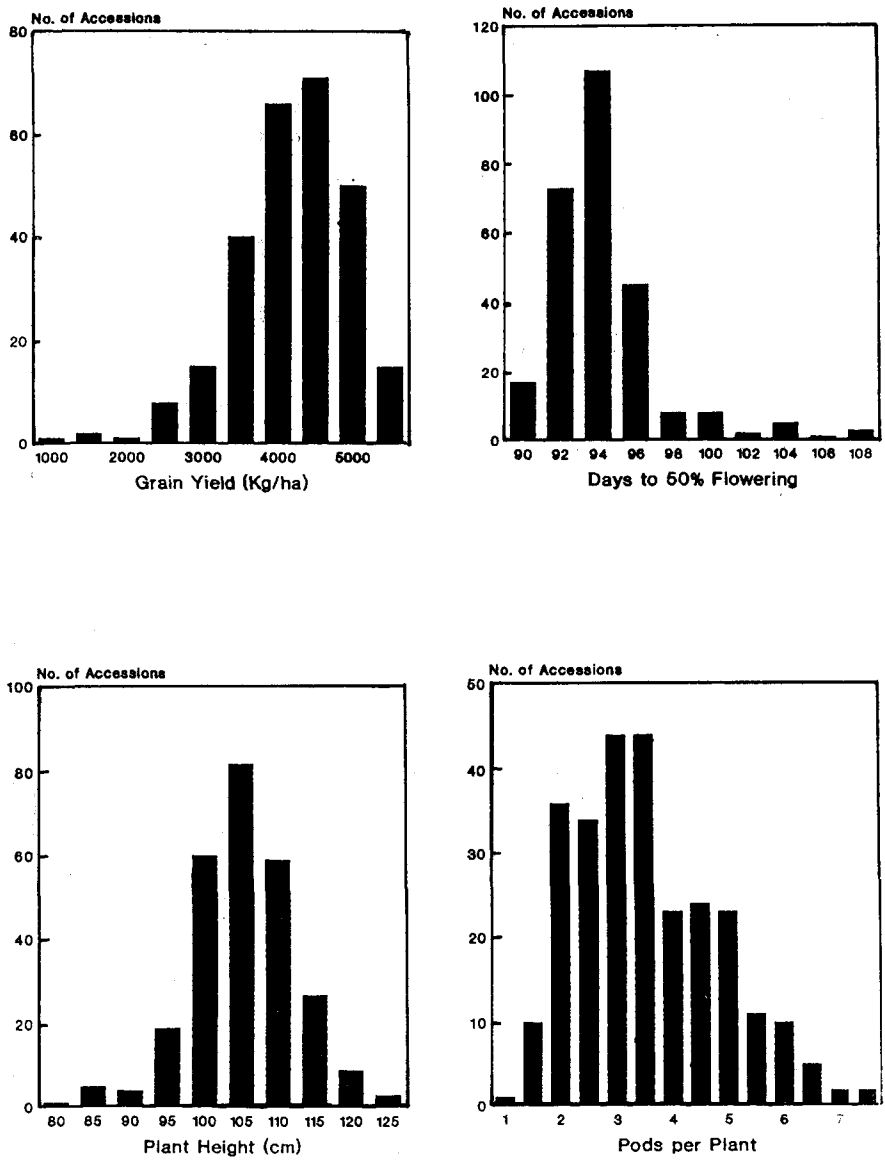


Fig1a. la. Frequency distribution of grain yield, days to 50% flowering, plant height, pods/plant, for 269 Moroccan faba bean germplasm accessions, Douyet, 1990/91.

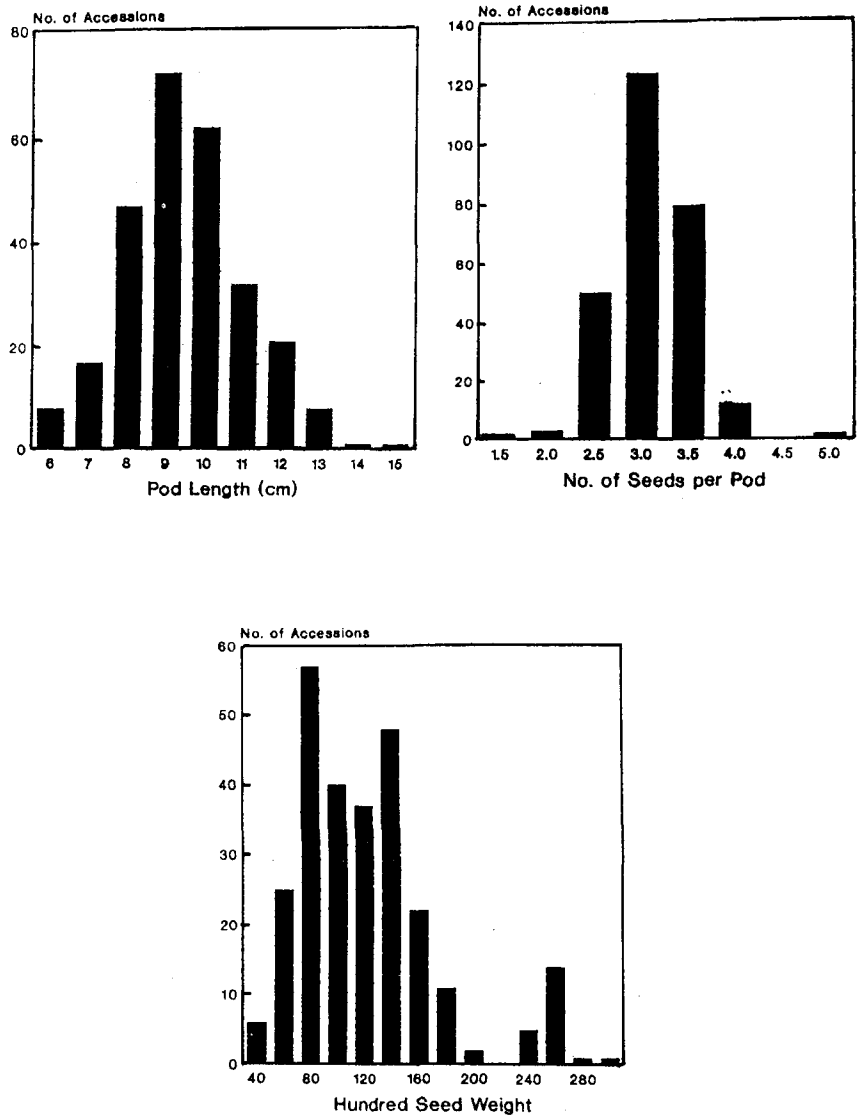


Fig. 1b. Frequency distribution of pod length, seeds/faba bean pod and 100- seed weight for 269 Moroccan faba bean germplasm accessions, Douyet, 1990/91.

Table III : **Correlations among grain yield, date of flowering, plant height, pods per plant, pod length, hundred seed weight, node and seeds per pod for 269 Morocco germplasm accessions grown at Douyet, Morocco, 1991.**

Descriptor	grain yield weight	Date of flowering	Plant height	Pods/ plant	Pod length	Hundred seeds	Pods/ node
Date of flowering	- 0.46**	1.00	0.29**	0.20**	-0.26**	-0.30**	0.31**
Plant height	-0.04	0.29**	1.00	0.07	-0.10**	-0.07	0.16**
Pod per plant	-0.44**	0.20**	0.07	1.00	-0.43**	-0.50**	0.65**
Pod length	0.47**	-0.26**	-0.12*	-0.44*	1.00	0.35**	-0.41**
Hundred seed weight	0.50**	-0.30**	-0.07	-0.51**	0.35	1.00	0.48**
Pods per node	-0.48**	0.31**	0.16**	0.65**	-0.42**	-0.48**	1.00
Seeds per pod	-0.40**	0.23**	0.12**	0.92**	-0.33**	-0.50**	0.61

Table IV : **Reaction of certain faba bean lines to different populations of broomrape in Syria and North Africa, 1987-1989.**

Sel. 88 Lattakia	Pedigree Cordoba	Reaction1				
		Syria 87/88	**Morocco** 89	**Algeria** 88	**Tunisia** 89	
18105	289264	R	R	R	R	S
18009	329K	R	R	R	R	S
18035	437K	R	R	R	R	S
Local	-------	S	S	S	S	S

1) R = Resistant ; no **Orobanche** shoots or very small with very little seed formation, less than 0.5 shoots per plant, and S = susceptible; shoots very common, more than four per plant, shoots large with normal seed formation, yield of host reduced greatly of lost completely.

by the three dates of sowing with 18 Nov sowing yielding highest (2651 kg/ha) followed by 10 Jan (2217 kg/ha) and 24 Oct sowing (1857 kg/ha). Glyphosate strayed plots, on an average, yielded 2804 kg/ha compared with an yield of 1679 kg/ha of the untreated plots. The number of pods per plant showed trends similar to the grain yield. The numbers of **Orobanche** shoots per plant were significantly reduced by using resistant veriety, a delayed sowing or glyphosate application.

Two-way interactions between varieties and dates, varieties and glyphosate application, and date and glyphosate application were significant for grain yield. The highest yields were obtained from the two resistant lines when sown on 18 Nov., whereas, from Aquadulce highest yields were obtained in the latest sowing date (Fig. 3). Glyphosate spray caused higher increases in yield in the susceptible cultivar (Aquadulce) than in the resistant cultivars (Fig. 4). The beneficial effect of glyphosate ray on yield was higher (about 3-fold increase in grain yield) in the earliest (24 Oct) sowing date than in the two later dates (Fig.5). Similar treatment interactions were observed for biological yield, pods per plant, and the number of **Orobanche** shoots per plant, which could well explain the trends observed in grain yields.

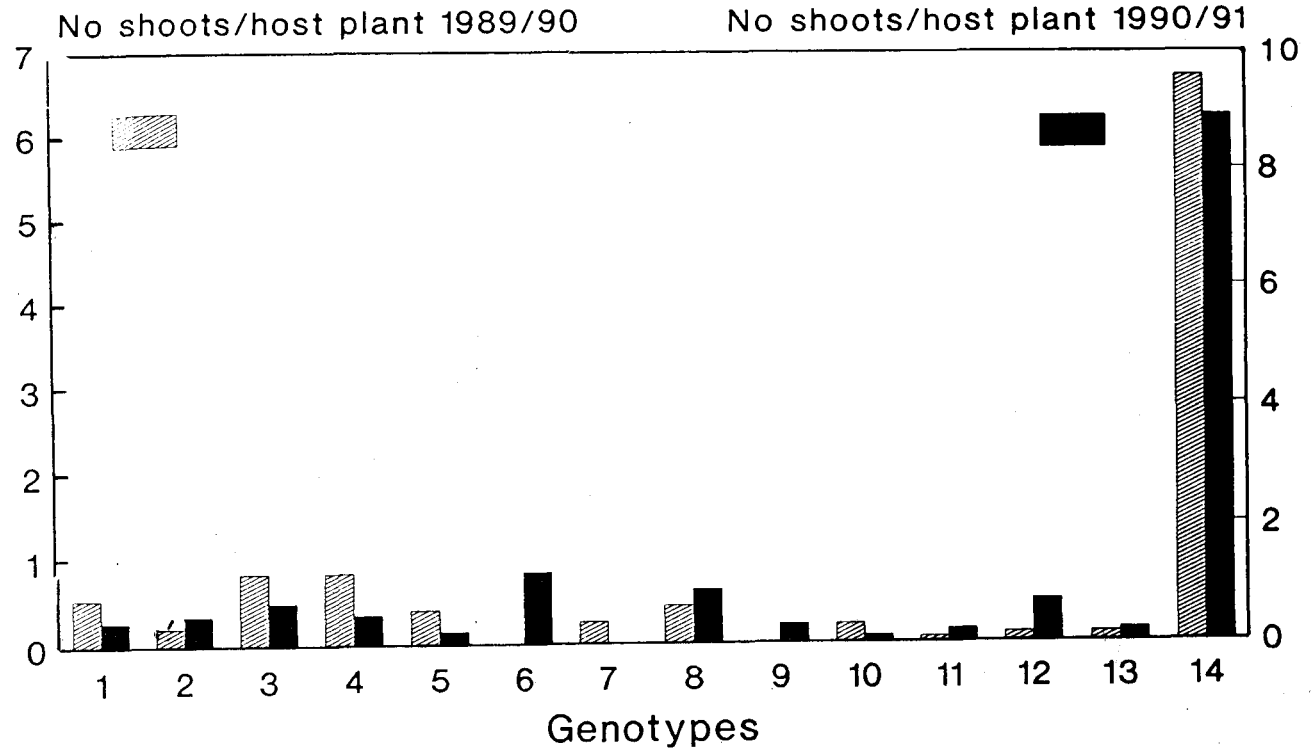
Results from this experiment clearly show the choices in controlling faba bean **Orobanche.** These include use of resistant variety planted slightly late, in Nov ; use of resistant or susceptible variety planted early but sprayed with glyphosate; and use of susceptible variety but planted late. These combinations will help control **Orobanche** infestation and increase faba bean grain yields.

3. 2. 3. Initial Seed Load and Damage

The effect of the initial seed load of **O. crenata** on the yield of a susceptible (Aquadulce) and resistant (Sel 88 Lat 18000) genotype was investigated through a pot experiment. Different quantities of **Orobanche** seeds (based on an average count of 250 seeds of **Orobanche**/mg) were mixed thoroughly with **Orobanch**-free soil from Douyet Station to obtain a seed bank of 3, 5, 9 and 22 per cc Soil. The **Orobanche**-free soil served as control. A fixed amount of soil (5652 cc) with different **Orobanche** seed load was filled in each pot (20 cm size) sown with either a susceptible or resistant genotype and placed in a bee-proof field cage. Only one plant was maintained in each pot. A randomized block design was used with three replications.

In general, grains yields of the resistant line 18009 were significantly higher than those of the susceptible cultivar Aquadulce at all **Orobanche** seed loads

Fig. 2. **Orobanche** infestation in 13 new **Orobanche** - resistant faba bean lines compared to the local check Aquadulce in an artificially infested field at Douyet, 1989/90 and 1990/91. Genotype : 1. LS 222; 2. LS 225; 3. 8/9 72; 4. 8/9 85; 5. 8/9 86; 6. 8/9 128; 7. 8/9 136; 8. 8/9 137; 9. 8/9 138; 10. 8/9 139; 11/ 8/9 143; 12. 8/9 52; 13. 8/9 153; and 14. Aquadulce.



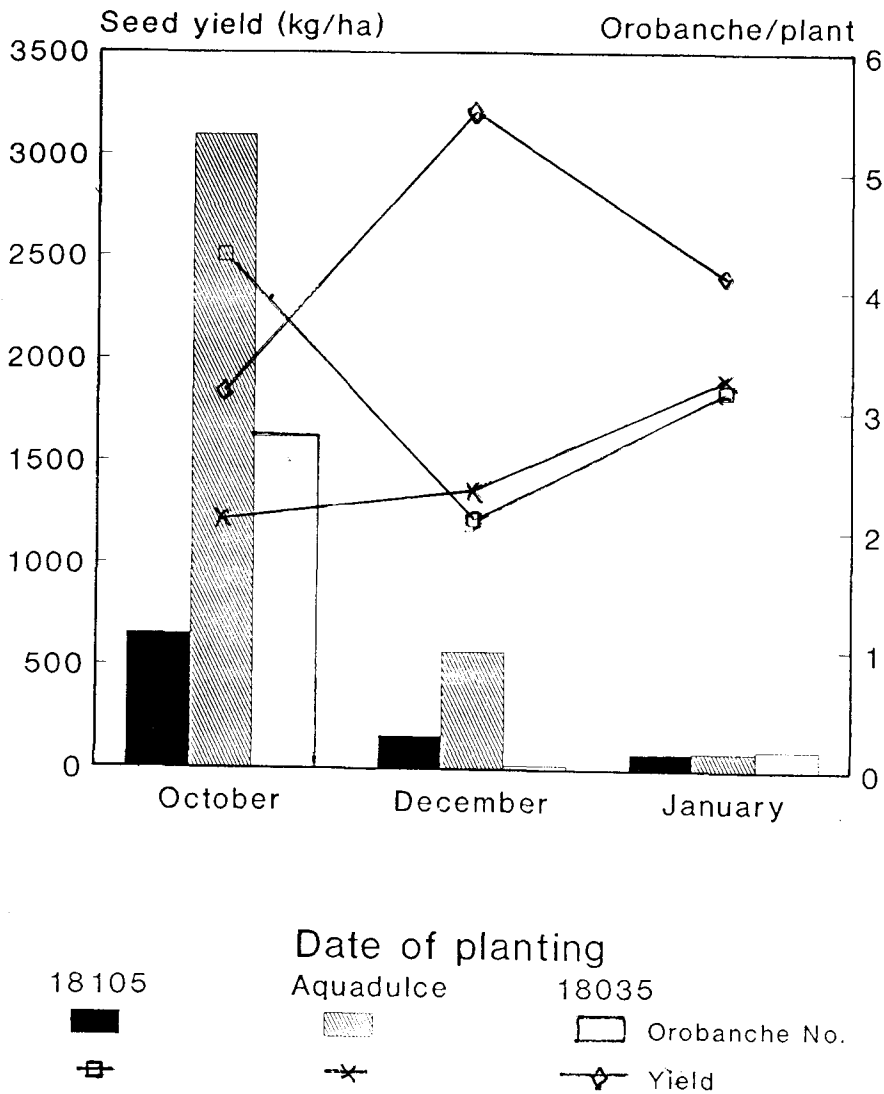


Fig. 3. Interaction of planting dates and varieties in affecting faba bean grain yield and number of **Orobanche** shoots per faba bean plant at Douyet, 1990/91.

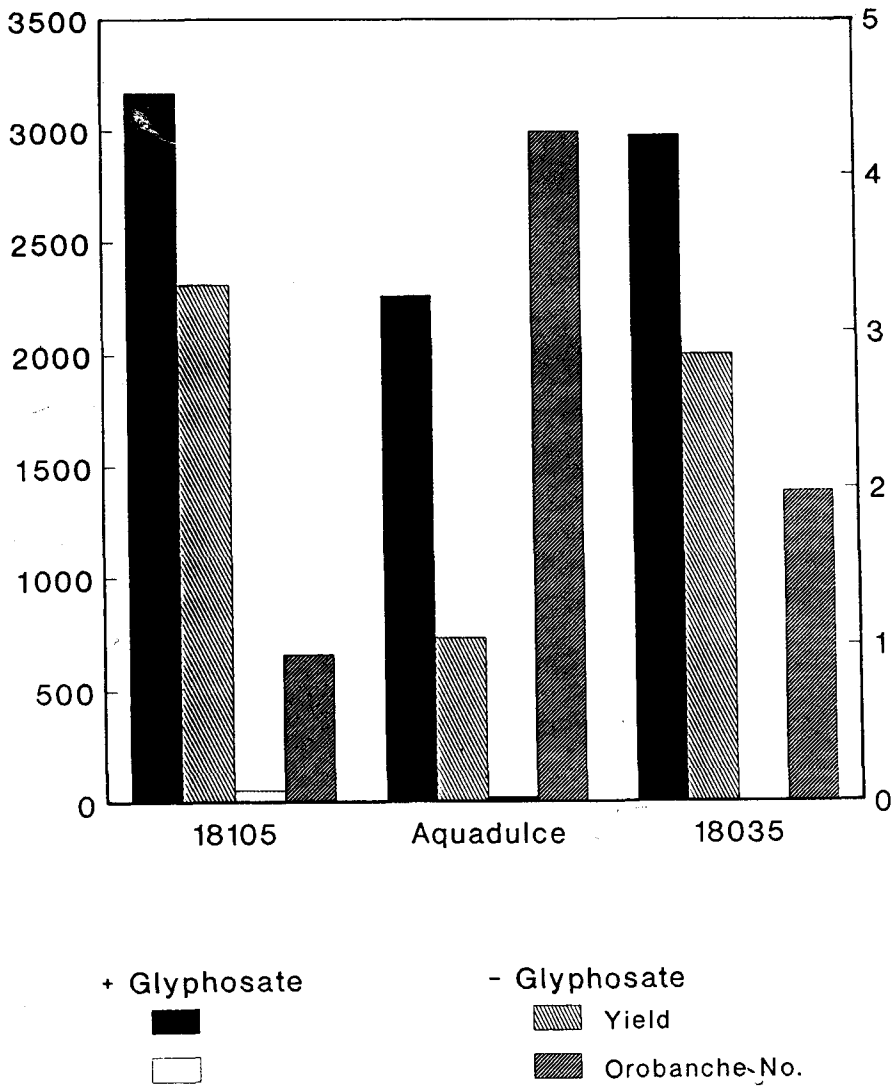


Fig. 4. Interaction of varieties and glyphosate spray in affecting faba bean plant at Douyet, 1990/91.

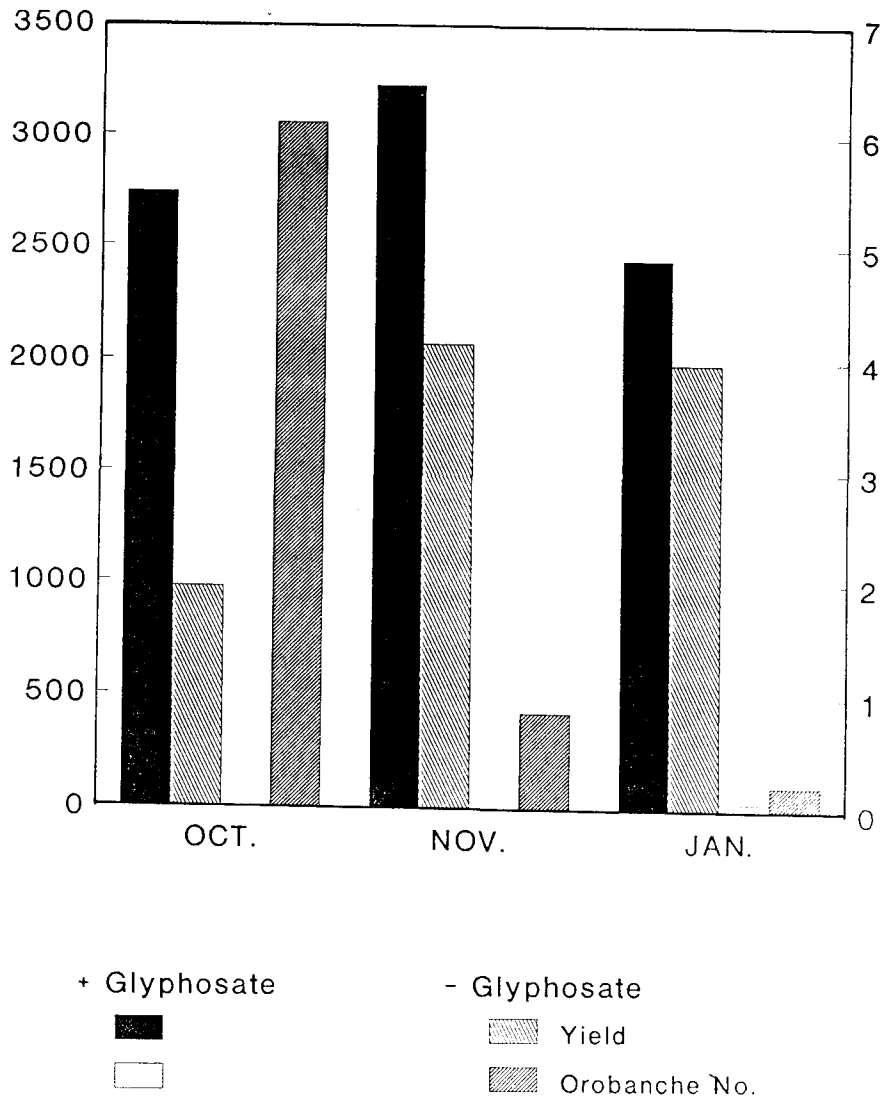


Fig. 5. Interaction between planting dates and glyphosate spary in affecting faba bean bean yield and number of **Orobanche** shoots per faba plant at Douyet, 1990/91.

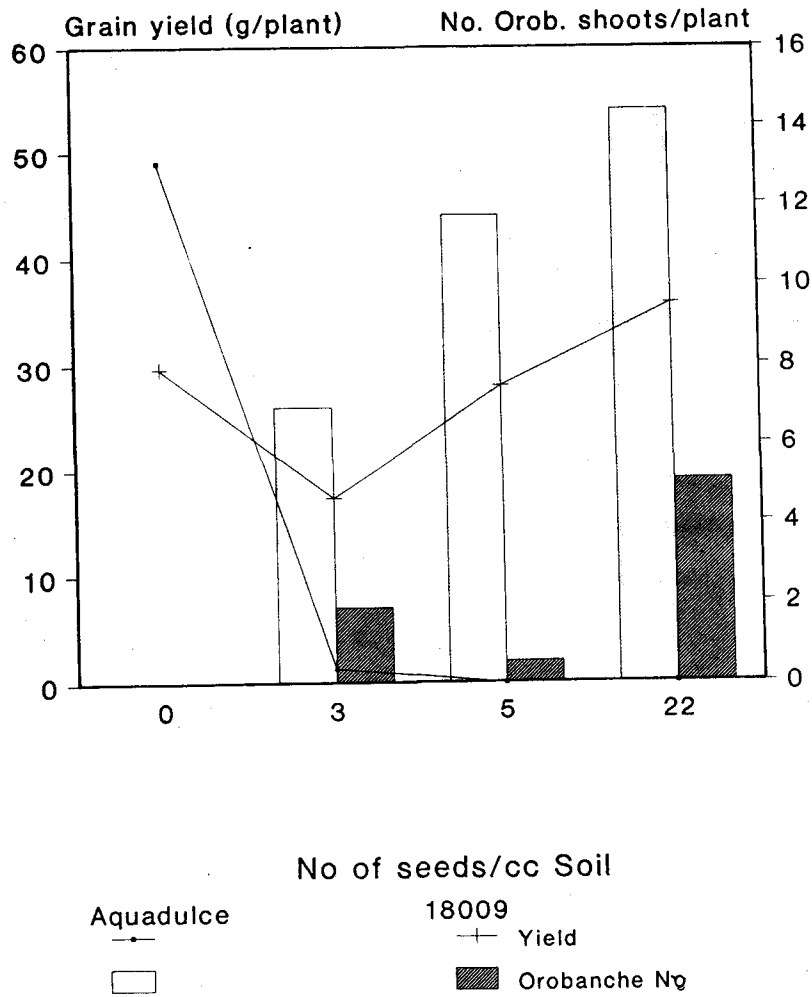


Fig. 6. Effect of **Orobanche** seed load in soil on grain yield and number of **Orobanche** Shoots per faba bean plant in two faba bean varieties at Douyet, 1990/91.

Table V : **Results of Regional Orobanche Nursey at Douyet, 1990/91.**

Line	Seed yield (kg/ha)	No. Orob. shoots per plant
18009	609	1.95
18025	535	3.45
18035	538	2.60
18054	385	3.50
18105	692	5.40
Aquadulce	0	16.00
Local	4	15.30
C.V. (%)	153%	63%

except at 0 seed load (**Orobanche**-free soil) where Aquadulce outyielded line 18009 by 38% (Fig. 6). The yield of Aquadulce decreased as the seed load of **Orobanche** increased and it failed to yield any grain when seed load was 9 more/ cc soil, whereas, the resistant line at these loads yielded as much as in the **Orobanche**-free situation.

Orobanche infestation increased with increasing seed load in both genothypes but the infestation was much higher in the susceptible than in the resistant genotype (Fig. 6).

3. 2. 4. Regional Orobanche Resistance Nursery

An **Orobanche** resistance regional nursery was also initiated in 1989/90 and distributed to Morocco, Algeria and Tunisia. Through this nursery, the faba bean lines 18009 and 18015 were further tested in Morocco, Algeria and Tunisia in naturally infested fields to study their resistance to different populations of **O. crenata** in the region. The plot size was one, 2-m row with 0.5 m spacing between rows. In 1990, theselines were rated as resistant to the parasite across all locations, except to the reddish population of **Orobanche** which occurs in the area of the Beja testing site in Tunisia (Table 4). There is an urgent need to identify new sources of resistance to the reddish population of the parasite.

Results from Morocco for the 1990/91 season are presented in Table 5. At Douyet there was an extremely severe infestation of **Orobanche.** Aquadulce (which was also the local check) yielded no grains and had eight times the number of **Orobanche** shoots per faba bean plant compared with the most resistant line.

Table VI : **Grain yield (kg/ha) and Orobanche shoots/faba bean plant at five locations in 1990/91 the verification trial with four faba bean genotypes in Morocco.**

Entry	1989/90	1990/91					
	Douyet	Douyet	CT	Ghania	Sais	Fes	Mean
18105	1120	397	2808	2191	3252	3105	2351
18035	1220	272	2698	2888	3022	3692	2514
18009	1230	276	2980	1989	3380	2671	2259
Aquadulce	440	0	0	2045	2045	3583	1616
S.E.D.	114	194	1598	1198	390	349	----
Mean	1003	315	2828	2278	3026	3264	2185
	Orobanche shoots/faba bean plant						
18105	0.40	3.90	0.63	3.70	0.30	0.30	1.77
18035	0.65	3.30	0.73	4.63	0.13	0.17	1.79
18009	0.80	3.73	0.43	4.03	0.27	0.23	1.74
Aquadulce	5.00	11.57	3.73	6.67	1.87	0.73	4.91
S.E.D.	0.25	0.71	0.24	2.16	0.22	0.39	----
Mean	1.71	5.63	1.83	7.02	0.64	1.95	2.55

3. 2. 5. On-farm Verification of Resistant Lines

In close collaboration with the extension Departement of Meknes, the control of **O. crenata** by the use of three resistant lines (Sel . 88. Lat. 18009, 18035 and 18105) was demonstrated in naturally infested farmers fields. The plot size was 5,4-m rows with 0.5 m between rows. Seed yield was measured on 3, 3-m rows.

Data from one location in 1989/90 and five locations in 1990/91 are presented in Table 6. It is clear that where there was heavy **Orobanche** infestation the resistant lines out yielded Aquadulce. Over five sites in 1990/91 the resistant lines were 46% higher yielding than Aquadulce and they had 64% less **Orobanche** shoots per faba bean plant than Aquadulce. Similar results can be seen for 1989/90. Interestingly, farmers wanted seeds of these lines despite their small seed size (50-70 g/100 seeds).

YIELD IMPROVEMENT

The majority of faba bean in Morocco is grown in wheat-based farming systems where there is adequate rainfall/supplementary irrigation. To be competitive with other crops in this farming system, faba bean has to have high and stable yields. This necessitates genotypes with resistance to **O. crenata, Botrytis fabae, Ditylenchus dipsaci, Ascochyta fabae and Uromyces fabae.**

4. 1. Yield Trials

The 1989/90 season had early and large amounts of rain which delayed planting and reduced grain yields; C.V. S were very high (16-48%) and trial mean grain yields ranged from 884 to 2138 kg/ha (Table 7). Because of the high C. V. S, no trial had significant differences among lines at the 5% probability level. The highest grain yield in replicated trials was 2651 kg/ha. A total of 128 lines outyielded the best check, but none significantly (Table 7).

The 1990/91 season had a good distribution of raifall. C.V. S ranged from 9.6 to 17. 8% for trials grown at Douyet and the trial means ranged from 3117 to 4191 kg/ha (Table 8). The highest grain yield in replicated trials was 5.4 t/ha. A total of 100 lines outyielded the best check and nine did so singnificantly.

4. 2. North African Regional yield Trials

North African regional yield trials, large and small seeded, were distributed in the 1989/90 season to Morocco and Algeria. Tunisia and Libya were added in 1990/90. These had a randomized complete block design with four replications. Plot size was 4, 4-m rows with 0.5 m between rows, with only 3 m of the two inner rows harvested for yield determination. Results for Morocco are presented in Tables 9 and 10. Over years there were no lines significantly higher yielding than Aquadulce in the large seeded trial (Table 9). However, in the small seeded trial there were 11 lines that were as high or higher yielding than the large seeded check, Aquadulce (Table 10).

DISEASE RESISTANCE SCREENING

5. 1. Screening for Chocolate Spot and Ascochyta Blight Resistance

Disease resistance screening nurseries were developed at ENA-Meknes and screening started in the 1989/90 season. All nurseries were inoculated artificially

Table VII : **Results of faba bean yield trials at Douyet and Jemaa Shim, 1989/90.**

Trial	No. of test entries	No. of lines>Check	Grain yield (kg/ha)			
			Trial mean	Best lines mean	Check mean	C.V. (%)
Advanced Trials						
FBMAYT-L	36	12	1869	2279	2010	24
FBAYT-L-1	36	6	2083	2651	2390	20
FBAYT-S-1	25	18	2138	2531	1920	16
FBAYT-D-1	36	0	1305	1960	1960	45
FBAYT-D-1	36	6	1006	1674	1110	28
Preliminary Trials						
FBMPYT-L-1	25	0	1445	2209	2260	30
FBMPYT-L-1	36	28	1638	2228	1350	21
FBMPYT-S-1	36	24	2009	2503	1890	17
FBMPYT-D-1	49	0	884	1422	1620	26
Regional Trials						
FBNATYT-L	24 D	2	1678	2126	2030	26
FBNARYT-L	24 JS	9	604	648	978	56
FBNARYT-S	24 D	6	1750	2147	2030	16
FBNARYT-S	24 JS	14	1153	1588	1100	40
FBMNYT-L	12 D	3	1010	2145	1950	24
FBMNYT-L	12 JS	0	918	1183	1320	48

Check was Aquadulce for all trials.
D = Douyet, JS = Jamaa Shim.

Table VIII : **Results of faba bean yield trials at Douyet, 1990/91.**

Trial	No. of test entries	No. of lines>		Grain yield (kg/ha)			
		Check	signi	Trial mean	Best lines mean	Check mean	C.V (%)
FBNARYT-L	21	11	1	4152	5141	4117	17.8
FBNARYT-S	23	7	0	4106	4610	4344	11.0
FBAYT-L-1	33	12	0	4191	4972	4364	11.3
FBAYT-L-2	46	18	1	3991	5135	4125	15.8
FBAYT-S-1	23	3	1	3959	4194	4401	9.6
FBAYT-D-1	46	1	0	3399	3881	3949	12.0
FBPYT-L-1	46	4	0	3585	4785	3966	16.0
FBPYT-L-2	46	34	5	4100	5391	3893	10.6
FBPYT-S-1	3	10	1	4182	5197	4360	10.8
FBPYT-D-1	46	0	0	3117	4422	4312	15.5

Table IX : **Grain yield (kg/ha) for the North Africa Regional Yield Trial-Large seeded in Morocco, 1989/90 and 1990/91.**

Pedigree /Accession	1989/90		1990/91	
	Douyet	jemaa Shim	Douyet	Mean
FLIP 82-30 FB	1932	740	3913	2195
FLIP 82-45 FB	2170	365	4055	2197
FLIP 84-107 FB	2286	183	4632	2367
FLIP 84-128 FB	1619	583	3895	2032
FLIP 84-147 FB	2610	953	4234	2599
FLIP 85-89 FB	1946	978	4114	2346
FLIP 86-35	1495	353	3938	1929
FLIP 86-36 FB	1911	403	3783	1395
FLIP 87-26 FB	1592	965	4134	2230
FLIP 87-70 FB	1805	438	4500	2248
FLIP 87-137 FB	2005	535	3749	2096
FLIP 87-140 FB	1974	835	5141	2650
FLIP 87-147 FB	1474	945	4299	2239
FLIP 88-1 FB	1843	553	3758	2051
FLIP 88-2 FB	1956	745	3844	2182
S 82113-8	2411	505	4130	2349
79 S4	2652	353	4466	2490
80S44027	1083	553	4304	1980
80S80028	2215	400	4369	2328
80S80125	2093	827	3739	2292
Reina Blanca	1983	680	3314	1992
Turkish Local	1982	432	-------	-------
Aquadulce	2011	520	4539	2357
Local Check 1	1931	648	4157	2245
Local Check 2	--------	--------	3655	2245
C. V. (%)	26	56	17.8	--------

and scored for disease reaction using ICARDA's 1-9 rating scales. In 1990, 743 single plant selections were made for resistance to chocolate spot and ascochyta blight, whereas, in 1991, 1274 single plant selections were made for resistance to chocolate spot. Also, in 1990 at Meknes, 177 selections were made for the IVS trait, whereas, 251 such selections were made in 1991.

5. 2. Screening for Stem Nematode Resistance

Screning carried out in collaboration with INRA and IAV-Hassan II at Guich Station in Rabat. Infested faba bean stems collected from the previous season were used to inoculate 200 faba bean inbred lines (BPL 3006 to BPL 3263) from ICARDA using procedures mentioned in ICARDA' 1989 Manual of Sceening Techniques for Disease Resistance in Faba bean. Of the 200 test entries tested, 147 were rated resistant (3 on ICARDA's 1-9 scoring scale) with the remaining 53 entries rated tolerant (rating 5), including local checks. one line INRA 29II from France was rated 1. (highly resistant).

AGRONOMIC STUDIES

6. 1. Plant Density and Faba bean Growth and Grain yield

The experiment was conducted in the 1990/91 season in a RCB design with four replications. Four faba bean densities of 5, 12. 5, 25 and 40 plants/m2 were used with a spacing combination of 100 x 20, 40 x 20, 40 x 8.5 and 30 x 8.5 cm, respectively. The plot size was 8 x 8 m. Seeds were hand-sown on 21 November 1990. The crop was hand-weeded twice. Diseases and insect-pests were controlled by regular chlorothalonil (Bravo 500) and triazophos (Hostathion) sprays. No chemical spray were done to control **Orobanche.** Observations on branching, height of plant dry weight were recorded over growing season. Plots were harvested by 25 of May, and observations on grain yield and its components were recorded.

Since no glyphosate treatment was applied the attack of **Orobanche** was severe in the trial. An increase of plant density from 5 to 40 plants/m2 had a depressive effect on the number of branches per plant because of increased interplant competition. The plants density also affected plant height. Plants were tallest (138 cm) in the highest density shortest (122 cm) in the lowest density.

Data on grain yield and its components are given in Table 11. The grain yield ranged from 3313 kg/ha for the lowest density to 1114 kg/ha for the highest one. The densities above 5 plants/m2 had lower grain yield because they were more

affected by **Orobanche** and diseases such as chocolate spot and Ascochyta blight.

6. 2. Effect of Crop Rotation on the Seed Bank of Orobanche

An experiment to see the effect of several two course of crop rotations with wheat on the crop productivity and seed bank of **Orobanche** was initiated in the 1990/91 season. The experiment was laid out in 10 x 3.4m plots in a split-plot design with four replications. The main plots had the phases and the sub-plots the rotations. Two faba bean varieties, viz. , Aquadulce (susceptible) and Giza 402 (resistant) were included in the rotations. It will take several cycles before conclusive results will become available from this study.

6. 3. Survey for Faba bean production practices at the farm level

A survey for faba bean production practices was carried out in the 1989/90 crop season in two major faba bean regions of Morocco, viz., Taounate and Taza, which have an annual area of 50 000 and 28 000 ha and production of 70 000 and 44 000 tonnes, respectively. A total of 63 farmers were selected from 13 villages of Taza and 10 of Taounate to ensure a fair representation of the two regions. The farmers were asked questions on faba bean production pratices. The average land-holding of the surveyed farmers was less than 20 ha for 70% of the cases.

The results show that faba bean is the most common precedent of the wheat crop in the prevalent crop rotations. Soils are ploughed by disk followed by one or two cultivations. Sowing is done by hand on ridges, mostly in November. Certified seeds are used by only 33% of faba bean farmers and their use results in 17% yield increase over the use of local seed. Plant densities range between 5 to 20 plants/m2 for 66% of the farmers, and are lower than those recommended for the two regions (around 30 plants/m2). Phosphorus application commonly used by all the farmers is 10 kg P2O5/ha. Nitrogen and potassium fertilizer use is highly variable.

Weed control is done mostly by one or two inter-cultivations using draft power. Hand-weeding is not a common practice.

About 50% of the faba bean fields surveyed were infested with various levels of **Orobanche.** Forty-two percent of fields had low infestation (score 1), 35% had medium infestation (score 2) and 23% had high infestation (score 3 to 6).

Table X : **Grain yield (kg/ha) for the North Africa Regional Yield Trial-Small seeded in Morocco, 1989/90 and 1990/91.**

Pedigree /Accession	1989/90		1990/91	
	Douyet	jemaa Shim	Douyet	Mean
FLIP 82-9 FB	2047	1183	4174	2477
FLIP 82-35 FB	1989	1345	3826	2387
FLIP 83-106 FB	2051	1495	4473	2673
FLIP 84-46 FB	1923	1010	4260	2398
FLIP 84-48 FB	1995	990	4190	2292
FLIP 84-59 FB	1961	1070	4610	2547
FLIP 85-13 FB	2006	1588	4125	2573
FLIP 85-28 FB	2319	755	4835	2636
FLIP 85-48 FB	1984	1200	4165	2450
FLIP 86-80 FB	2140	723	3810	2224
FLIP 86-85 FB	2220	1188	4548	2652
FLIP 86-86 FB	2533	1170	4423	2709
FLIP87-77 FB	2375	2885	3619	2426
FLIP 88-3 FB	2055	1303	3881	2413
FLIP 88-4 FB	2375	985	3690	2350
FLIP 88-6 FB	2105	793	3689	2196
76TA56267	1846	1410	3762	2339
B87148	2067	1040	4036	2381
B87149	2123	1263	4219	2535
B87249	1865	1590	4391	2615
B87258	1992	1180	3714	2295
B87259	1632	1250	4497	2460
B87263	1714	753	3702	2056
Local Check	1897	1108	4343	2449
C. V. (%)	16	40	11.0	--------

Table XI : **The effect of plant density on faba bean (CV. Aquadulce) yield and its components at Douyet, 1990/91.**

Plant density (Plants/m2)	Branches/ Plants	Pods/ Plant	Seeds/ Plant	100-Seed Weight	Grain Yield (kg/ha) (g)
5	5.3	8.0	35.0	182	3314
12.5	3.7	6.3	25.7	164	2271
25	2.9	4.7	16.0	157	1978
40	2.1	3.3	9.7	145	1114
Mean	3.5	5.6	21.2	162	2169
C. V. (%)	8.3	14.3	28.3	6.7	31.2

The attack was more in the fields that used seeds from seed companies for seed increase centracts. Chemical treatment to control **Orobanche** infestation is not widely practiced as only 21% of farmers used glyphosate sprays with half of them using two sprays, one third using one spray and only one farmer using three sprays. All the surveyed farmers asked for technical assistance in applying glyphosate treatments.

Grain yields were fairly low : 540 and 490 kg/ha for Taza and Taounate regions, respectively. These are much lower than the average faba bean yields of 1500 and 13520 kg/ha for these two regions, respectively.

SUMMARY AND CONCLUSIONS

This attempt to transfer an international crop improvement program to a national program has been a successful experiment. A strong national faba bean program is developing in INRA Morocco at Douyet Research station with a breeder, pathologist and agronomist. The breeding material from ICARDA headquarters has been transferred successfully with good selection done for North African conditions. A running program has been established for crossing, selection, especially for major diseases and **Orobanche**, yield testing, on-farm verification and for release and seed production. Regional work has been established from a national base with two yield trials and an **Orobanche** screening nursery.

The national faba bean germplasm collection has been consolidated and evaluated for useful descriptors, and accessions for potential use in the breeding program have been identified.

A large program has been established for **Orobanche** research includin selection and crossing, with lines with high levels of resistance identified. These lines have been tested regionally and found to have a broad-based resistance. Lines have been tested on farmers fields and been found to give 46% higher grain yield than Aquadulce ; with much higher increases in sites with heavy Orobanche infestation. Two of these lines will now go to 1991/92 catalogue trials for release. It has been demonstrated that these lines give better response to chemical control of **Orobanche** than Aquadulce, and much less reduction in grain yield with earlier planting dates, and perform equally well on soils with a wide range of seed load of **Orobanche crenata**.

Disease resistance screening has been established for chocolate spot and ascochyta blight with many selections identified in segregating populations.

A diagnostic survey to understand faba bean production practices at the farm level in Taounate and Taza provinces has shown that low plant densities, lack of certified seeds and presence of **Orobanche**, were major contraints to faba bean production.

RESUME

Un programme international d'amélioration de la fêve a été transferé avec succès au programme national de l'INRA (Maroc) au Domaine Experimental de Douyet. Ainsi, plusieurs sélections sont été faites pour les conditions nord-africaines.

La collection nationale de la fêve a été évaluée en utilisant les descripteurs de l'IBPGR/ICARDA. Ont été identifiées plusieurs entrées à utilisation potentielle dans le programme d'amélioration de la fêve.

Un effort a été dirigé vers la recherche concernant la lutte contre l'orobanche. Ont été identifiées plusieurs lignées à résistance large. Leur rendement dépassait de 46% celui de l'aquadulce dans les champs des agriculteurs. Deux de ces lignées seront testées en 1991-92 aux essais catalogue en vue de leur inscription. Ces lignées ont une meilleure réponse que l'aquadulce au contrôle chimique de l'orobanche et ont une très faible réduction du rendement quand semées precocèment.

PLusieurs lignées ont été sélectionnées pour leur résitance au bortrytis et à l'aschochyta.

Afin de mieux cerner les pratiques culturales de la fêve, une enquête a été menée dans les provinces de Taounate et de Taza. Il en ressort que les principales contraintes sont la faible densité de semis, l'absence d'utilisation de semences certifiées et le niveau élevé d'attaque par l'orobanche.

ABSTRACT

An international faba bean improvement program has been successfully transferred to national program in INRA, Morocco at Douyet Research Station where good selections were done for North African conditions.

The national faba bean germplasm collection has been evaluated using IBPGR/ICARDA descriptiors. Accessions with potential use in the breeding program have been identified.

The main emphasis was put in **Orobanche** research. Several lines were identified to have high level of broad-based resistanc. They gave 46% higher grain yield than Aquadulce in farmers' field.

Two of these lines will now be tested in 1991-92 catalogue trials for release. These lines gave better response to chemical control of **Orobanche** than Aquadulce, and much less reduction in grain yield with earlier planting dates.

Many selections were identified as resistant to chocolate spot and ascochyta blight.

In order to understand faba farm production pratices, a diagnostic survey was done in Taounate and Taza provinces. The major constraints to faba bean production were low plant densities, lack of use of certified seeds and **Orobanche** attack.

KEY WORDS : Faba bean, **Vicia faba** L., INRA MOROCCO, ICARDA, Morocco, Douyet Research Station, National collection, **Orobanche,** Chocolate spot, ascochyta blight, diagnostic survey.

ملخص

أدمج، بنجاح، برنامج دولي لتحسين الفول مع البرنامج الوطني للمعهد الوطني للبحث الزراعي (المغرب) بالضيعة التجريبية للضويات.

وهكذا تم انتخاب عينات بالنسبة لشروط افريقيا الشمالية.

وقدوصفت المجموعة الوطنية للفول باستعمال طريقة IBPGR/ICARDA. تم فرزت عدة عينات يمكن استعمالها في برنامج تحسين الفول.

هذا وقد بدل جهد للبحث عن كيفية محاربة الهالوك. كما اكتشفت عدة أنواع ذات مقاومة واسعة، مردودها يفوق ب 46٪ مردود Aquadulce في حقول المزارعين.نوعان، من هذه الأنواع، سيجربان في سنة 1991 - 92 من أجل تسجيلهما. ولهذه الأنواع إ جابات ممتازة بالنسبة ل Aquadulce في المعاينة بالمبيد الكيماوي للهالوك، ولها انخفاض ضئيل في المردود عند زراعتها مبكرا.

لذا انتخبت أنواع كثيرة من أجل مقاومتها للتبقع البني (BTtrytjs) والأسكوكيتي (ASCOchta).

وحتى يتسنى حصر طرق زراعة الفول، تمت دراسة استقصائية في مناطق تونات وتازة. يستنتج منها أن المشاكل الأساسية تكمن في قلة كثافة الحبوب وعدم اسعمال الحبوب المصادق عليها وكذلك إصابات الهالوك العالية للفول.