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FOOD LEGUME IMPROVEMENT PROGRAM

RESEARCH HIGHLIGHTS 1982-83

FLIP

The International Centre for Agricultural Research in the Dry Areas
(ICARDA)
Aleppo, Syria

CONTENTS

I. INTRODUCTION

1. Increasing the productivity and yield stability of faba beans (*Vicia faba*), lentils (*Lens culinaris*) and kabuli type chickpeas (*Cicer arietinum*) continues to be the major objective of the Food Legume Improvement Program at ICARDA. These three food crops are important in the diets of people not only in the West Asia and North Africa region but also in many other developing countries in the world. Besides their invaluable role in the diets of the people as a cheap source of good quality protein, the incorporation of these crops in cereal based rotations leads to improved overall productivity and reduced dependence of the whole cropping system on nitrogen fertilizer. Their byproducts serve as a valuable animal feed.

2. ICARDA has a worldwide responsibility for research on faba beans and lentils. The world mandate for research on chickpeas being with ICRISAT, the research on kabuli type chickpeas at ICARDA is a joint activity with that Center. ICRISAT has posted two senior scientists (a breeder and a pathologist) at ICARDA to complement this Center's team of researchers tackling the problems of improvement of kabuli type chickpeas.

3. The major constraints to higher production of faba beans, lentils and kabuli type chickpeas continue to be the same as in the past. These include inherently low yield potential of the existing landraces; high instability in yield because of their susceptibility to a number of diseases, insect pests and parasites and environmental stresses; unimproved methods of production including expensive hand harvesting and lack of mechanized harvesting techniques. Therefore, the major research emphasis of the program, during the 1982/83 season, continued to be to devise ways and means to overcome these contraints.

4. Research was carried out on the improvement of each of the three crops through a number of specific research projects, each

involving the participation of a multi-disciplinary team of researchers. The major research work was carried out at ICARDA's main station at Tel Hadya, where field experiments on different crops were conducted follwing the cropping sequences in which these legumes are grown. In the projects aiming at the development of faba bean genotypes and production techniques for assured moisture supply conditions, the crop was provided irrigation to supplement the seasonal precipitation. A coastal sub-site at Lattakia (Syria) was used for studies on resistance breeding and control of faba bean diseases and some pests, as the environmental conditions there facilitate the development of artificial epiphytotics. This and other sub-sites in Northern Syria, viz. Jinderis, Kafr Antoon, Breda, representing a range of rainfall isohytes, as also the ICARDA sub-site at Terbol in the Beqa'a valley of Lebanon, served as different environments for evaluation of the genetic material and technology being developed in the program for wider adaptation. Such an evaluation is considered improtant before these improved genotypes and production techniques are transferred to the national programs through international nurseries and trials for their local testing and adaptation.

5. To reduce the time needed for developing improved genotypes, summer nurseries were raised at high elevation sites - for lentils at Shawbak in Jordan, for faba beans at Shawbak and Bab Janneh (Northern Syria) and for chickpeas at Terbol (Lebanon) and Sarghaya (Syria).

6. The project areas for research on faba bean improvement included (1) The development of improved cultivars and production practices for West Asia, (2) The development of genetic stocks for all regions, (3) The development of cultivars and agronomic practices for production under low rainfall conditions, and (4) The development of alternative plant type. The research projects on lentil improvement included (1) The development of improved cultivars and technology for different agro-ecological situations, (2) The development of wide adaptation in lentils, and (3) The development of drought tolerance in lentils. The research on kabuli type chickpeas was conducted in two projects : (1) The development

of improved kabuli chickpea cultivars and production technology and (2) The development of improved kabuli chickpea cultivars and production technology for winter sowing. Scientists from the Farming Systems Program collaborated with us in such studies as economic evaluation of production practices, control of weeds (including parasitic weed *Orobanche* spp), symbiotic nitrogen fixation and soil fertility and soil moisture evaluation.

7. The results of international nurseries in the past have highlighted the need for adopting a more decentralised approach to breeding in order to ensure that national programs beyond the 'home' region (Syria, Jordan, Lebanon etc.) also benefit expeditiously from ICARDA's research efforts. Efforts have, therefore, been made to shift towards a research strategy that provides for a larger proportion of the selections of genotypes to be done in localities where they are to be grown. The Tunisian/ICARDA collaborative research project on food legumes, started in the 1981/82 season with the posting of two legume scientists, should form a base for such a decentralised breeding strategy for the North Africa region. The applied research project on faba beans in the Nile Valley, being executed as a special project, is providing an important regional dimension for food legume research in the irrigated farming system. Identification of sites for developing regional programs for high altitudes somewhere in West Asia and for the more southernly latitudes in Indian sub-continent will help ICARDA in meeting more effectively the needs of the national programs in these regions.

8. In order to ensure best pay-off for the resources available to the program, our research efforts at the Center have been mainly of an applied nature. The collaborative projects with the national programs have generally been given more of an adaptive bias. And, for meeting the needs of basic research, the support of advanced insitution has been sought. Links have been established with several insitutions in Canada, France, Italy, Netherlands, UK and West Germany.

II. RESEARCH HIGHLIGHTS

1. FABA BEAN PROJECT 1 : The Development of Improved Cultivars and Production Practices for West Asia.

1. Objectives :

1.1. To develop cultivars for production under higher rainfall/ supplementary irrigation in Syria, Lebanon, Jordan, Iraq, Turkey and Cyprus. Emphasis is placed on cultivars having the following characteristics :

a) high and stable yield
b) resistance to *Ascochyta fabae*
c) resistance to *Botrytis fabae*
d) resistance to *Orobanche crenata*
e) large seed and long pods suitable for both green and dry consumption
f) acceptable nutritional and quality characteristics
g) In addition, resistance to aphids, stemborers, and stem nematodes is being studied.

1.2. To develop appropriate production practices and plant protection techniques for existing and new cultivars.

2. Research Highlights :

2.1. Faba beans in West Asia are grown under high rainfall/supplementary irrigation. In order to obtain high and stable yields genotypes with high yield potential and resistance to *Ascochyta fabae, Botrytis fabae, Orobanche crenata* and *Ditylenchus dipsaci* are needed. Emphasis was, therefore, placed in developing such genotypes and suitable production technique including the control of disease, insect pests and weeds.

2.2. Development of Cultivars and Genetic Stocks :

Sources of resistance for *Ascochyta, Botrytis* and *Orobanche* identified from germplasm evaluation, have been used in the crossing program in increasing frequency. For the 1982/83 season 164 of the 234 crosses involved at least one parent resistant to a pest (Table 1.1). This trend will continue with the aim of involving at least one pest resistant parent in each cross. In addition, different sources of resistance were intercrossed for *Botrytis* (17 crosses) and *Ascochyta* (35 crosses) at Lattakia to increase levels of resistance and develop lines with resistance to more than one strain of the pathogen.

2.2.1. Yield Potential :

Replicated yield trials of 266 lines were conducted at Tel Hadya under irrigated conditions during the 1982/83 season (Table 1.2). The highest yield reported in a replicated trial was 4.1 tons/ha. A total of 43 entries exceeded the best check. Of these entries, 22 were large and 21 were small seeded. The number of lines tested in preliminary yield trials will be increased significantly by using two row plots and two replicates.

At Terbol a total of 154 lines were tested in 8 replicated trials. Of these, only seven trials were analyzed because in the remaining trial some plots were lost. There were 42 lines which exceeded the best check in Lebanon. Of these, 8 were common at both Terbol and Tel Hadya.

Thirty entries from the large seeded trial of the Faba bean International nursery and 46 entries from the small seeded trial were tested at both Tel Hadya and Terbol. Data is available from the Tel Hadya trial only. Of the tested lines at Tel Hadya, 4 and 16 exceeded the best check for the large and small seeded trials, respectively.

From 446 lines tested in preliminary screening nurseries for small seeded lines 134 lines were selected for testing in preliminary yield trials in 1983/84 and from 127 lines tested in large seeded

Table 1.1. Number of crosses made for each trait in the 1982/83 season (excluding crosses for determinate plant type).

Trait	Number of crosses
Orobanche resistance	56
Ascochyta resistance	66
Botrytis resistance	42
Yield	28
Earliness	22
Drought	20
Total	234

Table 1.2. Summary of results from the faba bean yield trials grown at Tel Hadya, Syria and Terbol, Lebanon during the 1982/83 season.

Trials/nurseries (number)	Number of tested lines	Tel Hadya			Terbol		
		Highest yield (t/ha)	No.of lines exceeding best check	C.V. range %	Highest yield (t/ha)	No.of lines exceeding best check	C.V. range %
Preliminary Yield Trials Large Seeded (2)	46	3.82	6a	13-14	-d	-	
Preliminary Yield Trials Small Seeded (3)	66	4.05	8b	12-17	-d	-	
Advanced Yield Trials Large Seeded (2)	43	3.91	11a	12-13	3.35	24 a,b	21-22
Advanced Yield Trials Small Seeded (3)	42	3.57	0b	15-16	3.90	3 a	18-21
Regional Yield Trial Irrigated	23	4.07	4a	12	3.45	8 a	28
International Yield Trial Large Seeded	23	4.08	1a	10	3.55a	7	22
International Yield Trial Small Seeded	23	3.68	13c	14	-e	-	
International Screening Nursery Large Seeded	30	4.01	4a	10	-e	-	
International Screening Nursery Small Seeded	46	4.49	16b	27	-e	-	

a. Best check was ILB 1814.
b. Best check was ILB 1813.
c. Best check was ILB 1812.
d. Not grown.
e. Not analyzed due to loss of plots.

preliminary screening nurseries 54 lines were selected for preliminary yield trials.

2.2.2. Disease Resistance :

The major disease resistance work was carried out at Lattakia, where environmental conditions were conducive for the development of natural epiphytotics. In order to ensure proper screening, however, artificial epiphytotics were developed.

2.2.2.1. *Ascochyta blight :* Various sources of resistance were used to make 66 crosses for ascochyta blight in 1982/83 and these will be screened in 1983/84 at Lattakia. From the screening of 1080 F_4 lines 63 were found resistant with a disease score of 3 or lower on a 1 to 9 scale. Of these 45 were increased in the off-season for preliminary yield trials in 1983/84. From 2252 F_3 lines 855 single plant selections were made. F_2 populations were also tested with 135 single plant selections made.

2.2.2.2. *Chocolate spot :* Adopting a two-cycle screening technique considerable progress was made in identifying promising sources of resistance to *Botrytis fabae*. Of 574 F_4 lines tested, 187 were rated resistant (3 or lower score) and 45 were increased in the off-season for preliminary yield trials. From F_2 populations 839 single plant selections were made and will be screened in the 1983/84 season. A total of 42 crosses were made and the F_1 grown in the off-season. These will be screened at Lattakia in the 1983/84 season.

From the crossing program lines have come out with good resistance to diseases and with high yield potential. Of the 43 lines tested in preliminary large seeded yield trials in 1982/83 at Tel Hadya nine were found with high levels of resistance to chocolate spot and also high yielding (Table 1.3). These lines not only yield at the same high level as ILB 1814 but also have stability with resistance to chocolate spot.

2.3. Diseases and their Control :

Although faba beans in West Asia are affected by several diseases, chocolate spot, ascochyta blight, stem nematodes and rust are the most important. Practical management of these diseases should mainly depend on the use of resistant cultivars, and the efforts being made in developing such cultivars have already been outlined earlier. For developing suitable protection strategy it is important that more is known about the epidemiology of the disease, variability in the pathogens and the scope of chemical control in combination with host resistance. Some of these aspects were studied during the 1982/83 season at Lattakia.

2.3.1. Chocolate Spot :

Host-pathogen interaction studies in the past indicated existence of pathogenic variability among different isolates of *Botrytis fabae* but the race status could not be determined because the isolates were obtained from single lesion on single plant. Recently 32 isolates of the pathogen collected from the faba bean growing regions in Lattakia and Tel Kalakh in Syria and Doha in Lebanon were used to study their virulence on chocolate spot resistant (BPL 710, 261, 1179) and susceptible (ILB 1815) genotypes using detached leaf technique. There were significant differences among different isolates within each of the populations of the three regions. Based on the type of lesions, the isolates could be grouped into 3 races (Table 1.4). Race 1 was different from races 2 and 3 because it was able to infect BPL 1179. Race 2 was different from race 3 as it infected BPL 1179 and ILB 1815. More survey work will be carried out in 1983/84 to get better understanding of the variability in *B. fabae*.

Studies on chemical control of chocolate spot in past had shown that vinclozolin (Ronilan 50 WP) was an effective fungicide. In the 1982/83 season a pot study involving artificial inoculation was undertaken to find out if the number of fungicide sprays could be reduced by

Table 1.3. Yield and chocolate spot resistance of lines in preliminary yield trials in 1982/83.

Line	Yield (t/ha)	Disease score[1)]
S 81057-5	3.22 ± .185	3
S 81071-1	3.15 ± .185	3
S 81066-16	3.00 ± .185	3
S 81056-7	2.94 ± .185	1
S 81064-15	3.54 ± .276	1
S 81062-8	3.27 ± .276	1
S 81055-5	3.12 ± .276	3
S 81064-8	3.02 ± .276	1
ILB 1814 (Check)	3.47 ± .348	9

1) Score of 1-9 with 1 = highly resistant and 9 = highly susceptible.

Table 1.4. Reaction of certain genotypes of faba bean to three different isolates of *Botrytis fabae*.

Isolate and origin		Race	Disease reaction[1)] of faba bean genotypes			
			BPL 710	BPL 261	BPL 1179	ILB 1815
TK	Tel Kalakh	1	R	R	S	S
DOH	Doha	2	R	R	MR	S
LAT	Lattakia	3	R	R	R	MR

1) R = resistant; MR = moderately resistant; S = susceptible.

relating the spray to the duration of leaf wetness rather than using a spray schedule based on the phenology. A certain minimum period of leaf wetness is a pre-requisite for the germination of spores and initiation of disease. Results indicated that the fungicide spray needs to be done only when the leaves remained wet for 4 hours or more (Table 1.5).

2.3.2. Ascochyta blight :

Combined effect of moderate host resistance and chemical treatments was evaluated in controlling ascochyta blight in a field experiment under artificial inoculation with the pathogen. Of the three fungicides tested (Table 1.6) Bravo-6F resulted in the best disease control and the highest green pod yield of faba beans. Dithane M_{45} also proved effective particularly with the moderately resistant genotype ILB 1814. Benlate 50% was ineffective in improving the yield although it partly reduced the disease severity in the susceptible genotype Giza 4.

2.3.3. Stem Nematodes :

The stem nematodes (*Ditylenchus dipsaci*) is a destructive seed and soil borne pathogen of faba bean. Infected seeds play an important role in its survival and dissemination. The possibility of producing nematode free seed through the use of a systemic nematicide, aldicarb (Temik 10G, at the rate of 10kg a.i. per hecatre) on the soil infested with different populations densities of the nematode was therefore, investigated. Population densities levels of 0, 40, 100, 300, 720 and 6500 larvae per 1000 cc soil were established. Application of aldicarb reduced the initial population level to 0, 16, 28, 80, 240 and 2400 larvae per 1000 cc in the respective treatments.

As the population of stem nematode increased (Figure 1.1) there was increase in the plant and seed infection, and decrease in the seed yield. Aldicarb application significantly decreased the plant

Table 1.5. Vinclozoline application as related to duration of leaf wetness to control chocolate spot in faba bean.

Treatments[1]	Disease reaction[2]			
	ILB710[3]	BPL1179	BPL261	ILB 1814
Sprayed after 0 hr. LW	1.5a	2.0f	1.5k	3.0q
Sprayed after 2 hrs. LW	1.5a	3.0f	2.5k	3.5q
Sprayed after 4 hrs. LW	2.5a	3.5f	3.0k	5.0q
Spryaed after 8 hrs. LW	4.0b	3.5g	4.0l	6.5r
Sprayed after 16 hrs. LW	4.0c	5.0h	4.5m	7.5s
Sprayed after 32 hrs. LW	5.0d	6.0i	5.5n	8.5t
Unsprayed	5.5e	6.0g	6.0p	9.0u

1. Leaf wetness (LW)
2. Disease readings done on a 1-9 rating scale.
3. Numbers followed by different letters are significantly (P=0.01) different according to Duncan's multiple range test.

Table 1.6. Influence of chemical treatments and host genotypes on severity of Ascochyta blight and green pod yield in faba bean.

Fungicides and rates[1]	Giza-4[2]		ILB 1814	
	Disease severity[3]	Yield kg/ha	Disease severity	Yield kg/ha
Bravo-6F (1.5cc/L)	3.0a	6250.0e	2.3h	6708.0j
Dithane M45 (1.5/L)	4.3b	4766.0f	2.3h	6316.0j
Benlate 50% (0.5g/L)	7.0c	1958.0g	5.0i	4458.0k
Untreated (control)	8.3d	1583.0g	5.6i	3791.0k

1 = Fungicides were applied in 600L of water per hectare

2 = Within a column, different letters indicate significant differences at the 5% level (P = 0.05) according to Duncan's multiple range test.

3 = Disease rating was done on a 1-9 scoring scale.

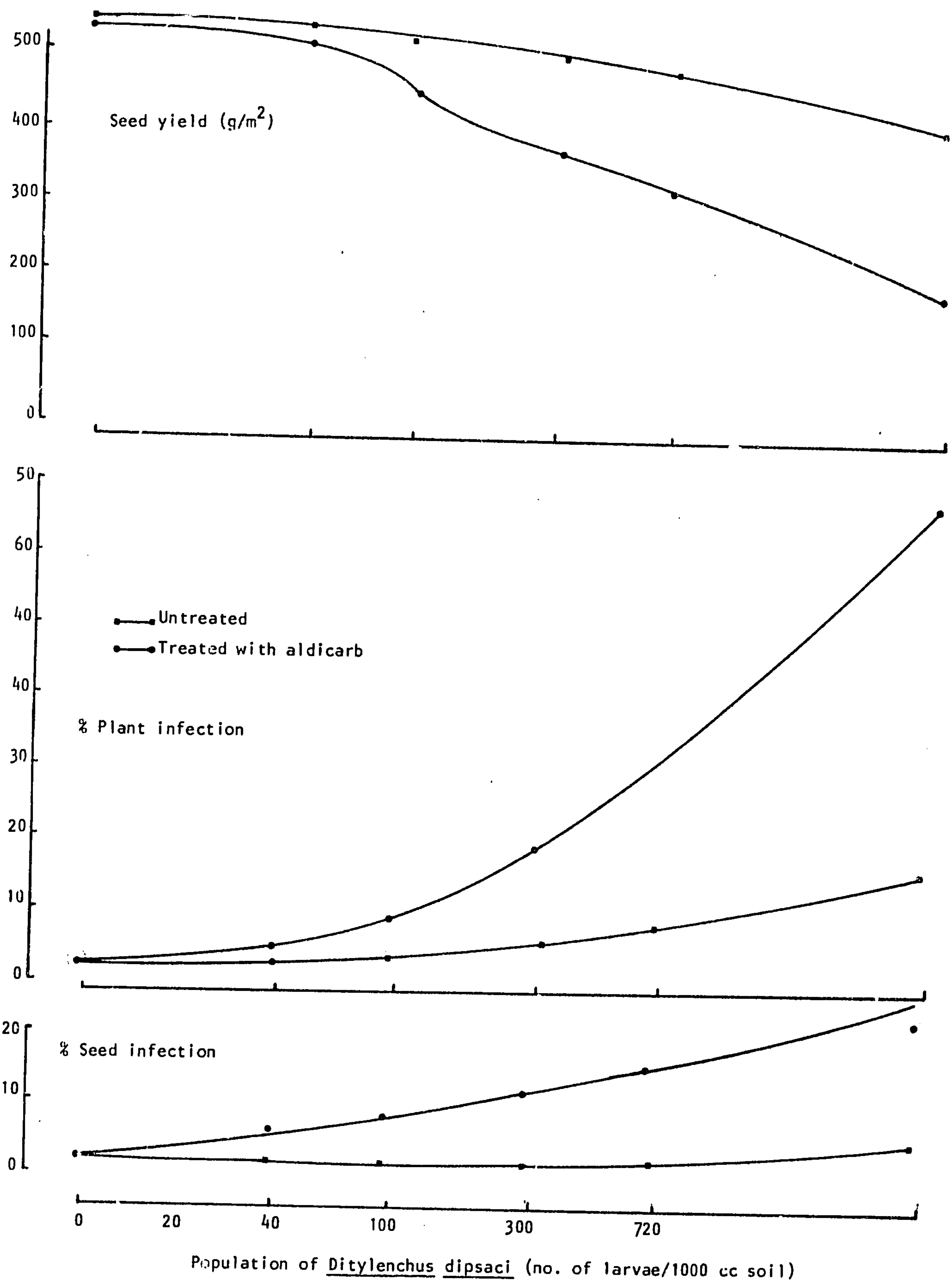


Fig. 1.1. Effect of aldicarb application on the percent seed and plant infection and seed yield of faba bean at different population densities of Ditylenchus dipsaci in soil.

infection and resulted in significant yield increase at population densities of 100 or more larvae per 1000 cc soil. Seeds obtained from plots treated with aldicarb were free from nematode at all the levels except the highest nematode population.

2.4. Insects and their Control :

2.4.1. Studies were continued to quantify yield losses, identify the key pests doing damage at various growth stages and to select most appropriate insect control technology. Chemical control of *Sitona* weevil through granular insecticides and/or foliar spray against *Apion*, thrips, and bruchids did not significantly increase yield (Table 1.7) suggesting that none of these became a major pest in the 1982/83 season. Aphids, whose occurrence is of cyclic nature, did not appear this season. The economic analysis of this season's response to previously recommended practices for insect control (Figure 1.2) suggested that the attempt to control *Sitona* weevils was less profitable than sprays against foliar insects.

2.4.2. Since previous results on economic importance of *Sitona* weevil (mainly *Sitona limosus*) were inconsistent, a trial was conducted again to measure the yield losses due to *Sitona* larval and adult damage. Even with high population of *Sitona* (up to 27% nodule damage) neither highly efficient larval control with granular insecticides nor less efficient foliar sprays against adults had a significant effect on yield (Table 1.8), and crop growth and nitrogenase activity (Figure 1.3).

2.4.3. For studying the biology of stem borer (*Lixus algirus*) a technique for artificial infestation of faba bean plots was developed. It was determined that the oviposition period lasts from mid-January to late April. The duration of the different stages is as follows : egg, 13 to 15 days; larvae, 30-40 days; pupae, 15 to 20 days. Attempts to control this insect should be made at the peak of adult activity which was found to occur between mid-February and mid-March. The

Table 1.7. Effect of different insecticidal regimes on the yields of Syrian local medium faba beans (Tel Hadya, 1982/83 season).

Treatment	yield (kg/ha)	% yield increase
Full protection (FP)[a]	3297.0	8.1
FP less soil insecticide	3328.7	9.1
FP less pre-flowering sprays	3206.7	5.1
FP less post flowering sprays	3266.3	7.2
Check	3050.8	-
Recommended protection (RP)[b]	3234.5	6.0
RP less soil insecticide	3220.2	5.5
RP less foliar spray	3227.4	5.8
LSD 5% for yields	N.S.	
CV (%)	6.0	

a) Soil insecticide (carbofuran) plus seven foliar sprays with methamidophos or endosulfan.

b) Soil insecticide (carbofuran) plus one foliar spray with methamidophos.

Table 1.8. The efficiency of insecticidal combinations to control *Sitona* weevils in faba beans and their effect on yields (Tel Hadya, 1982/83 season).

Adult control[a)]	Larval control[b)]	% efficiency against adults	% efficiency against larvae	yield (kg/ha)	% yield increase
Yes	with carbofuran	93.8	99.6	3605.7	11.2
No	with carbofuran	95.4	93.6	3541.4	9.2
Yes	with heptachlor	90.7	99.2	3480.6	7.3
No	with heptachlor	34.0	97.3	3345.4	3.1
Yes	no	67.0	-	3253.9	0.3
No	no	-	-	3243.4	-

LSD 5% for yields : N.S.
C.V. for yields = 8.2%

a) Four sprays with methidathion 0.5 kg a.i./ha
b) With carbofuran 1.0 kg a.i./ha or heptachlor 2.0 kg a.i./ha

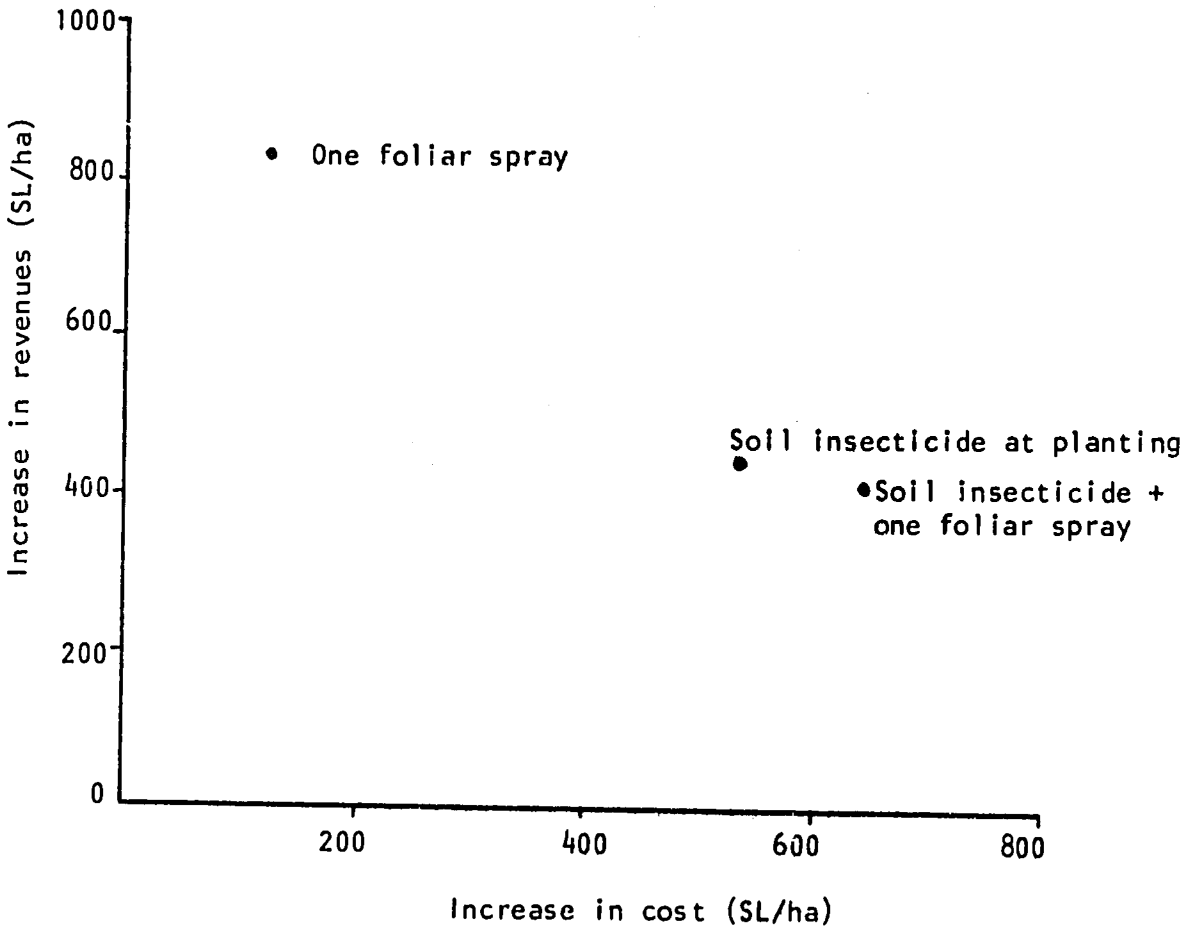
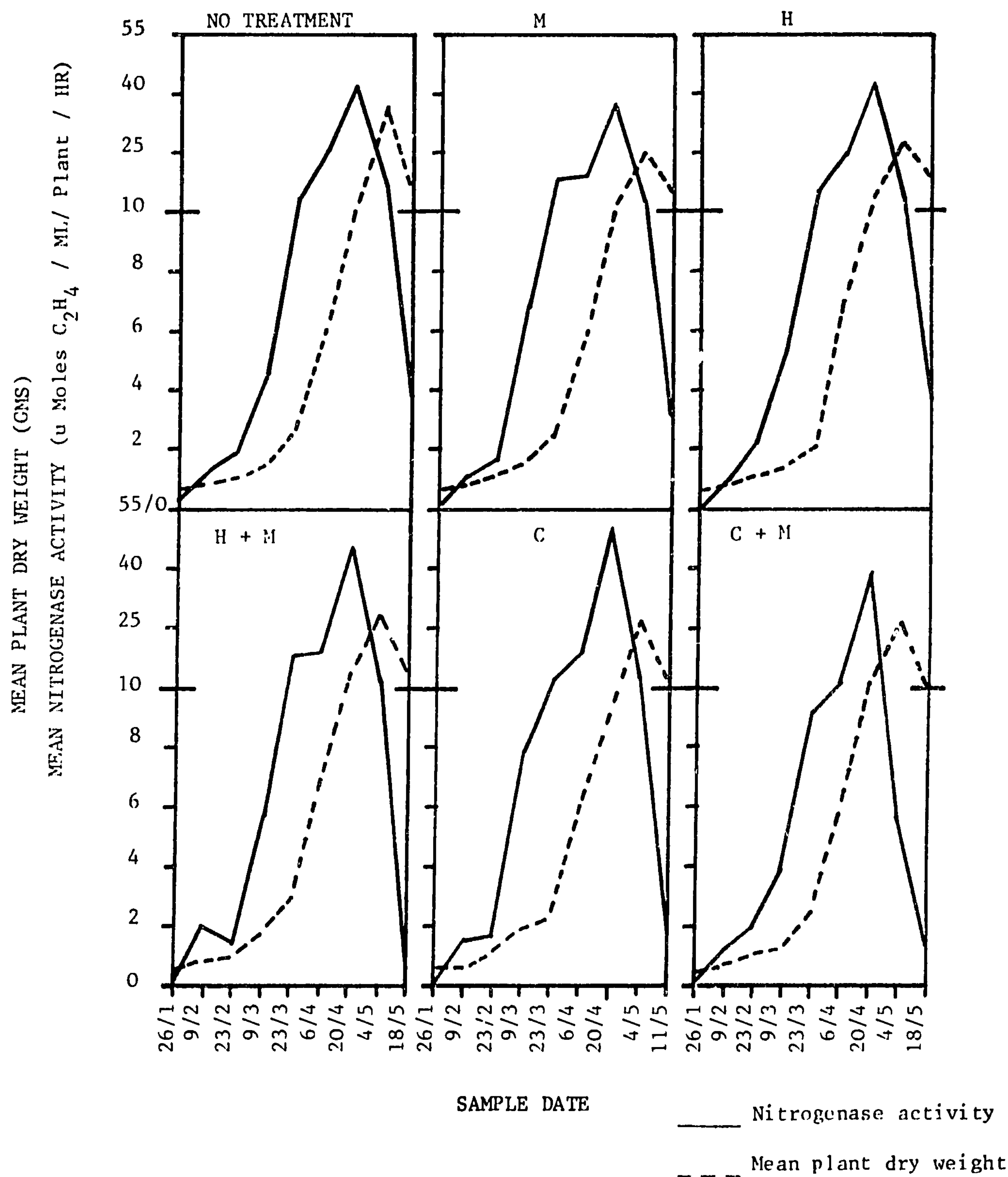


Figure 1.2. Cost - benefit relationships for insect control alternatives in faba beans.

Figure 1.3. A comparison of mean nitrogenase activity (C_2H_2 reduction) and mean plant dry weight with time for faba bean (Syrian Local Medium) where plants were treated with Heptachlor (H) or Carbofuran (C) for protection against Sitona weevil larva and with Methidathion (M) for adults.



artificial infestation technique will be used next season to measure yield losses due to the stem borer.

2.5. Production Practices :

2.5.1. Planting Date and Plant Population :

Response of Lebanese Local large seeded landrace (ILB 1816) to date of sowing and plant population was studied in a faba bean international date of planting plant population trial (FDPPT-83) at Terbol. Consistent with the observations in the past, advancing the sowing date from 31 January to 12 November and increasing the population from 16.7 plants to 33.3 plants/m^2 increased the total biological yield. However, the seed yield (Table 1.9) was the highest with an intermediate date of sowing (10 December). Frosty weather coinciding with the early reproductive growth of the crop sown before December nullifies the potential yield advantage of early sowing. There was no seed yield increase with increase in plant population beyond 25 plants/m^2.

2.5.2. Starter Nitrogen :

There are variable reports on the response of faba beans to starter nitrogen application. A trial was, therefore, conducted during 1982/83 to study the nitrogen status and productivity of faba beans as affected by starter N application at 20 and 40 kg N/ha. A large seeded genotype ILB 1814 (172g/100 seeds) and a genotype with medium seed size (148g/100 seeds), ILB 1813 were included as the seed size may affect the amount of nitrogen available to the seedling initially. The nitrogen concentration in the plant, studied at 45, 60, 75, 90 and 154 days after emergence, was not affected by treatments except at the first stage when it increased with starter nitrogen. Seed yield and total nitrogen accumulation per plant (Table 1.10) were decreased with higher rate of starter nitrogen in ILB 1813 but were not affected in ILB 1814. These studies show that there is no need for starter nitrogen application and that higher rates of application may even have a negative effect on some genotypes.

Table 1.9. Seed yield (kg/ha) of faba bean as affected by date of sowing and plant population at Terbol, Lebanon in the 1982/83 season.

Date of sowing	Plant population/m^2				Mean
	33.3	25.0	20	16.7	
12 November	2865	2753	2650	2722	2748
27 November	2262	2742	2676	2247	2482
10 December	3194	2831	2770	2555	2838
31 January	2696	2698	2159	2548	2525
Mean	2754	2756	2564	2518	
LSD (5%) Sowing date (D)	128				
Population (P)	109				
D X P	434				
CV (%) Sowing date	13.5				
Population	11.5				

Table 1.10. Effect of starter nitrogen application on the nitrogen accumulation at various stages of growth and seed yield of two faba bean genotypes (V_1-ILB 1813, V_2-ILB 1814).

Starter	N. accumulation (mg/plant) at						Seed yield (g/plant)	
	45 DAE		90 DAE		154 DAE			
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
0	36	43	111	126	1066	861	15.7	12.1
20	41	44	105	102	904	856	13.0	11.8
40	41	49	100	122	739	925	11.0	13.5
CV (%) Main plots (V)	21.3		20.8		14.2		20.8	
CV (%) Sub-plots (N)	16.4		15.7		17.3		12.1	
LSD (5%) V	NS		4.0		NS		NS	
N	3.5		8.8		119		NS	
V X N	NS		NS		168		3.8	

2.5.3. Environmental Constraints to Production :

The cooperative study with the faba bean research group of the European Economic Community on "Growth and development of faba beans in relation to specific environmental conditions", started in 1981/82 season, was continued using two genotypes of European origin (Minica and Herz Freya) and two of Mediterranean origin (Aquadulce and Giza 3). Unlike 1981/82 when the effects of both soil moisture and mineral nutrient supply were studied, the variable imposed in the 1982/83 study was that of moisture supply (rainfed vs. assured moisture through irrigation). The growth season was cooler than average and temperatures below zero were recorded on 53 nights in the whole season. This element of environment affected the growth, development and productivity of the genotypes and their response to moisture supply. The genetic differences for adaptation of temperature conditions were reflected in the reaction of the test genotypes to frost (Table 1.11). Giza 3, a genotype originating from relatively warmer winter environment proved most susceptible to frost followed by Herz Freya and Minica- the two spring types from Europe. The susceptibility of Giza and Herz freya to frost was increased under improved soil moisture supply. The low temperature conditions of 1982/83 season limited the overall productivity of even the well adapted genotype Aquadulce to only 5.7 t/ha (Table 1.12) as against more than 8 t/ha in 1981/82. The potential benefit of improved moisture supply was also reduced because of the unfavourable temperature conditions.

2.5.4. Weed Control :

Crop losses from weeds at Hama, Lattakia, Tel Hadya and Terbol, in the international faba bean weed control trial (FBWCT-83), amounted to 22, 57, 33 and 52% respectively. Pre-emergence herbicides were also evaluated in this trial. Since several test plots at Lattakia and Terbol were damaged, yield results for only Tel Hadya and Hama are presented in Table 1.13. The trial at Tel Hadya was rainfed and that at Hama was irrigated. Of the various herbicide treatments cyanazine @ 0.5kg a.i. per ha at Tel Hadya and cyanazine + pronamide

Table 1.11. Frost damage in four diverse faba bean genotypes in relation to moisture supply.

Genotype	Percent plants affected by frost in					
	Irrigated plots			Rainfed plots		
	Killed	Damaged	Total	Killed	Damaged	Total
Aquadulce	0.0	10.8	10.8	0.0	10.8	10.8
Giza 3	25.4	36.2	62.4	6.0	45.3	51.3
Herz freya	20.0	41.6	61.6	5.6	30.1	35.7
Minica	5.8	27.5	33.3	8.1	43.1	51.2

Table 1.12. Total recoverable biological yield (TBY), seed yield (SY), nitrogen yield, seasonal evapotransperation (Et) and water use efficiency of the four diverse genotypes of faba beans under rainfed and assured moisture conditions.

Moisture supply	Genotypes	Yield (kg/ha)		Total N yield (kg/ha)	Et (mm)	Water use efficiency (kg/mm/ha)	
		TBY	SY			TBY	SY
Assured	Aquadulce	5682	3113	109.8	351	16.2	8.9
	Giza 3	3501	1949	78.4	356	9.8	5.5
	Herz-freya	5007	2207	104.2	439	11.4	5.0
	Minica	3280	1307	59.4	387	8.5	3.4
Rainfed	Aquadulce	5585	2192	137.6	308	18.1	7.1
	Giza 3	4228	2107	117.6	297	14.2	7.1
	Herz-freya	4262	1725	94.6	310	13.7	5.6
	Minica	3571	1698	85.7	287	12.4	5.9

Table 1.13. Effect of weed control on yield of faba bean in the international faba bean weed control trial (FBWCT-83) at Tel Hadya and Hama.

Weed control treatment	Yield (kg/ha)	
	Tel Hadya	Hama
Weedy check	882	4844
Weed free	1304	6144
Weeded twice	1298	6141
Chlorbromuron @ 1.5kg a.i./ha	913	5914
Methabenzthiasuron @ 3.0kg a.i./ha	1135	6105
Terbutryne @ 2.5kg a.i./ha	1136	6358
Cyanazine @ 0.5kg a.i./ha	1278	5952
Cyanazine @ 1.0kg a.i./ha	1201	5883
Chlorbromuron + Pronamide @ 0.5kg a.i./ha	1217	6105
Methabenzthiazuron + Pronamide	1136	6210
Terbutryne + Pronamide	1061	5699
Cyanazine @ 0.5kg a.i. + Pronamide	1200	6502
CV (%)	15.7	7.8
LSD (5%)	254	667

both @ 0.5kg a.i. per ha at Hama proved most effective and resulted in yields equal to that under 'weed free' treatment. Since several other herbicide treatments also proved effective, there is a possibility to chose based on price and local availability.

2. FABA BEAN PROJECT 2 : The Development of Genetic Stocks for all Regions

1. Objectives :

1.1. To develop and distribute genetic stocks (ealry generation and/or random-mating source populations) having one or more of the following attributes :

a) adaptation to a specific country or sub-region
b) resistance to *Ascochyta fabae*
c) resistance to *Botrytis fabae*
d) resistance to *Orobanche crenata*
e) resistance to aphids
f) resistance to stem nematode
g) resistance to rust
h) resistance to root rot/wilt
i) large and/or small seed size as required in the target sub-region
j) acceptable nutritional and quality characteristics

1.2. In future, it is expected that other source populations may be developed including : a) resistance to virus diseases, b) high protein, c) tannin-free, d) low vicine/convicine, e) determinate growth habit.

2. Research Highlights :

2.1. The demand for genetic stocks with special traits such as adaptation to a specific environment, resistance to one or more common pathogens and pests, etc. has continued to grow in the past years. Hence development and distribution of genetic stocks was given high priority during the 1982/83 season.

2.2. Disease Resistance :

Work for developing disease resistant sources included screening BPL accessions for resistance to *Ascochyta*, *Botrytis*, *Uromyces*, and *Ditylenchus*. Also, international nurseries were distributed by ICARDA for chocolate spot, ascochyta blight, and rust.

2.2.1. Screening of Pure Lines for Disease Resistance :

For chocolate spot 200 BPL accessions were screened but because of flooding this will be repeated in 1983/84. But for ascochyta blight and stem nematodes 200 BPL accessions were screened and all found susceptible. Rust screening of 200 BPL accessions produced 81 single plant selections from one line with a rating of 1 and 35 with a 5 rating (on a 1-9 scale). Screening and selection will continue with BPL accessions in the 1983/84.

2.2.2. Multiple Disease Resistance :

Genetic stocks with multiple disease resistance would be of great importance in developing faba bean cultivars with stable yields. Twenty most promising selections made from the pure lines in the past were evaluated for resistance to six different diseases. Table 2.1. presents the uptodate information on resistance to different diseases.

2.2.3. International Disease Screening Nurseries :

Seed from resistant sources to chocolate spot, ascochyta blight and rust identified from screening the ICARDA germplasm collection were distributed to Egypt, Tunisia, Algeria, Canada, and the UK as International disease nurseries in 1982/83. Three lines (BPL 710, 1179, and 1196) were found resistant or highly resistant to chocolate spot across three locations (Syria, Egypt, and the UK) in the international chocolate spot nursery (FBICSN 83). BPL 1196 is a new report of multi-location resistance to chocolate spot. From the data returned for the international ascochyta blight nursery (FBIABN-83) several lines were found to be rated resistant to moderately resistant at both Syria and Canada (BPL 460, 471, 465, 2485, ILB 161, 37, and A2). Two new sources of multi-locational resistance to ascochyta blight are BPL 465 and the selection from ILB 161. Data was returned from only Syria and Egypt for the international rust nursery (FBIRN-83). Ten lines were rated resistant or highly resistant in both countries (BPL 266, 274, 461, 1055, 1056, 1058, 1538, 1543, ILB 938 and 80 Latt 15563-3).

Table 2.1. Multiple Disease Resistance of certain Faba Bean Germplasm Lines.

Selection	BPL	Reaction to					
		Rust	Stem-phylium	Alter-naria	Chocolate spot	Asco-chyta	Stem Nematode
Sel.82 Lat.(31)	27	NT	NT	NT	NT	NT	**
Sel.82 Lat.(47)	40	NT	NT	NT	NT	NT	**
Sel.81 Lat.(24638)	112	NT	**	***	**	NT	NT
" " " (24694)	261	NT	***	***	***	NT	NT
" " " (24698)	266	**	***	***	**	NT	NT
" " " (24701)	274	**	***	***	**	NT	NT
" " " (24857)	710	**	**	**	***	NT	NT
" " " (24801)	470	**	***	***	**	NT	NT
Sel.79 Lat.(70015)	74	NT	NT	NT	**	***	NT
Sel.80 Lat.(14434)	471	NT	NT	NT	NT	***	NT
" " " (14435)	472	NT	NT	NT	**	***	NT
" " " (14422)	460	NT	NT	NT	NT	***	NT
Sel.81 Lat.(25114)	1821	NT	***	***	**	NT	NT
" " " (24996)	1538	***	**	***	**	NT	NT
" " " (25001)	1544	NT	***	**	**	NT	NT
" " " (25003)	1546	NT	***	**	**	NT	NT
" " " (25007)	1550	NT	**	***	**	NT	NT
" " " (25011)	1556	NT	**	***	**	NT	NT
" " " (25075)	1686	NT	**	***	**	NT	NT
" " " (24948)	ILB938	***	***	**	***	NT	NT

1 = Moderately resistant **, Highly resistant ***, Not tested NT.

From the international disease nurseries valuable information is obtained on multi-locational disease resistant sources for different regions and diseases. This will greatly improve the efficiency of distribution of disease resistant sources for breeding programs.

2.2.4. Recombination of Disease Resistance with Local Adaptation :

The results of international trials in previous years show that selections made in Syria and Lebanon are of little value as direct introductions into the markedly different irrigated environment in the Nile Valley. Similarly, there has been little indication that the adaptation of selections made in West Asia will extend to rainfed conditions in North Africa. There is clearly a need to recombine identified sources of resistance with local adaptation. For example, BPL 1179, a selection from Columbia germplasm, has been found resistant to *Botrytis fabae* in Egypt, Syria, and the UK. However, it is poorly adapted to each location and must be used in recombination before the source can be exploited.

At Tel Hadya local germplasm from Tunisia, Morocco, Tunisia, Egypt and Sudan was used for crossing to disease resistant lines, and early and determinate lines (Table 2.2). F_2 bulks from these crosses will be grown in the 1983/84 season and F_3 bulks will go into 1985 international F_3 trials. Also F_3 progeny rows will be grown and lines fed into preliminary trials. This is in addition to selection of disease resistant F_2 plants at Lattakia for development of disease resistant lines for yield testing.

2.3. Resistance to *Orobanche crenata*:

In 1982/83 64 *Orobanche* resistant BPL accessions were tested for a third year and 14 lines were found with high levels of resistance for three years (Table 2.3). Those lines were used for the 1984 Faba Bean International Orobanche Nursery (where seed supply was adequate) for testing multi-locational resistance at ten sites.

Table 2.2. Number of crosses made for specific traits in the 1982/83 season at ICARDA using lines adapted to different countries.

Country	No. of lines	No. of crosses made for						Total crosses
		Ascochyta blight resistnace	Chocolate spot resistance	*Orobanche* resistance	Earli-ness	Deter-minate	Yield	
Tunisia	1		2				5	7
Morocco	4	4	10	7			6	27
Sudan	1				2	18	4	24
Egypt	2	5	2		4	38	4	53

Table 2.3. Number of *Orobanche* shoots per faba bean plant for *Orobanche* resistant BPL accessions screened for three years, 1980/81, 1981/82 and 1982/83.

BPL	YEAR		
	1980/81	1981/82	1982/83
2270	0.40	0.84	0
2267	0.60	1.51	0
2235	0.90	1.54	0
1517	0.71	0.85	0.02
2053	0.70	1.27	0.03
2022	0.30	1.50	0.03
1636	1.26	2.5	0.03
2009	0.90	1.21	0.05
2017	1.00	3.17	0.07
2317	0.90	1.70	0.08
2170	0.60	1.94	0.08
1532	1.49	1.66	0.08
2244	1.10	2.66	0.10
2012	0.50	1.30	0.10
F. 402 (resistant check)	1.05	2.19	0.72
S.L.L. (susceptible check)	9.00	6.63	2.23
L.S.D. (5%)	2.57	-	0.44

2.4. Resistance to *Bruchus dentipes*:

Screening was performed for resistance to *Bruchus dentipes* in the 1982/83 season at Tel Hadya for 810 BPL accessions. The lowest infestations found were with BPL 856, 182, and 747 with 7, 19, and 20% infestations, respectively. Figure 1.4 shows the distribution of the BPL accessions tested for *Bruchus dentipes* infestation. Rescreening will be done with the most promising lines in 1983/84 and attempts made to determine the mode of resistance.

2.5. Yield Potential over Wide Areas :

Results from faba bean adaptation trial conducted for four seasons, with the 1981/82 season being the fourth and last, showed few positive significant correlations between locations for yield. For example, during 1981/82 only one of 15 correlations between sites for grain yield for the international large seeded yield trial was significant. Similarly, of the 15 correlations in case of small seeded yield trial, only two were signficant. These correlations demonstrate the need for multi-locational testing of material at an early stage. We have started testing advanced yield trials for large seeded lines and also the lines from preliminary yield trials for the 1983/84 season at Tunisia. This should improve chances of identification of lines with wider adaptability and also lines adapted to specific subregions.

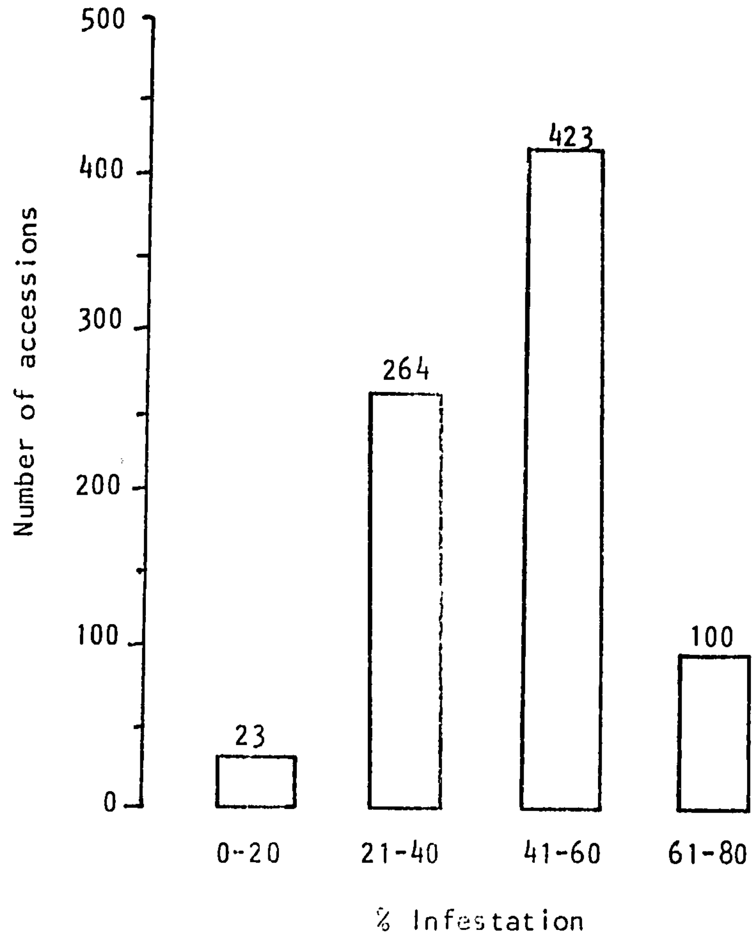


Figure 1.4. Frequency distribution of 810 BPL accessions of faba beans according to percent infestation by *Bruchus dentipes*.

3. FABA BEAN PROJECT 3 : The Development of Cultivars and Agronomic Practices for Production under low Rainfall Conditions.

1. Objectives :

1.1. To develop high and stable yielding faba bean cultivars capable of producing an economic dry-seed yield under 300-400 mm of annual precipitation; such cultivars will have the following attributes:

a) an inherently large and stable yield
b) drought resistance or escape through early maturity
c) resistance to major dryland pests and diseases
d) resistance to pod shattering
e) characters required for mechanization including pods borne high off the ground, non-lodging, small seed size
f) acceptable nutritional and quality characteristics.

1.2. To develop appropriate production technology for rainfed conditions.

2. Research Highlights :

2.1. Efforts were continued to develop high and stable yielding faba bean cultivars and agronomy capable of producing an economic dry seed yield in low rainfall (300-400mm) environments so that farmers there may get another crop option and may diversify their cropping. The total seasonal reinfall during 1982/83 at Tel Hadya was 322 mm. Faba beans are normally grown only with supplementary irrigation with this amount of precipitation.

2.2. Development of Cultivars :

A total of 20 crosses were made for low rainfall conditions with lines selected under these conditions. These crosses were increased in the off-season and will be screened in the 1983/84 season. A total of 90 single plant selections were made from F_2 populations in Shawbak.

These will be yield tested in the 1983/84 season aling with 46 lines selected from preliminary screening nurseries.

In yield trials under rainfed conditions 383 lines were assessed. A total of 118 lines exceeded the best check and the highest yield in a replicated trial was 2.11 t/ha (Table 3.1). Work now is being concentrated on small seeded lines for low rainfall conditions so as to facilitate mechanical operations.

2.3. Drought Tolerance Studies :

Evaluation of a number of genotypes for their relative drought tolerance by growing them in locations with different amounts of rainfall (Jinderis, Tel Hadya and Breda) as also by raising them at varying moisture supply at Tel Hadya through supplemental irrigation was continued during the 1982/83 season. Soil moisture extraction and water use efficiency of six of these genotypes was studied at Tel Hadya under rainfed condition.

Yield data in Table 3.2 show that the total recoverable biological yield was closely related with total seasonal moisture supply. As in the previous season ILB 10, 605, 1266, 1813 and 1814 tended to be less sensitive than others to the limited moisture supply. The soil moisture recharge and discharge curves for six genotypes are shown in Fig. 3.1 and differences in extractable soil moisture, total evapo-transpiration and water use efficiency are given in Table 3.3. The highest soil moisture extraction was recorded in ILB 1813 and the least in ILB 10. The water use efficiency for both these genotypes was higher than in the rest of genotypes. Apparently the mechanism to cope with the reduced moisture supply differs in these two genotypes. The technique of evaluating genotypes simultaneously at drier rainfed sites of Breda and Tel Hadya and comapring with their performance under assured moisture supply at Tel Hadya will be extended to larger number of genotypes with 1983/84 season in order to identify genotypes suitable for low rainfall conditions.

Table 3.1. Summary of yield trials grown under rainfed conditions at Tel Hadya during the 1982/83 season.

Trial/Nursery	Number of entries tested	Highest Yield (t/ha)	No. of lines exceeding best check	CV %
Preliminary Yield Trials Small Seeded	258	2.11	111a	11-24
Advanced Yield Trials Small Seeded	63	1.91	3b	12-16
Regional Yield Trial	16	1.78	0b	11
International Yield Trial Large Seeded	23	1.57	0b	19
International Yield Trial Small Seeded	23	1.59	4a	12
International Screening Nursery Large Seeded	30	1.73	4b	13
International Screening Nursery Small Seeded	46	2.40	19a	24

a. Check entry was ILB 1812.

b. Check entry was ILB 1814.

Table 3.2. Total recoverable biological yield (TBY, kg/ha) and seed yield (SY, kg/ha) of some selected genotypes of faba beans at Breda, Tel Hadya and Jinderis during 1982/83 season.

	Breda		Tel Hadya				Jinderis	
	Rainfed (285mm) [1]		Rainfed (322mm)		Irrigated (472mm)		Rainfed (429mm)	
	TBY	SY	TBY	SY	TBY	SY	TBY	SY
ILB 1814	847	375	3459	1924	3595	2570	2303	1372
ILB 10	628	304	2282	1417	3126	2025	1900	1316
ILB 277	578	288	1886	1202	2490	1577	1569	1086
ILB 605	747	377	2168	1341	2810	1796	1460	968
ILB 1266	610	253	2240	1359	2914	1869	1353	933
ILB 1813	657	302	2522	1515	4032	2539	1937	1231
ILB 1819	572	273	2112	1212	2740	1678	1722	1178
ILB 1816	585	278	1761	1084	3237	1963	1884	1212
Mean for location	653	306	2304	1382	3163	2002	1766	1162
C.V.%	13.4	15.4	22.6	24.2	22.6	24.2	21.4	17.4
LSD 5%	129	70	881	584	881	584	557	297

1 Values in parantheses are total seasonal moisture supply.

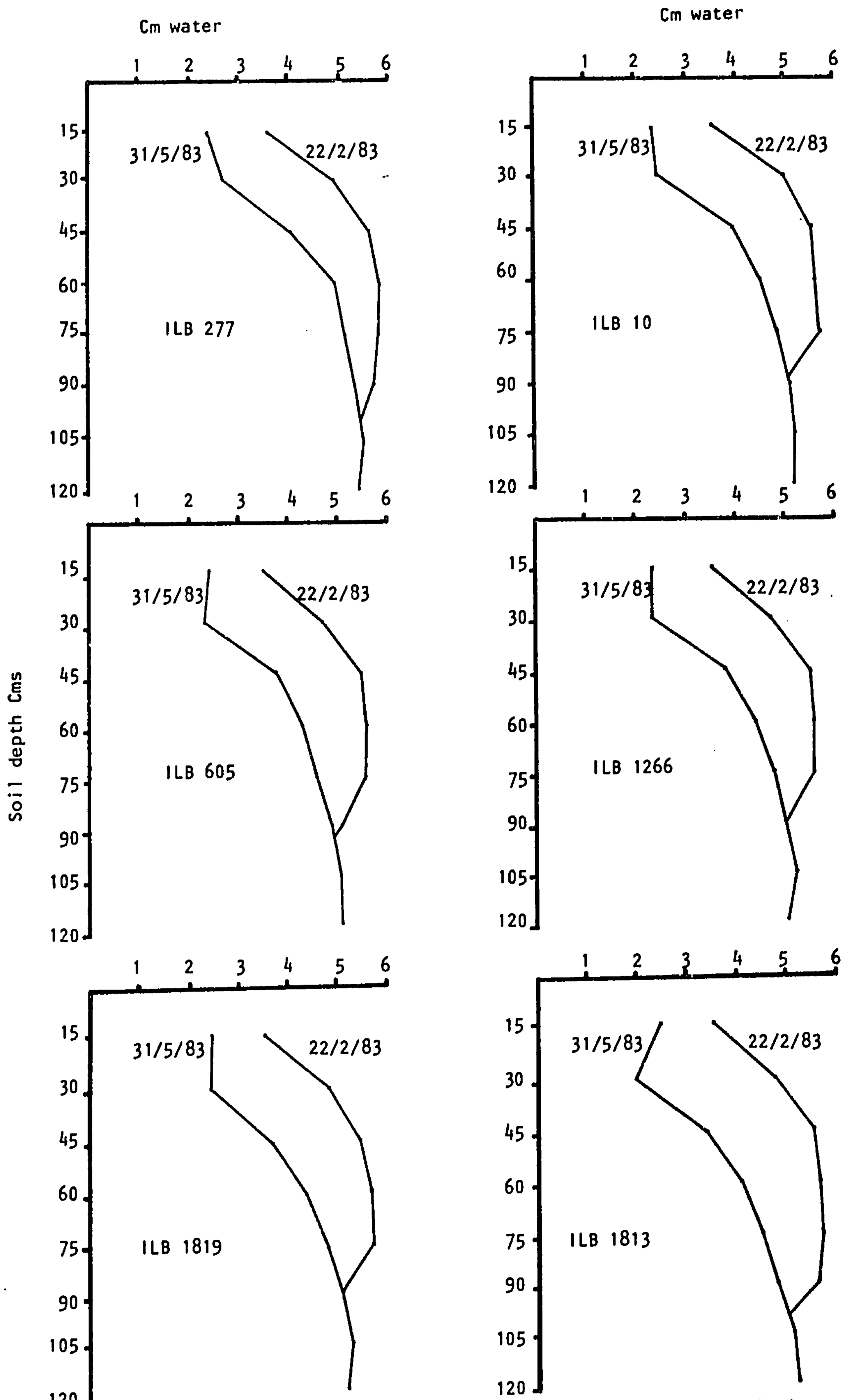


Fig. 3.1. Soil moisture recharge and discharge curves for six faba bean genotypes grown at Tel Hadya under rainfed conditions.

2.4. Response to Residue Management and Phosphate Application :

In some of the areas receiving 300-400 mm seasonal precipitation it is a common practice to burn the residues of previous cereal crop before planting the legumes. Also the soils in many of these areas are low in available phosphorus. A study was, therefore, started in the 1982/83 season to evaluate the effect of soil incorporation vs. burning of cereal residues in combination with different methods of application of 50 kg P_2O_5 per hectare on a soil having an available phosphorus content of 1.63 ppm P in 0-15 cm and 1.13 ppm P in 15-30 cm soil layers.

Both the burning of straw and application of phosphorus increased the yield of faba bean (Table 3.4). Placement of phosphorus mixed with the seed or placed 5 cm below the seed resulted in significant increase in yield over broadcast application as well as control, the difference between the later two treatments being non-significant. Phosphate placement improved the nitrogenase activity of the faba bean root system evaluated early in the season. The aspect of residue management, however, needs further studies to ascertain the way in which this treatment affects the growth and productivity.

Table 3.3. The total extractable moisture (EM), evapotranspiration (ET), water use efficiency (WUE, kg/ha/mm) for total recoverable biological yield for some selected genotypes of faba bean under rainfed condition at Tel Hadya.

Genotypes	ILB	EM (mm)	Total ET (mm)	WE
78-S-49907	10	57.6	207.6	10.99
78-S-48428	277	54.3	221.7	8.51
78-S-49694	605	61.8	245.2	8.84
Aquadulce	1266	55.9	243.4	9.20
Syr.L.M.	1813	86.6	273.7	9.21
Giza-3	1819	61.6	246.7	8.56

Table 3.4. Seed yield (kg/ha) of ILB 1814 faba bean as affected by the application of 50 kg P_2O_5 per hectare and the method of management of residues from the previous wheat crop.

	Seed yield (kg/ha)		
	Straw incorporated	Straw burnt	Mean
No phosphate (control)	1727	2565	2146
50 kg P_2O_5/ha broadcasted	2085	2600	2343
50 kg P_2O_5/ha deep placed	2347	3123	2735
50 kg P_2O_5/ha mixed with seed	2477	3027	2752
Mean	2159	2829	
	Phosphate	Residue management	Interaction
CV (%)	18.1	20.5	
LSD (5%)	123	313	435

4. FABA BEAN PROJECT 4 : The Development of Alternative Plant Types.

1. Objectives :

1.1. To develop high-yielding determinate ('topless') faba beans and to examine their potential under different environmental conditions.

1.2. To investigate other morphological characters such as branch number, secondary branching and narrow leaves, and to carry out growth analysis and study the physiology of yield build-up in alternative plant types.

1.3 To study the pollinating system of faba beans.

2. Research Highlights :

2.1. This project was started to develop and evaluate alternate plant types for their yield potential in different environments, investigate the relationship between different morphological characters and yield development, and to study the pollinating system in faba beans.

2.2. Determinate Faba Bean Genetic Stocks :

The determinate habit of mutants from Sweden is of potential importance in faba bean production areas which are either irrigated or are highly fertile. Its use will stem from the curtailment of vegetative growth, which is currently excessive under these conditions, and a corresponding increase in harvest index.

The 'topless' mutant from N.Europe is poorly adapted to the Mediterranean environment, and efforts are being made to transfer the character into an adapted background. Crosses made with at least one determinate parent numbered 197 this season. These were increased in the off-season and F_2 populations will be screened for determinate plants in the 1983/84 season. From F_3 bulks received from Italy, 30 determinate plants were selected and increased in the off-season. These will be used in the crossing program in 1983/84.

From F_2 populations grown in the 1982/83 season, 150 single plants were selected for determinacy and increased in the off-season. These will be tested in yield trials in the 1983/84 season along with 34 lines selected from the preliminary screening nursery for determinate lines.

Yield tests of 75 lines with the determinate trait were conducted in the 1983/84 season. Table 4.1 gives the results for the ten best determinate lines and the two checks. The determinate lines exceeded the yield of one check, Syrian local small (ILB 1811) but not other, Syrian local short pod (ILB 1812). The most striking figures in the table are for plant height where all determinate lines are much shorter than the indeterminate checks, in most cases half the height. The 1982/83 season was with a very cold and long winter with reduced plant growth. The two checks in a normal season can exceed one meter plant height, however, the effect of the determinate gene on plant height can be seen this season. Approximately half the determinate lines are also later flowering than the indeterminate checks.

2.3. Flowering and Podding Behaviour in Determinate Faba Bean :

A comparative study of flowering and podding behaviour of a determinate mutant bulk (DMB) and the indeterminate ILB 1814 faba bean was carried out at two levels of population (22.2 and 50 plants/m^2). ILB 1814 produced more flowers per plant than DMB because of higher number of flowering nodes per plant and more flowers per flowering node. The flower abortion was more in ILB 1814 but the young pod abortion was higher in DMB. The distribution of flowers, young pods and mature pods on different flowering nodes in the two plant types at the two population levels are shown in Fig. 4.1. The first four flowering nodes appeared to be the most important in case of both the genotypes, although the distribution of flowers in ILB 1814 is spread on more number of nodes, as compared to DMB. The per plant productivity of DMB was slightly more than half of ILB 1814 at 22.2 plants/m^2

Table 4.1. Performance of the ten best determinate lines and checks in preliminary determinate trials grown at Tel Hadya, Syria under irrigation.

Line	Grain yield (t/ha)	Flowering date (days)	Plant Height (cm)
S 79022-1	2.35 ± .246	122 ± 1.3	28 ± 2.9
S 79022-2	2.35 ± .246	121 ± 1.3	29 ± 2.9
S 79027-1	2.22 ± .246	128 ± 1.3	31 ± 2.9
82S 50447	2.19 ± .246	121 ± 0.7	30 ± 2.5
L 79079-1	1.98 ± .246	121 ± 0.7	33 ± 2.5
S 79187-1	1.91 ± .246	122 ± 0.7	34 ± 2.5
S 79028-1	2.92 ± .172	121 ± 0.9	36 ± 2.0
L 79079-2	2.42 ± .172	125 ± 0.9	40 ± 2.0
L 79079-3	2.40 ± .172	125 ± 0.9	33 ± 2.0
L 79079-4	2.29 ± .172	124 ± 0.9	35 ± 2.0
ILB 1811	1.41 ±0.380	121 ± 0.7	53 ± 6.1
ILB 1812	4.73 ±0.861	120 ± 0.9	59 ± 1.7

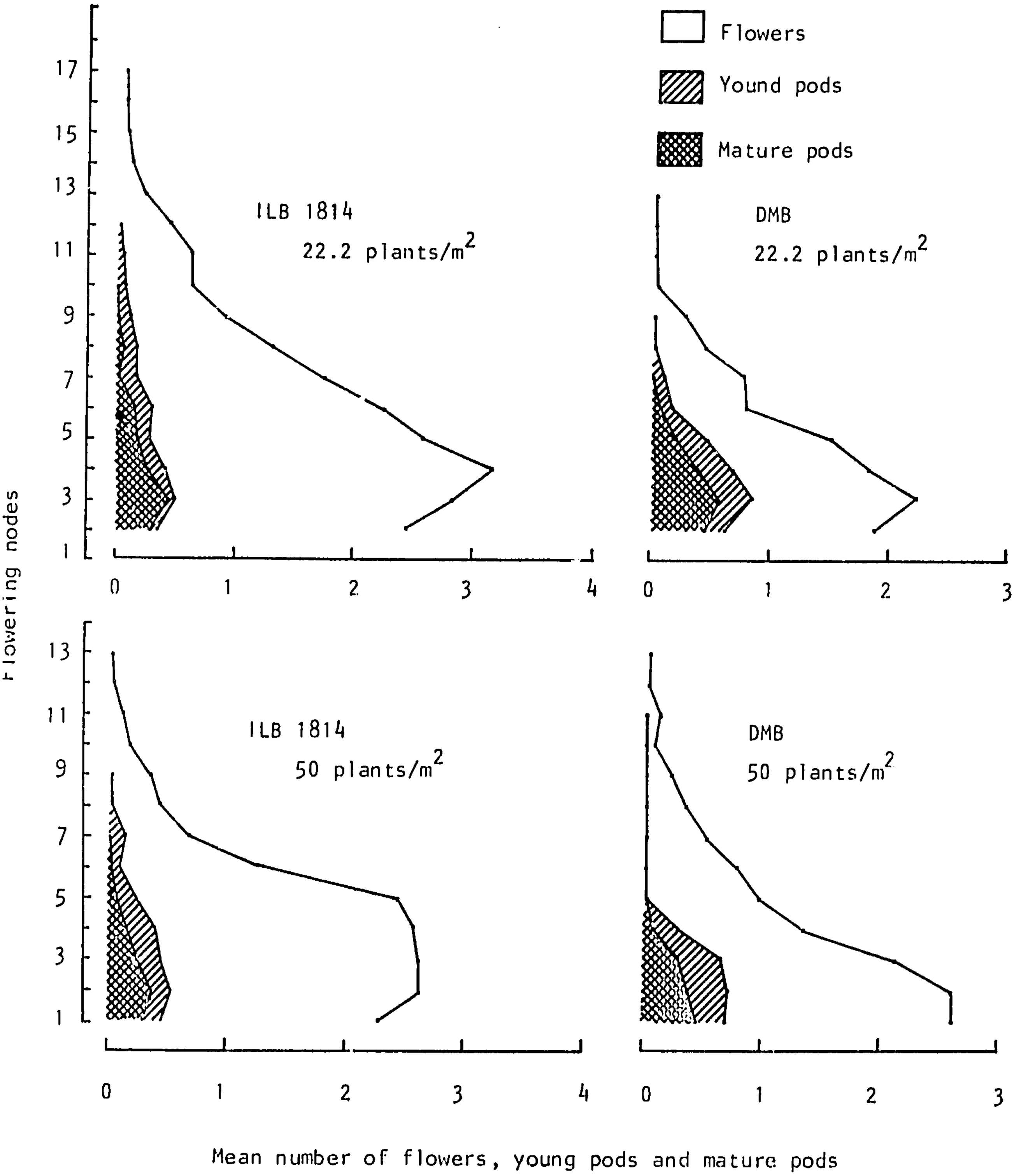


Fig. 4.1. The distribution of flowers, young pods and mature pods along the flowering stems of ILB 1814 and the determinate mutant bulk at low and high plant population levels Tel Hadya 1982/83.

population and less than half at 50 plants/m^2. For improvement in the productivity of the determinate type, increased number of flowering nodes and reduced young pod abortion will have to be sought.

2.4. Studies on Out-crossing :

A survey of insect pollinators in faba beans indicated that honey bees (*Apis mellifera*) and two species of solitary bees (*Eucera cincta* Fr., and *Anthophora canescens* Br.) account for up to 95% of the insects visiting faba bean flowers. During the 1982/83 season, honey bees were more abundant than solitary bees.

In large-scale breeding programs out-crossing due to insect pollinators is undesirable because it makes it difficult to maintain the genetic identify of many different lines. To prevent out-crossing cumbersome and costly methods of isolation such as distance, insect-proof cages or individual bagging of plants with nylon nets have had to be used.

Two methods are under study at ICARDA for isolation of faba bean increase plots, use of triticale as a mechanical barrier, and use of *Brassica campestris* as an attractant to the insect pollinators to surround the faba bean plots. In the 1982/83 season different faba bean plots were planted in 9x12 m plots completely surrounded by 6 m wide strips of triticale or *Brassica*. In a different field faba bean plots of the same size were surrounded by 6 m strips of bare soil to serve as a check.

Results of regular counts of honey bees and solitary bees visiting faba bean flowers made in four replications of each treatment indicate that *Brassica* was very efficient in reducing bee activity in faba beans (Figure 4.2). Triticale was less efficient. Reduced bee activity should reflect on lower out-crossing rates. To measure this check plots were grown with Reina Blanca which has a white hilum marker.

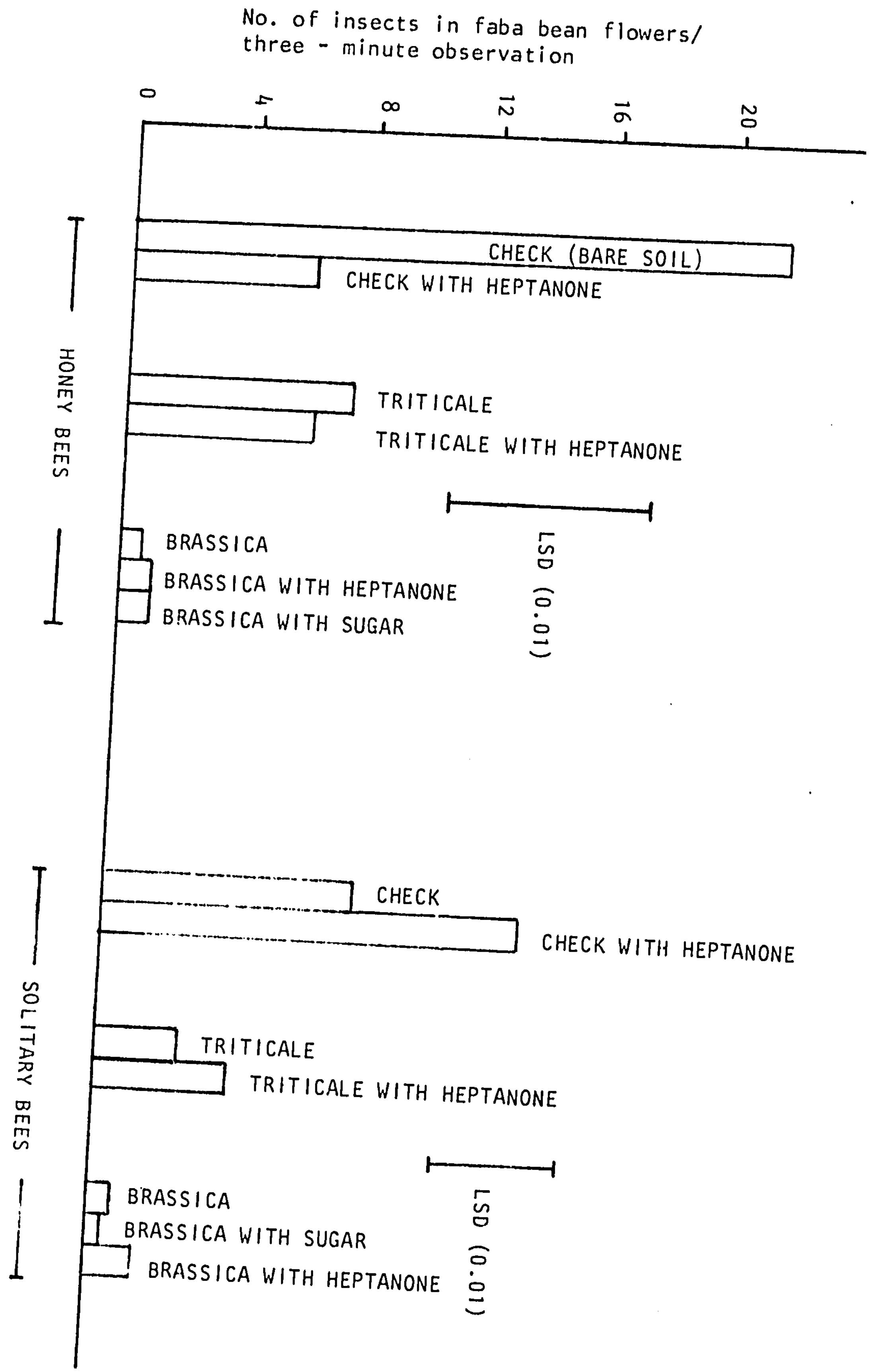


Figure 4.2. Effect of isolation mechanisms on the number of honey bees and solitary bees visiting faba bean flowers in 9x12 m plots (means of 6 scoring dates).

Seeds from these plots will be grown and scored for out-crossing this year. Preliminary results from previous years showed low out-crossing rates for both *Brassica* and triticale plots, 7.0 ± 1.5% and 9.0 ± 2.2%, respectively. These low out-crossing values are acceptable for pragmatic breeding programs. Areas being further studied are growing F_2 populations and F_3 progeny rows in blocks surrounded by *Brassica* and the reduction of area planted to *Brassica* to make the technique more efficient.

5. LENTIL PROJECT 1 : Development of Improved Lentil Cultivars and Technology for Different Agro-Ecological Situations.

1. Objectives :

1.1. To develop cultivars or genetic stocks with appropriate phenology and high and stable yields for each of the three major agro-ecological regions of lentil production with maintained, or wherever possible improved, cooking and nutritional quality and nitrogen-fixing ability. The additional specific traits required for the different regions are as listed below :

a) high altitude region: cold tolerance for winter planting and attributes to facilitate harvesting (tall, non-lodging growth habit and both pod retention and indehiscence).
b) middle to low elevation areas in the Mediterranean region : maintained biological yield, tolerance to broomrape (*Orobanche sp.*), resistance to root rot/wilt complex, attributes to facilitate harvesting, tolerance to droughty conditions during the reproductive period of growth.
c) region of more southernly latitudes (including Egypt, Sudan, Ethiopia, India, Pakistan, etc.) : earliness through insensitivity/reduced sensitivity to photoperiod and temperature, resistance to root rot/wilt complex and rust.

1.2. To develop appropriate agronomic and protection techniques for existing and improved cultivars.

2. Research Highlights :

2.1. Development of Genetic Stocks :

A total of 350 crosses were made with the objectives listed earlier to meet the specific needs for the main agroecological regions of lentil production. Of the total crosses 66% were made for the Mediterranean medium - low elevation region and 34% were directed toward southern latitudes. Thirteen of the 350 combinations were three way crosses.

The breeding material was advanced by bulk breeding through two generations in the last year by sowing at Tel Hadya in winter and at Shawbak, Jordan in summer. Single plant selections were made at the F_4 generation on the basis of heritable characters associated with phenology, growth habit and both seed colour and seed shape. A total of 10616 progeny rows were grown at Tel Hadya, and only 1502 rows were selected for advancement, representing a selection pressure of 14.2%. Selections from the progeny rows are promoted to preliminary screening nurseries and thence to replicated yield trials.

2.2. Yield Trials :

A total of 390 selections were tested in 18 yield trials at Tel Hadya. There were 170 large-seeded entries (seed size$>$4.5g/100 seeds) in these trials, amongst which 74 entries or 44% yielded more than the best local check. The highest yield was 1388 kg/ha. The remaining 220 selections were small seeded (seed size$<$4.5g/100 seeds), and 35 of these entries yielded more than the best check. The coefficients of variation ranged from 19% up to 33%, consequently only 4 entries yielded significantly more than the checks. Yield trials containing 162 of the 390 selections above were also conducted at Terbol, Lebanon.

Regional yield trials of both large and small seeded selections were conducted in cooperation with the national programs of Jordan and Syria. In Syria in the large-seeded trial the best ICARDA selections yielded over 1500 kg/ha averaged over five sites. By comparison this was 25% more seed yield than the local check which had a mean yield of 1216 kg/ha. The best entries in the regional trials are promoted to on-farm trials.

2.3. On-farm Trials :

In Syria on-farm trials comprising ICARDA lentil selections and local checks were initiated in cooperation with the Research

Directorate of the Syrian Ministry of Agriculture, Douma at six locations. Amongst the red cotyledon entries, the best ICARDA selections -78S 26013 gave 28% more yield on average than the local red-cotyledon check - Hurani 1 (Table 5.1) In the yellow-cotyledon group, the best ICARDA selection yielded 15% more yield than the local check-Kurdi I.

2.4. Use of Genetic Material by National Programs :

A range of ICARDA lines from the international nursery program have been selected for inclusion in either on-farm trials or multi-location testing by the national programs of Australia, Ethiopia, India, Jordan, Morocco, Pakistan, Sudan, Syria, Tunisia and USA (Table 5.2).

2.5. Selection for Mechanical Harvest :

To assist with the selection for increased plant height required for havest mechanization, estimates of the heritability of plant height were made in two crosses. The broadsense heritabilities were 61.6% and 7.0% emphasizing the difference between the two crosses studied.

A delay in the time of harvest after 90% pod maturity results in a loss in seed yield both from pod dehiscence and also pod drop. Complete maturity (90% pods mature) must be attained prior to harvesting with a combine harvester. Visual observation indicated that there were genetic differences in pod dehiscence and pod drop. Selected entries were tested in the last two seasons by measuring the yield of half the plot harvested at the normal harvest date, and by measuring the yield in the remaining plot harvested six weeks later. The seed loss from a delayed harvest was then calculated. The selection 74TA 550, had a markedly lower seed loss than any other selections in both seasons (Table 5.3). The low loss in seed yield is largely caused by the indehiscence of the pods of 74TA 550.

Table 5.1. Seed yield (kg/ha) from lentil on-farm trials in Syria during 1982/83 season.

Selection	ILL	Locations						Mean	Rank
		Breda	Gelline	Heimo	Izra'a	Jail farm	Tel Hadya		
Red cotyledon group									
78S 26013	16	443	1520	278	1942	679	1461	1054	1
76TA 66088	223	434	1120	491	1594	457	1165	877	2
Hurani 1*	2130	297	864	451	1611	462	1253	823	3
Yellow cotyledon group									
78S 26002	8	430	1780	590	2106	619	1137	1110	2
78S 26004	9	473	1687	531	2280	582	1320	1146	1
Kurdi 1*	2126	353	1620	529	1829	670	948	992	3

* Local checks

Table 5.2. ICARDA selections used/to be used in either multi-location testing or on-farm trials by national programs in 1983 and 1984.

Country	Identifier
Australia	74Ta 19, ILL 707, ILL 4400
Ethiopia	ILL 355, ILL 358
India	ILL 4505
Jordan	ILL 4400
Morocco	74TA 19
Pakistan	ILL 4605
Sudan	ILL 813
Syria	78S 26002, 78S 26004, 78S 26013, 76TA 66088
Tunisia	74TA 19, ILL 4354, ILL 4400
USA	ILL 857

Table 5.3. Loss in seed yield (kg/ha) from a six-week delay in harvest date of three selections.

Selection	ILL	Loss in seed yield	
		1982	1983
74TA 260	253	595	171
74TA 276	262	871	175
74TA 550	470	250	0
Syrian local	4400	-	240
Standard error ±		94.6	62.1

2.6. Measurement of Out-crossing :

In a cooperative project with the University College of Swansea, UK the rate of outcrossing at Tel Hadya was studied. The variation at a polymorphic Aspartate aminotransferace locus was assayed in about 300 germplasm accessions. Two alleles $Aat\text{-}1^F$ and $Aat\text{-}1^S$ were detected at frequencies of 0.51 and 0.49 respectively. The frequency of outcrossing was estimated from the observed heterozygosity to be about 1%. This is higher than direct estimates of out-crossing and implicates selection in favour of heterozygous gene combinations.

2.7. Genetic Variation in Straw Quality :

Lentil straw is an important livestock feed in the Middle East entering into both national and international trade. In last year's annual report it was shown that seed yield was positively correlated to straw yield, and that selection for increased seed yields would tend to increase straw yields also. Thus far attention has been focused on lentil straw quantity and not on its quality. A study of the genetic variation in straw quality was, therefore, conducted at Tel Hadya. The neutral and acid detergent fibre contents of the straw varied from 55-64% and 38-45% respectively. There were also highly significant differences amongst the genotypes in dry matter digestability, which varied from 48 to 58%. The dry matter digestability of the local check was 54% on average. The overall productivity of the trial was 1414 kg/ha seed and 2464 kg/ha straw. The plants were well nodulated, and there were significant genetic differences in the protein content of both straw and seed. The range in straw protein content was from 5.9 to 8.6% with the local checks showing a level of 6.5% protein on average. The corresponding range for seed protein content was from 24.3 to 25.7%. The average seed protein yield and straw protein yields were 353 kg/ha and 171 kg/ha respectively.

The results clearly establish the presence of considerable genetic variation in the quality of lentil straw. As a result the quality of straw of lentil selections will be monitored in the future.

2.8. Genetic Variation in Nitrogenase Activity :

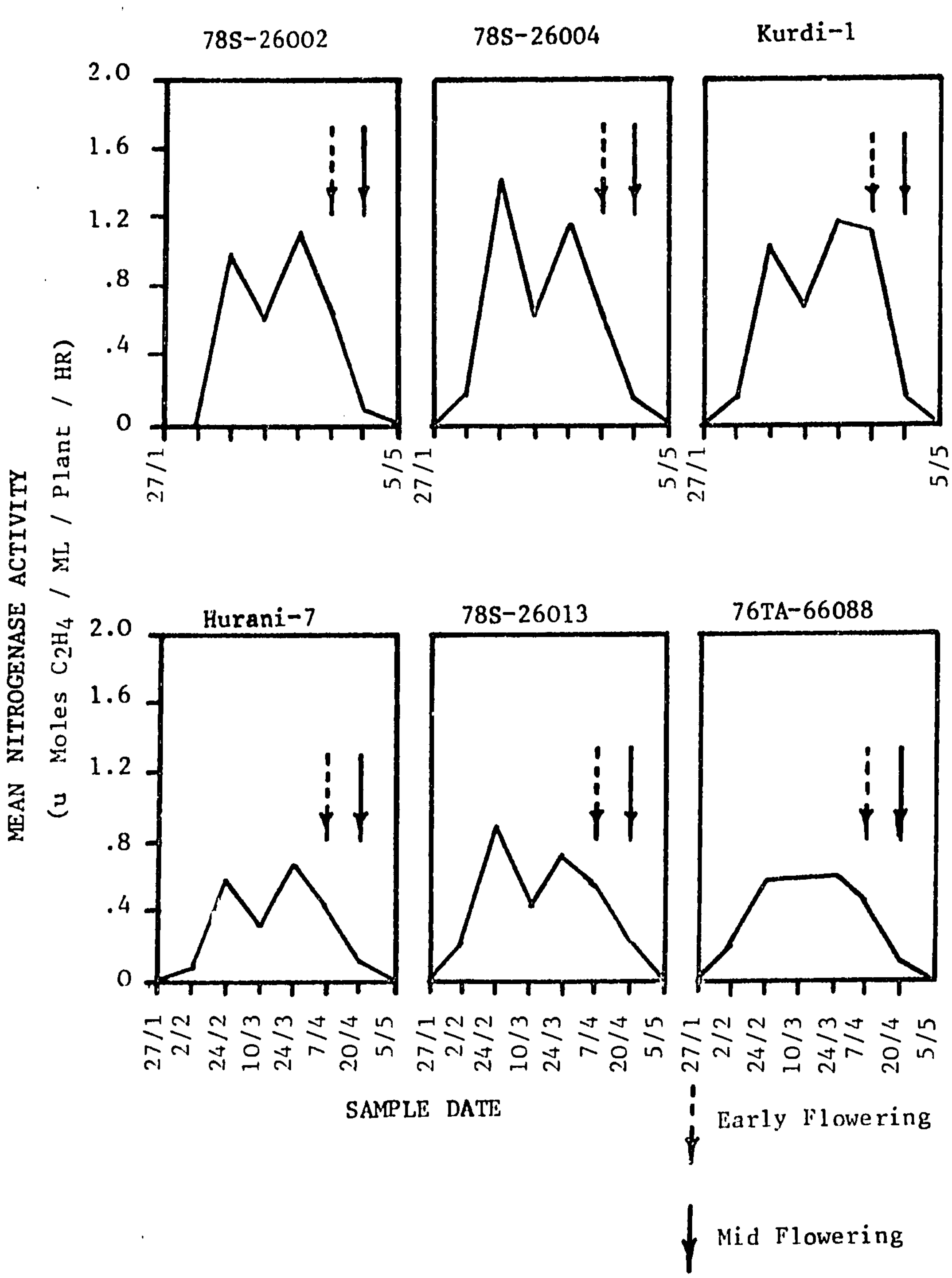
In an attempt to ascertain differences in the nitrogen fixation potential of the genotypes included in the on-farm trials their nitrogenase activity at Tel Hadya was assayed from end of January to early May, 1983. Results are presented in Figure 5.1. In general, the *macrosperma* types (78S-26002, 78S-26004 and Kurdi 1) displayed bigger nitrogen fixation profile than the *microsperma* types (78S-26013, 76TA-66088 and Hurani 1), although within each group also the differences were evident. The area under each curve in Fig. 5.1 was computed to get a relative estimate of overall nitrogen fixation potential of the test genotypes. The highest value was for Kurdi 1. In relation to Kurdi-1, the nitrogen fixation potential of 78S-26004, 78S-26002, 78S-26013, 78TA-66088 and Hurani 1, respectively, was 93, 79, 67, 58 and 50%.

An interesting genotypic difference observed in this study was the sensitivity of the nitrogenase activity to low temperature. Unlike all other genotypes, 76TA-66088 did not show any decrease in the nitrogenase activity between 24 February and March 10 in response to very low temperature recorded on March 7 (-5.6^{o}C). Interesting was also the observation that Kurdi 1 maintained higher nitrogenase activity over a longer period of time than other genotypes. Possibility of exploiting these genotypic differences in improving the nitrogen fixation of lentil cultivars will be examined in the coming season.

2.9. Seed Quality :

Lentils are priced according to seed size, seed uniformity and the presence of foreign material including broken seeds. A routine sizing technique was established for sizing *macrosperma* and *microsperma* lentils. Screens used for *macrosperma* lentils had round holes of 7, 6, 5 and 4 mm diameter. Criterion for selection considers mean seed size and the standard deviation of seed size distribution.

Figure 5.1. Nitrogenase activity, (C_2H_2 reduction) in six lentil entries grown at Tel Hadya.



Small seeded lentils are generally decorticated and split before export. Loss in decortication is an important quality characteristic. Based on Schule laboratory scale equipment, a laboratory decorticator has been designed and built at Tel Hadya. The decorticator consists of 2 circular carborandum discs. The bottom disc rotates at 700 RPM and the top disc is stationary. The distance between the discs, being adjustable, is set according to lentil seed size. Using this decorticator, preliminary work was carried out on standardising the technique for evaluation of lenitl genotypes.

A study to investigate the relation between seed size (ranging for 3.5 to 5 mm) and loss in decortication revealed that decortication loss was inversely proportional to seed size (Fig. 5.2), the coefficient of correlation being 0.95.

2.10. Response to Date of Planting :

Previous studies have shown that early planting of lentil (before mid December) gives superior growth and yield. However, the results of past two years have shown that the advantage of early sowing with respect to seed yield was not that remarkable, most probably because of relatively more severe winters experienced in those two seasons (Table 5.4). A trial was therefore initiated in the 1982/83 season to evaluate some of the new superior lentil genotypes from the breeding program, for their growth and yield under November and early February sowing. Winter this season was even colder than in 1981/82 (Table 5.4). The November sown crop took between 135 to 148 days to flower and 170 to 180 days to physiological maturity while the February sown crop took 82 to 87 days to flower and 110 to 117 days to maturity (Fig. 5.3). It is this difference in the length of the growing season which results in better performance of the early sown crop, whose reproductive growth thus spreads on a longer period and coincides with a relatively better soil moisture availability than the later sown crop.

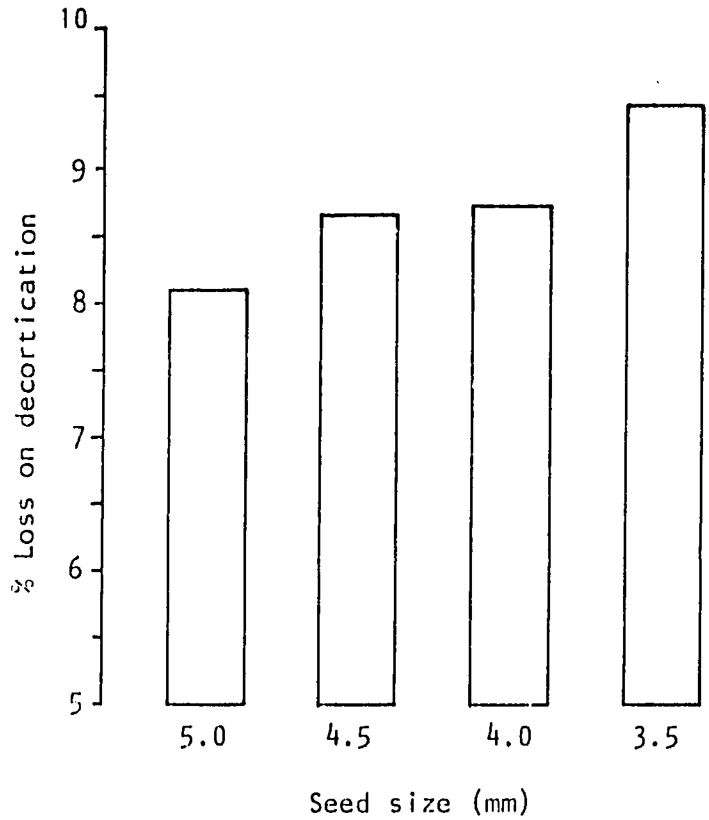


Figure 5.2. Relationship between the seed size and loss on decortication in small seeded lentils.

The growth of November sown crop was extremely low early on for a long period of time because of the cold. Genotypic differences were nevertheless perceptible. ILL 8 showed its superiority over the rest of the genotypes from the very beginning (Fig. 5.3) and seems to be better adapted for winter sowing. The total biological yield and seed yield of the genotypes under two planting dates are shown in Table 5.5. Whereas total biological yield averaged over all genotypes was significantly increased with advancement in planting date, this effect was not there with respect to seed yield . Improvement in ILL 8 with November planting was very conspicuous for total biological yield and less so for the seed yield (Table 5.5). It points to the fact that genotypes with relatively better tolerance to cold can be identified to stabilise the yield advantage from early planting in the low to intermediate elevation areas of the Mediterranean region.

2.11. Date of Planting and Plant Population :

In a date of planting and plant population trial conducted with a new lentil genotype, ILL 223, the total dry matter was again significantly improved by advancing planting date from early December to mid November but the seed yield was not much affected. Increasing the population from 133.3 plants/m^2 onwards increased both seed and straw yield and the highest values were attained at 333.3 plants/m^2. The moisture extraction pattern, consumptive use of water and water use efficiency was studied in 4 selected treatment combinations of 2 dates of planting and 2 population levels. These are shown in Table 5.6. The soil moisture changes under these treatments during the cropping season are shown in Fig. 5.4. Results confirmed the observations of the last season that early planting at higher population extracted more water perhaps because of deeper penetrating root system (Fig. 5.4). The water use efficiency was also improved, particularly at higher population level, with early sowing (Table 5.6).

Fig.5.3. Total dry matter (g/plant) production in some promising lentil genotype planted in November and February at Tel Hadya in the 1982/83 season.

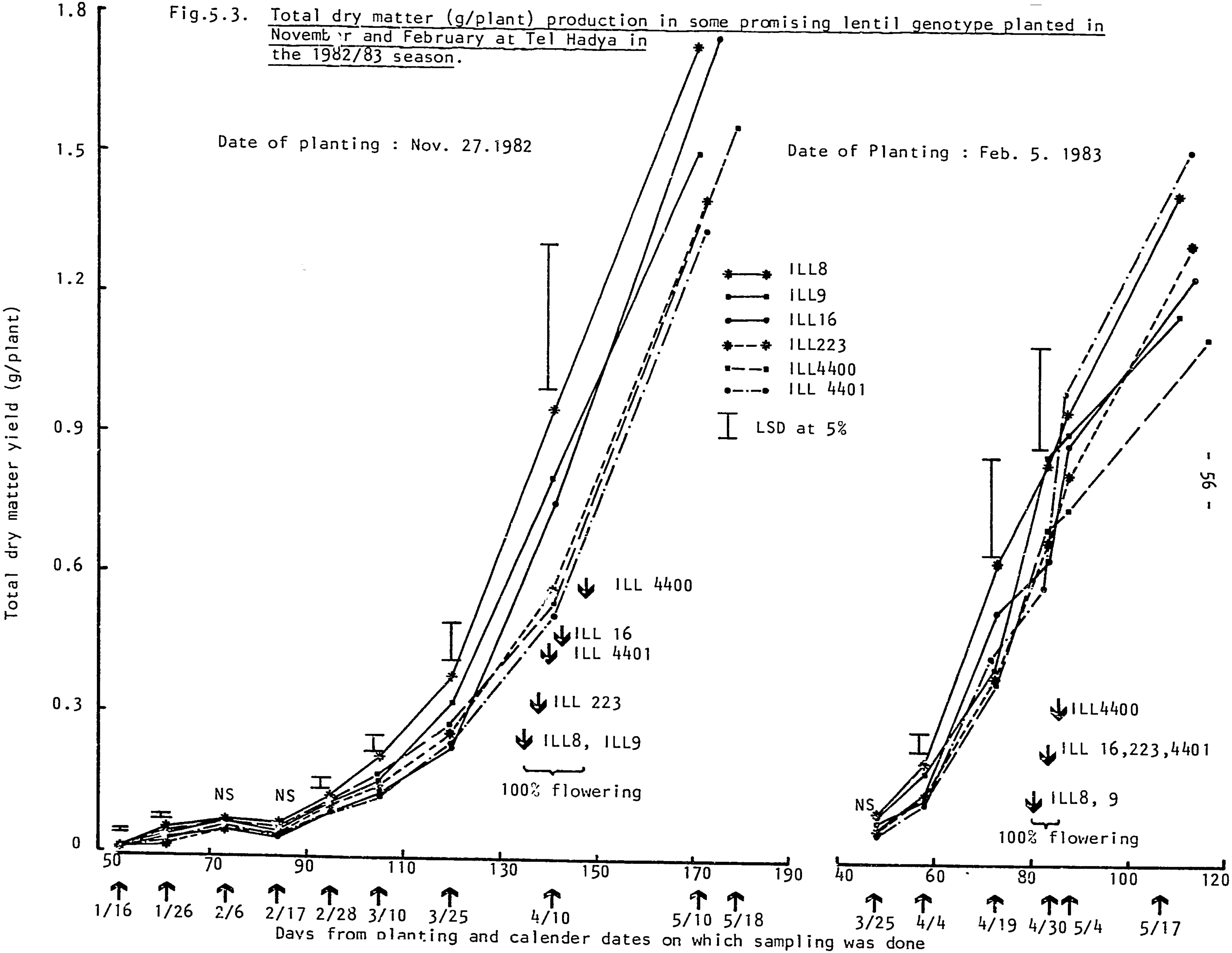


Table 5.4. Mean monthly minimum temperature for five successive seasons (1979/1983) at Tel Hadya.

Year	Mean monthly minimum temperature (°C)								No. of frosty days in the season
	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean	
1978/79	2.8	5.3	4.0	6.0	7.0	9.0	14.0	6.9	15
1979/80	9.7	4.0	1.8	3.3	6.4	8.8	12.0	6.6	19
1980/81	6.8	3.4	3.7	2.8	6.3	6.9	9.6	5.6	22
1981/82	4.6	5.2	2.4	-0.6	2.3	9.7	12.2	5.2	39
1982/83	3.5	0.8	-1.3	1.0	4.3	6.8	12.5	3.9	52

Table 5.5. Yield of some promising genotypes of lentils as affected by sowing date, Tel Hadya, 1982/83.

Genotype	Total biological yield			Seed yield		
	Date of sowing			Date of sowing		
	27 Nov	4 Feb	Mean	27 Nov	4 Apr	Mean
ILL 8	4285	3396	3841	1300	1162	1231
ILL 9	3309	2641	2975	889	819	854
ILL 16	3538	3081	3310	1060	1095	1078
ILL 223	3242	2922	3082	1014	1007	1011
ILL 4400	3289	2962	3126	857	1049	953
ILL 4401	3049	2683	2866	850	781	816
Mean	3452	2948		995	986	
CV (%) Dates (D)	9.7			16		
Genotypes (V)	18.6			24.1		
LSD (5%)						
D	283			NS		
V	606			243		
V in D	857			344		
D in V	827			NS		

Fig. 5.4. Change of water content with respect to time under ILL 223 lentil planted at two different dates and two population levels.

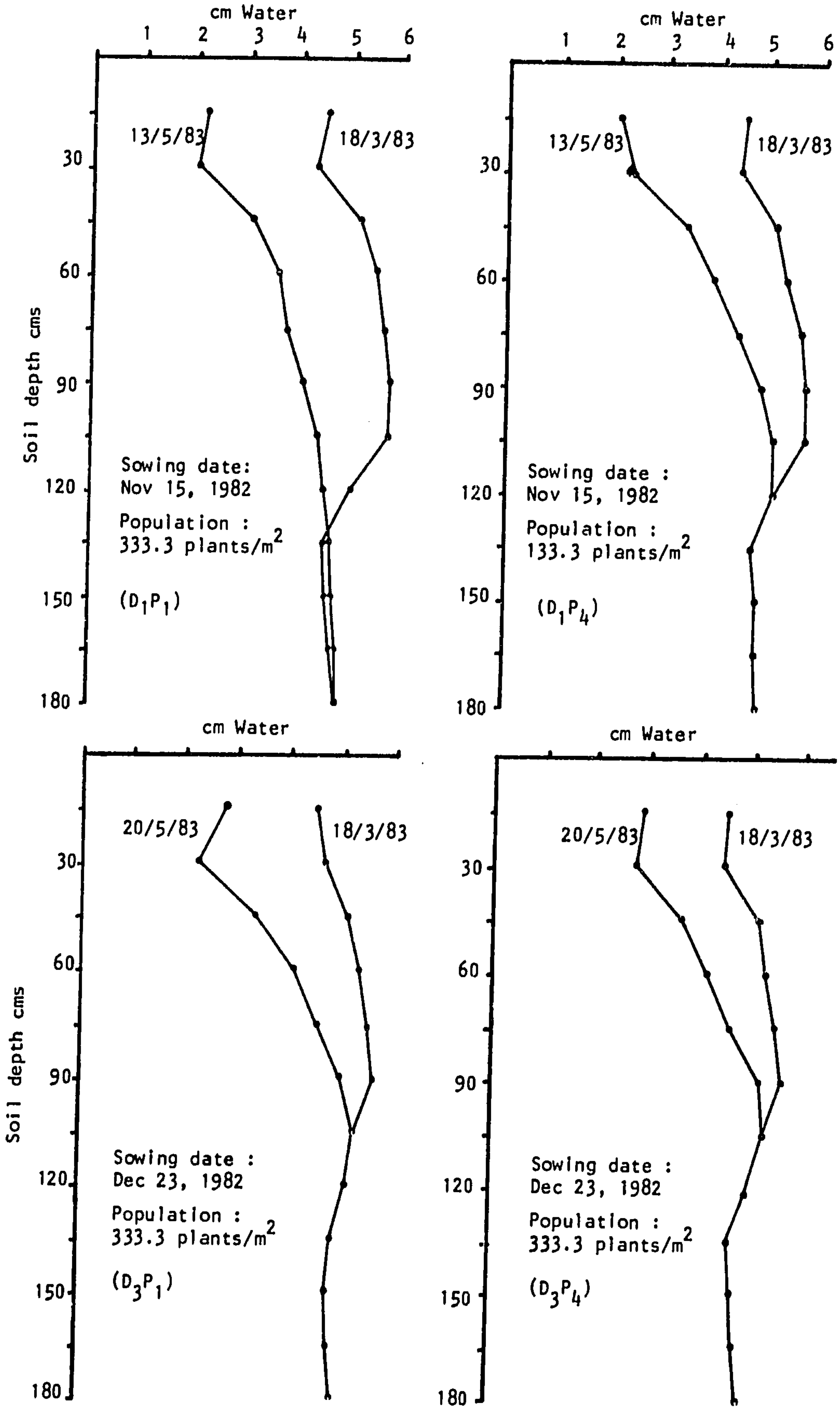


Table 5.6. Effect of date of planting and plant population on the productivity and water use efficiency (WUE) of ILL 223 at Tel Hadya 1982/83.

Particulars	333.3 Plants/m^2			133.3 Plants/m^2		
	Planting date		Relative	Planting date		Relative
	15 Nov	23 Dec	D3/D1	15 Nov.	23 Dec.	D3/D1
Date of maturity	May 5	May 17		May 17	May 17	
Total Et (cm)	28.02	24.79		24.74	22.48	
Total Eo (cm)	53.12	51.81		53.12	51.81	
Seed Yield (kg/ha)	1246	1041	0.84	1111	652	0.59
Biological yield(kg/ha)	4025	2860	0.71	3114	1717	0.55
Harvest index	0.31	0.36		0.36	0.38	
WUE 1 (kg seed yield/ ha cm Et)	44.5	42.0	0.94	44.9	29.0	0.65
WUE 2 (kg Rec. Biol yield/ha/cm Et)	143.6	115.4	0.80	125.9	76.4	0.61

2.12. Off-station Evaluation of Early Planting :

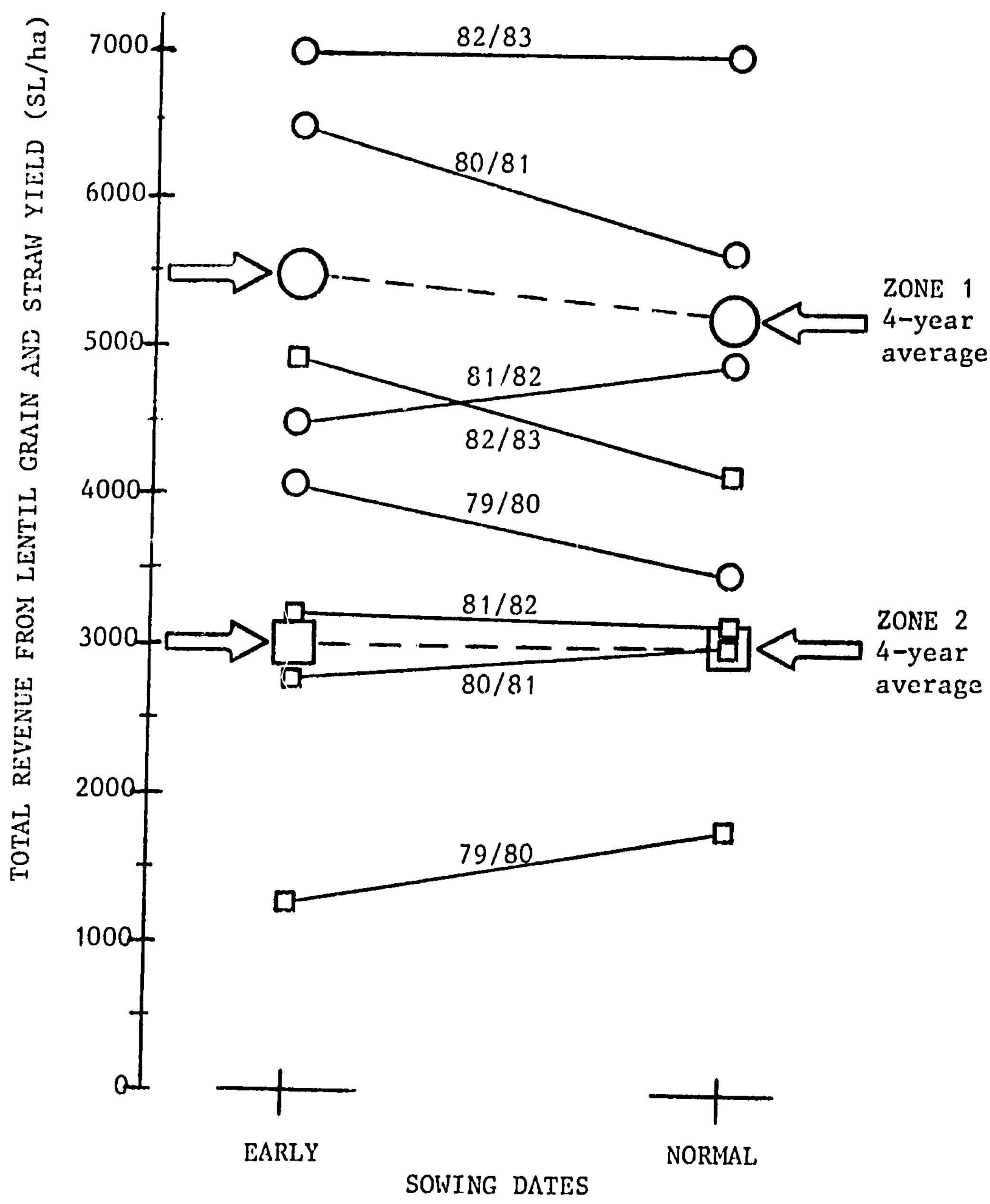
The program, in collaboration with the farming systems program, uses off-station trials on farmer's fields as a step in the process of developing profitable and appropriate techniques for Syrian farmers. On-farm trials were conducted over the past 4 seasons to see the advantage of early sowing under actual farming conditions. Farms were selected at different sites each year in the high and medium rainfall zones of North-West Syria, where lentils are grown in rotations with cereals and summer crops.

Large differences in lentil crop revenue between sites, between years and between zones were noticed (Figure 5.5). Surprisingly there was no consistent pattern in the effect of early vs. normal sowing dates. This apparent difference in the results of on-farm trials from those on the research station is not uncommon but needs to be analysed to identify the major constraints causing such a difference. Differences in the variety and the control of diseases and pests, seed bed preparation, sowing methods between the research farm and farmers' field may be the cause. Also the number of on-farm trials particularly in the last three seasons has been rather small, and the margin of benefit from early sowing even at the experimental station has been relatively smaller because of more drastic winters (Table 5.4). It is therefore proposed to continue the on-farm evaluation of the early vs. normal sowing date in the coming season.

2.13. High Density Cropping to Increase Water Use Efficiency :

Winter sown crop of lentil at traditional plant populations covers usually less than 50% of the ground until the beginning of spring. Under such situation soil moisture is lost from bare surface through evaporation. Whether growing a thicker stand to startwith and thinning it down to optimum population level later in the season could permit conversion of a greater proportion of this evaporation to transpiration and thus increase the water use efficiency, was

Figure 5.5. Effect of sowing date on total lentil crop revenue*: summary of four years of on-farm trials in two rainfall zones of N.W. Syria.



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* Revenues based on 1983 harvest-time prices: SL 1.6/kg for lentil grain and SL 1/kg for lentil straw.

studied in a trial during the 1982/83 season. The treatment details are given in Table 5.7. To increase the scope of the trial, inter-cropping of barley in between the lentil rows was also evaluated. The total biological yield per unit area was maximized in the non-thinned crop established at 15 cm row spacing (444.4 plants/m^2) and was minimized by inter-cropping lentil with 2 rows of barley with 15 cm row width (Table 5.7). The total biological yield of the crop thinned to a given density was lower than that of the crop establihsed at the same density right from planting. When the dry matter yield from thinning was added to the total biological yield of the remaining stand, it was interesting that the total biological yield in case of thinning of lentils from 15 cm to 30 cm row width, was more than that of the non-thinned crop planted at 30 cm row spacing. It is proposed to repeat this study during 1983/84 season to get more conclusive results.

2.14. Response to Residue Management and Phosphate Application :

Studies on the effect of incorporating vs. burning of the residues of preceding cereal crop on the yield of lentil revealed that the incorporation of straw significantly increased the productivity of lentil as evaluated in terms of total biological yield as well as seed yield. Application of 50 kg P_2O_5/ha either mixed with seed or placed 5 cm below the seed resulted in significant increase in the seed and total biological yield over no phosphate control. Boradcast application of 50 kg P_2O_5/ha was not at all effective. The available soil phosphorus status of this soil was very low (1.3 - 1.5 ppm P).

2.15. Weed Control :

Crop loss from weeds was assessed at Tel Hadya and Terbol where weedy check yielded only 70% and 63%, respectively of the weed free treatment. Hand weeding twice was as effective as the treatment having complete weed free situation obtained by repeated

Table 5.7. Yield estimates in lentils as affected by different cropping systems Tel Hadya 1982/83 (Total seasonal rainfall = 317 mm).

Treatment	Total recoverable biological yield (kg/ha)				Seed yield of lentil kg/ha at harvest
	Early veg. phase	begin-ning of flowering	At maturity	Total	
T_1 - Lentil established at 15 cm row width	-		5313	5313	1855
T_2 - Lentil established at 30 cm row width	-		4018	4018	1491
T_3 - Lentil established at 60 cm row width	-		3105	3105	1212
T_4 - Thin lentil from 15 to 30 cm row width in the early vegetative phase (St_1)	330		3833	4163	1383
T_5 - Thin lentil from 15 to 60 cm row width at the beginning of flowering (St_2)	-	924	3461	4385	1278
T_6 - Thin lentil from 15 to 60 cm row width at the two stages	334	997	1990	2987	641
T_7 - Barley removed between lentil rows to make 30 cm row width in the early vegetative phase	146	-	3657	3803	1244
T_8 - Barley removed between lenitl rows to make 30 cm row width at the beginning of flowering	-	765	3524	4289	1300
T_9 - Remove 2 rows of barley in two stages to leave lentil at 60 cm row width	123	113	2331	2567	910
LSD at 5%	-	-	562	483	259
C.V. %			11.1	15.5	14.1

hand weeding. Of the various pre-emergence herbicides (chlorbromuron, prometryne, methabenzthiazuron and cyanazine alone or mixed with pronamide) tested, none proved promising at Tel Hadya.

At Terbol prometryne at 1.5 kg a.i./ha gave a 62% increase in yield over the weedy check proving as effective as the hand weeding. But still more promising were the treatments methabenzthiazuron (2kg a.i./ha) + pronamide (0.5 kg a.i./ha) and cyanazine (1 kg a.i./ha) + pronamide (0.5 kg a.i./ha) which respectively gave 86% and 73% increase in seed yield over weedy check.

2.16. Insect Control :

2.16.1. Control Methods :

A trial was designed to partition yield losses among crop growth stages, to identify the key pests responsible for yield losses and to select appropriate insect control technology. When different insecticidal regimes were compared, a 23.7% increase in yield was obtained when a soil application of a granular insecticide to control *Sitona* weevils was complemented with one foliar spray against *Apion*, aphids, thrips and very low populations of *Laspeyresia* and *Heliothis* (Table 5.8). Partition of insecticidal regime indicated that *Sitona* control alone significantly increased yields by 19% whereas foliar insect control increased yield by only 4.2%. High dosages of N did not compensate for *Sitona* damage. The economic analysis confirmed that *Sitona* control is important and that this insect was the key pest during the past season. The best option for a farmer willing to prevent *Sitona* damage would be the application of a granular insecticide at planting.

2.16.2. Determination of the economic importance of *Sitona*:

A detailed study of the economic imporatnce of *Sitona* larval and adult damage was carried out. At high levels of infestation (up to 93.5% nodules damaged in check plots), the insect caused 17.7% and

14.1% losses in straw and grain yields, respectively. Both heptachlor and carbofuran applied as granules at planting significantly increased straw and grain yields (Table 5.9). Foliar sprays against adults were not as efficient and had a detrimental effect on straw yields. Best yield increase were obtained with heptachlor granules at planting. The economic analysis (Figure 5.6) confirmed that heptachlor 4G at the relatively high dosage(2.0 kg a.i./ha)was a better alternative than carbofuran 5G applied at 1.0 kg a.i./ha. Both out performed the foliar sprays. Future studies will concentrate on searching for cheaper, safer and easier to use alternatives of control.

The nitrogenase activity was assayed in all the treatments (Fig. 5.7). Where there was no protection, nitrogenase activity fell to barely detectable levels on March 30 sampling. Such levels for the plants treated with granular insecticides were not reached till April 27. The combination effect between the adult control (sprays) and granular products used for larval control was interesting. In case of heptachlor the use of foliar spray suppressed the nitrogenase activity in contrast to that of carbofuran with which the sprays enhanced it. Attempts to understand better the effect of insecticidal sprays on the nitrogenase activity will be made in the 1983/84 growing season.

Table 5.8. Effect of different insecticidal regimes on the yields of Syrian Local Large lentils (Tel Hadya, 1982/83 season).

Treatment	Yield (kg/ha)	% yield increase
Full protection (FP)[a]	2714.3	19.3
FP less soil insecticide	2639.3	16.0
FP less preflowering sprays	2683.0	17.9
FP less post flowering sprays	2734.5	20.2
Check	2274.8	-
Recommended protection (RP)[b]	2813.0	23.7
RP - soil insecticide	2371.0	4.2
RP - foliar spray	2707.4	19.0
Alternative practice[c]	2243.7	-1.3
LSD 5% for yields	248.0	
CV (%) for yields	6.0	

a) Soil insecticide (carbofuran) plus seven foliar sprays with methamidophos or endosulfan.

b) Soil insecticide (carbofuran) plus one foliar spray with methamidophos.

c) 100 kg N/ha plus one foliar spray with methidation.

Table 5.9. The efficiency of insecticidal combinations to control *Sitona* weevils in Syrian Local Large lentils and their effect on straw and grain yields (Tel Hadya, 1982/83 season).

Adult Control[a]	Larval Control[b]	% efficiency		Yield (kg/ha)		% yield increase	
		against adults	against larvae	straw	grain	straw	grain
Yes	with heptachlore	86.0	99.9	4114.1	2643.0	13.8	15.6
No	with heptachlore	72.1	99.9	4391.3	2628.9	21.5	15.0
Yes	with carbofuran	89.3	100.0	4235.2	2586.2	17.2	13.1
No	with carbofuran	87.4	99.9	4337.8	2583.6	20.0	13.0
Yes	no	29.8	-	4197.2	2439.7	16.1	6.7
No	no	-	-	3614.4	2286.8	-	-
	LSD 5% for yields			308.1	123.3		
	CV (%) for yields			4.2	4.4		

a) Four sprays with methidathion 0.5kg a.i./ha

b) With carbofuran 1.0 kg a.i./ha or heptachlor 2.0kg a.i./ha.

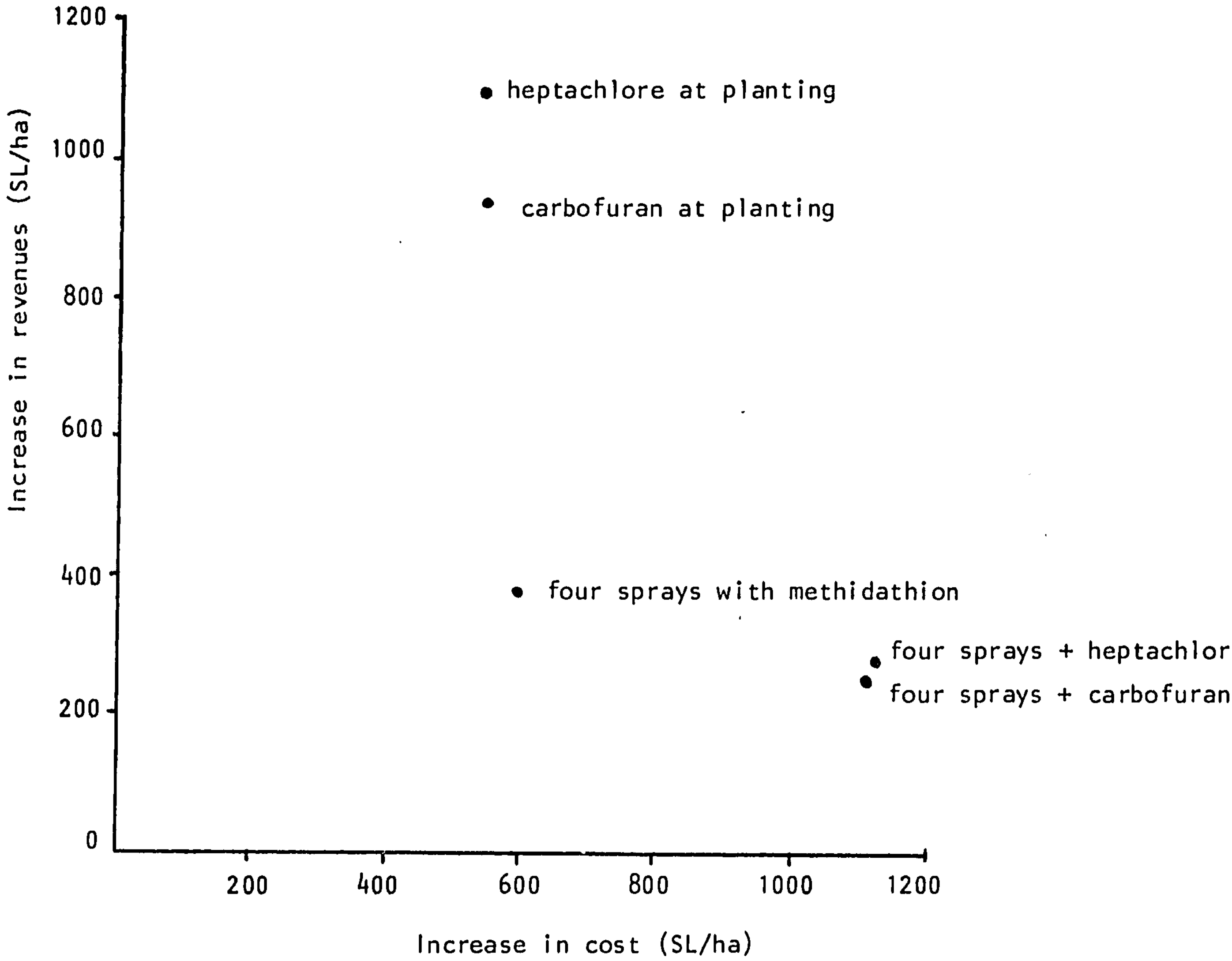
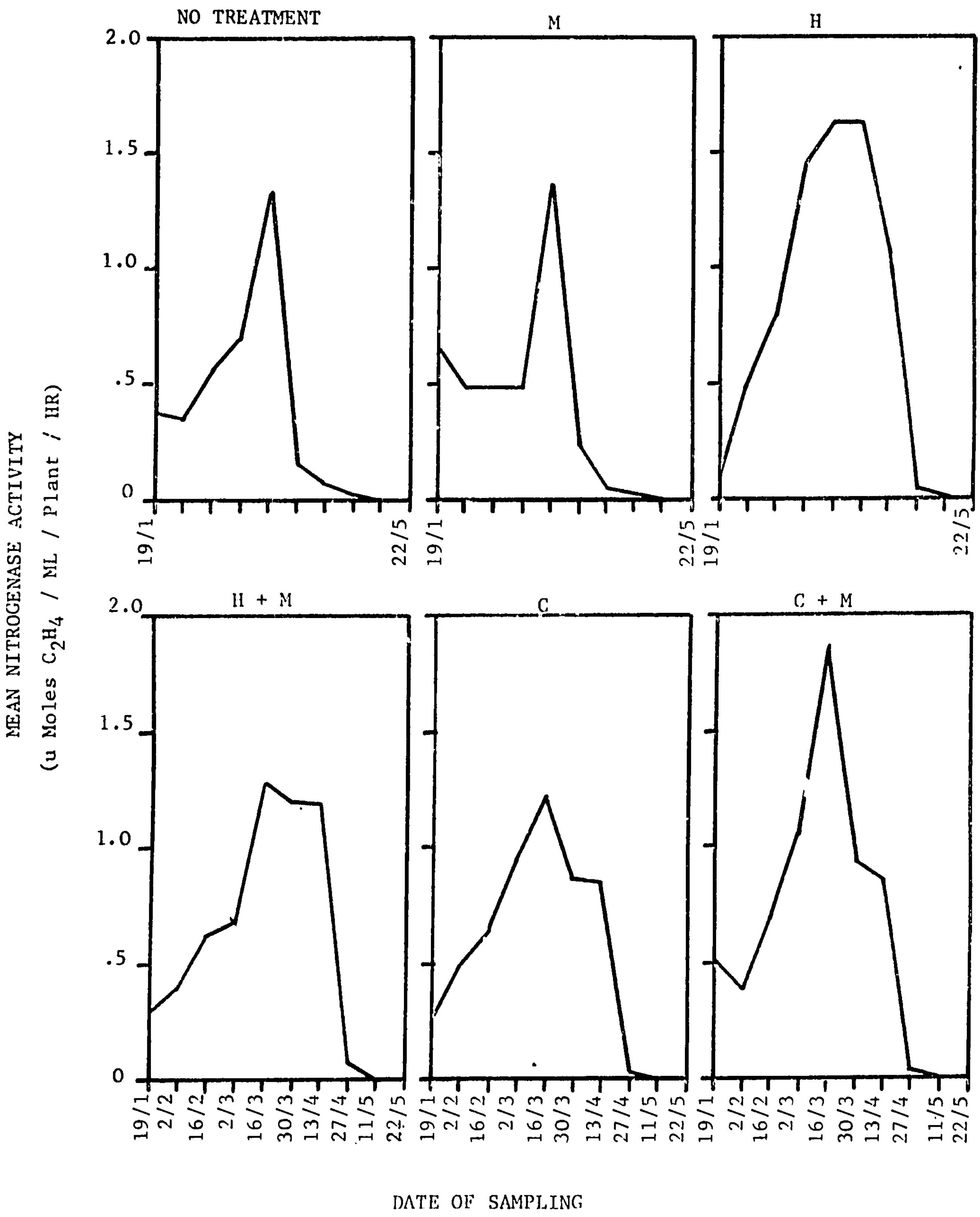


Figure 5.6. Cost - benefit relationships for five alternatives of chemical control of *Sitona* weevils in lentils.

Figure 5.7. A comparison of mean nitrogenase (C_2H_2 reduction) enzyme activity in lentils treated with heptachlor (H) or carbofuran (C), for *Sitona* weevil larva and methidathion (M) for adults.



6. LENTIL PROJECT 2 : Development of Wide Adaptation in Lentils

1. Objectives :

1.1. To develop separate high yielding and stable genetic stocks with wide adaptability for each of the following lentil growing regions : high altitude region, middle to low elevation Mediterranean region, and southern latitude region (Africa/Asia).

1.2. To study the physiological basis for wide adaptation.

2. Research Highlights :

2.1. Limited adaptation of most lentil cultivars has hindered their wide-spread use in different environments. Previous studies on the performance of lentil genotypes in the International Lentil Adaptation trial and the green house experiments at Aleppo have indicated that both temperature and photoperiod exert profound influence on the phenological development of the crop and thus affect its adaptation.

2.2. A collaborative project with the University of Reading, UK has now started to examine the photo-thermal effects on flowering of diverse genotypes of lentil in controlled environments. Earlier, this collaborative project examined the suitability of different sources of artificial light for growing lentils in controlled environments so that plants of different genotypes closely resemble those grown in the field.

2.3. In the meanwhile, the green house study at Aleppo, under relatively less controlled conditions, continued to examine the flowering response of some diverse genotypes of lentils to photoperiod and temperature. Some new entries (ILL 1, 16 and 223) from the breeding program were addeded to those studied earlier because of their superior performance across several locations. In one of the day length treatments, the photoperiod naturally increased from 9.8 hrs, at the start of the experiment, to 14.1 hrs near the termination of the study. In the other treatment the normal day length was extended to 16 hrs using fluorescent tubes. Two temperature regimes were established : 1) the low temperature regime as obtained naturally in the open cage and the 2) the high temperature regime obtained through the circulatory heater in the plastic house. The mean maximum and minimum temperatures for the period by which flowering was recorded in all treatments, were 28.5^{o} and $11.3^{o}C$ respectively for high temperature treatment. The respective values for the low temperature treatments were $20.7^{o}C$ and $9.4^{o}C$.

The results obtained in the 1982/83 season (Table 6.1) confirm the previous findings: warmer thermal regime and longer photoperiod hastened the onset of reproductive growth. ILL 4605 (Ex-Argentina) again showed least sensitivity to day length change and ILL 2526 (Ex-India) showed no sensitivity to day length change under warmer regime. Amongst the new entries tested, ILL 223 was least sensitive to day length variation at low temperature and ILL 16 at high temperature regimes.

Use is being made of genotypes such as ILL 4605 and ILL 2526 in crossing program to develop genetic stocks for more southernly latitudes where lentil are grown in relatively shorter day lengths.

Table 6.1. The effect of long-day (LD) of 16 hr. vs. normal day (ND) conditions on the days to flower bud appearance of 10 genotypes of lentil under low and high ambient temperature conditions.

Genotype	Origin	Days from planting to first flower bud			
		High Temperature		Low Temperature	
		LD	ND	LD	ND
ILL 1	Jordan	88.5*	107.8	126.5	135.9
ILL 16	Jordan	85.5	114.3	126.3	139.3
ILL 92	USSR	94.7	124.7	133.5	150.1
ILL 204	Ethiopia	82.7	122.3	135.2	149.1
ILL 223	Iran	78.9	113.7	132.9	135.4
ILL 784	Egypt	77.8	110.7	128.6	146.6
ILL 2526	India	80.7	82.0	124.2	139.6
ILL 4400	Syria	81.1	130.2	124.6	146.1
ILL 4401	Syria	79.2	111.6	120.2	135.5
ILL 4605	Argentina	84.0	80.5	127.6	126.3

* Mean of approximately 20 plants.

7. LENTIL PROJECT 3 : Development of Drought Tolerance in Lentils.

1. Objectives :

1.1. To develop cultivars and genetic stocks capable of producing an economic and stable yield under low rainfall situations through tolerance to drought and heat stress during the reproductive period of growth.

1.2. To develop appropriate agronomic practices for increasing the water-use efficiency of promising cultivars under low rainfall conditions.

2. Research Highlights :

2.1. The search for drought-avoiding genotypes which mature early enough to escape severe water and temperature stress during the reproductive period of growth has continued. The correlations between both flowering and maturity and seed yield in a dry environment (Breda) were studied in order to gauge the effect of selecting for early maturity on seed yield. Breda received 260 mm precipitation in the season up to harvest. In the regional yield trial (Large seeded) grown at Breda the phenotypic correlations between seed yield, on the one hand, and time to flowering and maturity, on the other hand, were $r = -0.55$ and $r = -0.66$ respectively. In the small seeded regional yield trial at Breda the phenotypic correlations between seed yield and time to flowering and maturity were again significant, but lower at $r = -0.42$ and $r = -0.38$ respectively. These negative correlations show that the highest seed yields at Breda were achieved by the early flowering and maturing selections, endorsing the approach of selecting for drought avoidance through early maturity.

2.2. A screening nursery of 408 early germplasm accessions and also an early yield trial were grown at both Breda and Tel Hadya to find early maturing material. A few selections yielded as well or better than the local checks but matured significantly earlier. These entries will be retested in the coming season.

2.3. Response of 12 diverse genotypes, including some of those found superior yielding in multi-location testing by the breeding program, was studied to total seasonal moisture supply by growing them under rainfed conditions at Tel Hadya (seasonal rainfall 322 mm) and Breda (seasonal rainfall 260 mm) and also with supplemental irrigation (150 mm total in the form of three irrigations between early April and early May) at Tel Hadya. Intensive soil moisture studies were carried out on eight selected genotypes to determine consumptive use of water and water use efficiency under rainfed conditions at Tel Hadya. Also early root growth was studied in germinator (at 20^{o}C) and the growth of root and shoot in pot culture in the green-house.

Averaged over all the genotypes, the yield was closely related to total seasonal moisture supply (Table 7.1). Compared with the rainfed situation at Tel Hadya, an assured moisture supply (472 mm) through supplemental irrigation increased the total biological yield of all the genotypes. But ILL 101, 793 and 16 responded most conspicuously while the response of ILL 1861, 4401 and 470 was the least. Yields of all genotypes decreased sharply when they were grown in the drier location, but the reductions were least in ILL 8, 9, 16, 1861 and 4354. Genotype ILL 16 responded positively to increased moisture supply at Tel Hadya and it was amongst the varieties least affected by droughty conditions of Breda. This may partly explain its wider adaptability previously reported in the breeding program.

The seasonal water use and water use efficiency of the eight selected genotypes grown rainfed at Tel Hadya are given in Table 7.2. The genotypes maturing latest (ILLL 793 and 4349) had the highest

Table 7.1. Effect of total seasonal moisture supply on the seed and total biological yield of 12 diverse genotypes of lentils in North Syria during the 1982/83 season.

Genotype	Origin	Seed yield (kg/ha)			Total biological yield (kg/ha)		
		Breda	Tel Hadya		Breda	Tel Hadya	
		Rainfed (260 mm)	Rainfed (322 mm)	Irrigated (472 mm)	Rainfed (260 mm)	Rainfed (322 mm)	Irriagted (472 mm)
8	Jordan	518	840	1375	1646	3049	4371
9	Jordan	419	1115	1480	1685	3594	4874
16	Jordan	399	908	1749	1804	3255	5414
101	Syria	341	861	1950	1006	3130	5454
223	Iran	384	1018	1414	1283	3117	4294
470	Syria	287	1015	1196	1110	3315	4482
793	Egypt	120	846	1794	994	3134	5144
1861	Sudan	327	714	1255	1098	2784	3728
4349	USSR	90	913	1412	1206	3482	5132
4354	Jordan	429	1250	1700	1498	3655	5224
4400	Syria	163	939	1688	1078	3131	4588
4401	Syria	349	1130	1422	1202	3588	4693
Mean		319	962	1536	1301	3270	4783
CV (%)		35.8	20.2		14.7	15.4	
LSD(5%) Genotypes (V)		164	253		275	619	
V in moisture supply		-	357		-	1139	

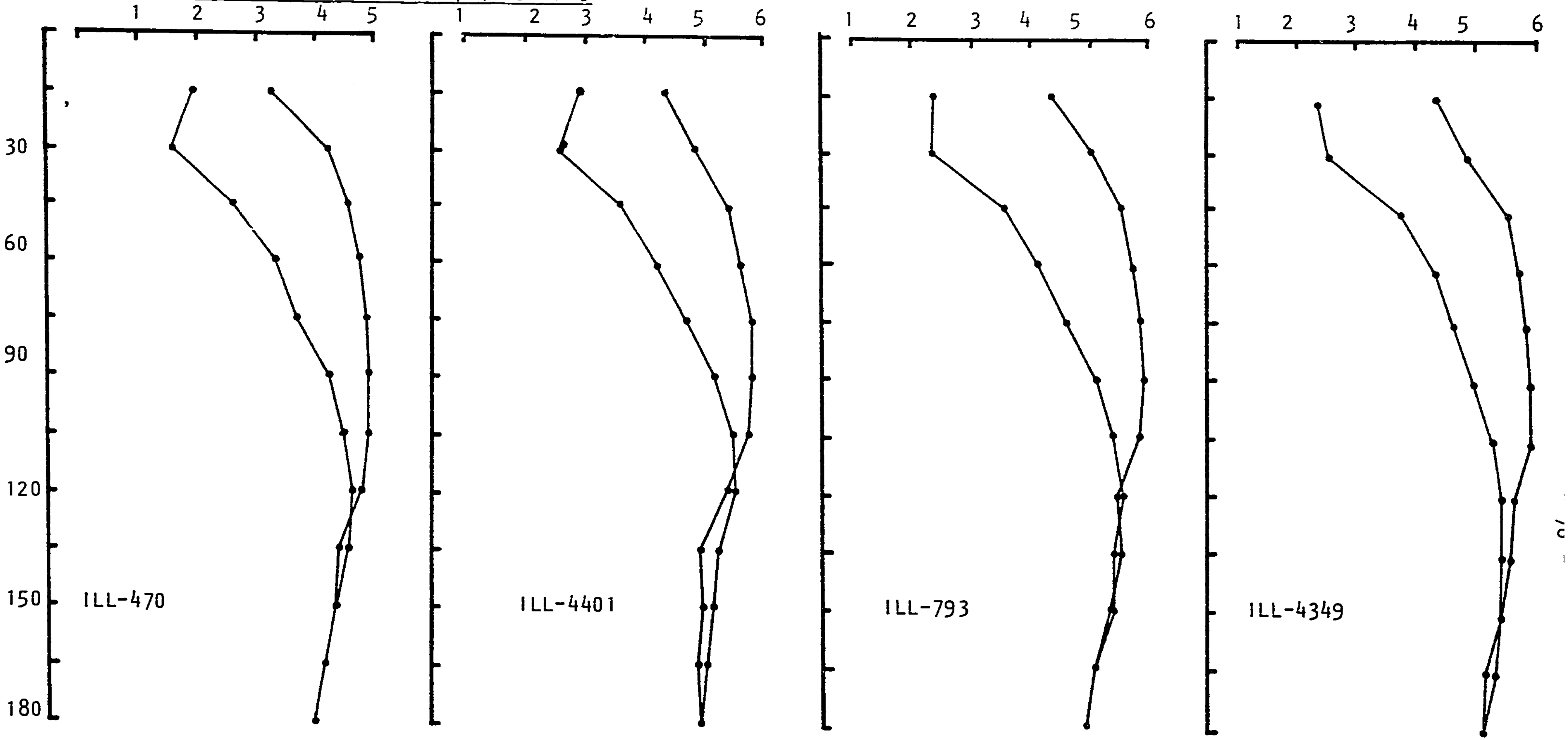
Table 7.2. Total extractable moisture (EAA), evapotranspiration (Et) and water-use efficiency, (WUE) for total biological yield (TBY) and seed yield (SY) of different lentil genotypes under rainfed conditions at Tel Hadya, 1982/83.

Genotypes ILL	Date of maturity	EM (mm)	Et (mm)	WUE (kg/ha/mm)	
				TBY	SY
9	May 13	67.7	242.7	14.8	4.6
16	May 13	85.2	258.0	12.6	3.5
101	May 17	91.0	267.1	11.7	3.2
223	May 12	81.4	251.1	12.4	4.0
470	May 10	95.1	274.9	11.3	3.7
793	May 28	104.2	287.7	10.9	2.9
4349	May 28	103.1	289.7	12.0	3.1
4401	May 13	82.3	255.3	14.0	4.4

consumptive use of water and ILL 9, a relatively earlier maturing genotype had the lowest water use. The water use efficiency was highest in the early genotype ILL 9. Earliness combined with higher growth rates appear to be the key factors in improving the water use efficiency.

Of the genotypes evaluated for their early root growth, ILL 470 was the fastest. In two separate germination studies, using all the test genotypes this was confirmed. Also in the pot-culture study with different moisture regimes this genotype produced more roots and had higher root to shoot ratio than other genotypes. In the field experiment also, amongst the early maturing types it had highest extractable moisture (Fig. 7.1). It would, therefore, be of interest for further studies.

Fig. 7.1. Soil moisture content in different soil layers (cm water/15 cm soil layer) at the highest recharge and at physiological maturity of some contrasting lentil genotypes under rainfed conditions at Tel Hadya, 1982/83.



8. CHICKPEA PROJECT 1: Development of Improved Kabuli Chickpea Genotypes and Production Technology

1. Objectives :

1.1. Development of cultivars and genetic stocks having a range of maturities to fit different agro-ecological situations and having kabuli seed characteristics as demanded by the consumer and having high and stable yield, resistance to ascochyta blight and suitability for earlier sowing.

1.2. Development of appropriate agronomic practices and plant protection measures for existing and improved cultivars.

2. Research Highlights :

2.1. Development of Cultivars and Genetic Stocks :

2.1.1. Crossing :

A total of 375 crosses were made during the 1982/83 season at Tel Hadya. The break up of the crosses are : 109 crosses for development of cultivars for winter and spring sowing, 30 for large seeded cultivars, 25 for tall types, 25 for large seeded and tall cultivars, 12 for cold tolerance, 20 for improvement of local land races, 48 for the national programs in Tunis and Jordan, 66 for identification and pyramiding of genes for resistance to ascochyta blight, 40 crosses for inheritance studies of height and seed size, cold tolerance, protein content, iron chlorosis, and resistance to leaf miner. Further, 326 single crosses, 45 three-way crosses, and 4 backcrosses were made. While the main emphasis continues to be on development of cultivars for winter and spring sowing, the breeding work has been diversified to develop cultivars to meet varied needs of the national programs, such as large seed, tall type, cold tolerance, incorporation of adaptation from the land races, etc.

As the main focus of the program is to develop high yielding and ascochyta blight resistant genetic stocks, one of the parents in all the crosses was ascochyta blight resistant. In view of the different races, we are attempting to identify genes for resistance and to pyramid them.

2.1.2. Segregating Populations :

The F_2 to F_4 generations were grown in the ascochyta blight disease nursery during winter at Tel Hadya. The F_5 to F_7 generations were grown both during winter and spring for selection at Tel Hadya. The F_1, F_3 and advanced generations were grown at Sarghaya during the off-season. The total segregating material grown during 1982/83 is shown in Table 8.1. The progenies found uniform and promising were bulked in F_5 to F_7. During 1982/83, 126 promising lines have been bulked. These will be evaluated for yield potential and adaptation during winter and spring at Tel Hadya and Terbol.

2.1.3. Yield Trials :

Newly developed 273 lines were evaluated in five advanced yield trials (AYT) and eight preliminary yield trials (PYT) during spring season at Tel Hadya. A total of 24 entries including 21 test entries and 3 checks were evaluated in each trial. The results are summarized in Table 8.2. Only 10 entries could exceed all the three checks. At Terbol 189 FLIP lines were tested in 5 AYTs and 4 PYTs. The performance of the lines was better there than at Tel Hadya. As many as 28 lines exceeded all the 3 checks (Table 8.3).

Though most of the lines failed to produce higher yields than the checks, they possess resistance to ascochyta blight. Therefore, they are expected to produce stable yields over the years in blight prone areas. Furthermore, performance of some of these lines may be better in other chickpea growing countries. Hence, promising lines will be furnished to the national programs.

Table 8.1. Chickpea segregating breeding material grown for winter (W) and spring (S), plants selected and progenies bulked during 1982/83 main season at Tel Hadya and 1982 off-season at Sarghaya.

Generation	No. of Segregating material grown			No. fo plants selected			No. of progenies bulked
	Main season	Off-season	Total	Main season	Off-season	Total	(Main season)
F1	-	191	191	-	6856 [a/]	6856	-
F2 Population	179 (6856 single plants)	15	179	3312	-	3312	-
F3 (Bulks)	27	-	27	505	-	505	-
F_3 (Progenies)	2310	1007	3317	1541	1212	1753	-
F4-W	1219	1099	2318	426	1830	2256	-
F5-S	228	-	228	126	-	126	17
F5-W	2243	-	2243	586	-	586	56
F6-S	510	-	510	222	-	222	18
F6-W	751	-	751	201	-	201	36
F7-S	372	-	372	-	-	-	4
F7-W	547	-	547	-	-	-	13

a/ To eliminate selfed plants, single plants are harvested in F1 and plant-rows grown in F2.

Table 8.2. The number of chickpea test entries exceeding yield of check in AYT and PYT at Tel Hadya during spring 1982/83.

Trial	No. of test entries exceeding check			Highest yield of test entries (kg/ha)	Yield as Percent of check			CV (%)
	ILC 482	ILC 263	ILC 1929		ILC482	ILC263	ILC1292	
AYT-1	21	-	-	1757	152	95	98	16.0
AYT-2	14	2	2	1698	157	109	110	20.2
AYT-3	5	1	-	1420	110	101	97	11.5
AYT-4	6	-	-	1251	108	90	94	12.5
AYT-5	-	-	-	1375	94	92	91	13.5
PYT-1	4	-	-	1442	118	98	95	23.7
PYT-2	1	1	-	1539	101	108	93	24.3
PYT-3	-	-	-	1086	86	86	88	16.5
PYT-4	13	1	1	1036	127	108	106	24.5
PYT-5	1	1	1	1433	110	107	111	27.3
PYT-6	-	2	3	1256	98	107	110	21.3
PYT-7	5	14	15	1553	112	127	137	18.2
PYT-8	1	5	2	1461	102	116	111	17.5

2.1.4. Large Seeded Chickpeas :

The progress in breeding large seeded high yielding and ascochyta blight resistant lines has been slow because the resistant sources have very small seed size. However, 9 lines with seed size larger than 40 g/100 seeds were developed and tested in an advanced yield trial for large seeded types during winter and spring at Tel Hadya. The results indicated that 7, 9 and 5 entries exceeded ILC 482, ILC 464, and ILC 3279 during winter (Table 8.4). Only one entry was found better than the large seeded check (ILC 464) in spring. Since enough entries are not available to incorporate them in the international nursery, the newly bred lines will be used in the crossing program.

Despite slow progress, the national program in Syria has identified ILC 620 and ILC 629, the two large seeded types, for their evaluation in the on-farm trial during the 1983/84 season.

2.1.5. Host Plant Resistance to the Leafminer :

The search for sources of resistance to the chickpea leafminer was continued with a mass screening of germplasm and breeding materials. More than 4300 genotypes were evaluated. Only 13 (0.4%) of these were rated as resistant and selected for rescreening and yield testing. The visual damage scale used for screening was put to a test by planting 35 previously selected accessions in different fields and in both winter and spring seasons. Rank correlation coefficients for visual damage scores between fields and seasons were highly significant, ranging from 0.931 to 0.956. The rescreening confirmed resistance ratings for all but three of the materials, suggesting that, at least for initial mass screening, a reliable visual damage score has been developed. Progress was also made in identifying highly susceptible materials which will be used as spreaders and as susceptible checks in yield trials.

Table 8.3. The number of chickpea test entries exceeding the yield of check in AYT and PYT during spring at Terbol, 1982-83.

Trial	No. of test entries exceeding check			Highest yield of test entries	Yield as percent of check			CV (%)
	ILC 482	ILC 263	ILC 1929	(kg/ha)	ILC482	ILC263	ILC1929	
AYT-1	-	5	-	1940	100	111	97	17.0
AYT-2	-	4	2	2042	99	106	101	16.0
AYT-3	6	3	15	2315	116	108	128	16.0
AYT-4	-	-	9	2149	92	99	112	12.0
AYT-5	3	-	1	2175	108	94	103	14.2
PYT-1	9	21	5	2264	115	154	107	19.0
PYT-2	5	2	10	2681	130	125	138	19.0
PYT-3	17	9	8	2056	122	112	110	20.0
PYT-4	10	18	11	2278	123	136	129	23.0

Table 8.4. The number of chickpea test entries exceeding the yield of check in AYT-L (W,S) 1982-83 at Tel-Hadya.

Trial	No. of test entries exceeding check			Highest yield of test entries	Yield as percent of check			CV (%)
	ILC 482	ILC 363	ILC 3279		ILC482	ILC464	ILC3279	
AYT-L(W)	7	9	5	2458	127	-	108	14.9
	ILC 492	ILC 464	ILC 263		ILC482	ILC464	ILC263	
AYT-L(S)	-	1	-	1475	93	103	94	11.5

2.1.6. Host Plant Resistance to Bruchids :

The mass screening for resistance to *Callosobruchus chinensis* continued. More than 3000 genotypes have been screened, none of which has passed the replicated tests required to be rated as resistant.

2.1.7. International Trials :

One of the major goals of the chickpea improvement program is to strengthen the national programs by furnishing promising genetic materials and early generation and advanced breeding lines. Therefore, there has been a rapid increase in distribution of nurseries from 34 sets in 1977/78 to 339 sets in 1983/84. Greater demand by the national programs is an indication of usefulness of the nurseries. Types of nurseries have also increased from two in 1977/78 to nine in 1983/84 to meet diverse needs of the national programs.

Promising materials from the international nurseries have been selected and included in the multi-location or in the on-farm trials with a view to release them as cultivars, if found suitable (Table 8.5). After initial testing, a few lines have been identified for pre-release multiplication and large scale testing by the following five national programs : (i) Syria: ILC 3279; (ii) Lebanon: ILC 482; (iii) Jordan: ILC 484, ILC 202; (iv) Cyprus: ILC 3279; (v) Morocco : ILC 195, ILC 482, ILC 484. It is expected that they will be released as cultivars if they maintained superior performance.

2.2. Seed Quality :

A total 3600 lines of chickpeas were evaluated for their seed protein concentration. Considering the importance of seed size in determining the price and fitness for international trade a technique for evaluation of seed size was also developed similar to the one described for lentils. Samples of chickpeas are sieved in a stack of round hole sieves having hole diameter of 9, 8, 7 and 6 mm for

Table 8.5. Promising chickpea lines included in multi-location, on-farm or other national trials in different countries.

Country	Cultivar
Syria	ILC-72, -195, -202, -3279, -620, FLIP 82-64,FLIP 82-336
Jordan	ILC-484, -202
Lebanon	ILC-482, -484
Cyprus	ILC-3279
Egypt	ILC-249, -484, -1407, -2912
Sudan	ILC-1919
Tunisia	ILC-482, -484
Morocco	ILC-195, -482, -484
Pakistan	ILC -192, -195, -482
Canada	ILC-451, -464, -604
U.S.A	ILC-90, -102, -171, -232, 517, 650
North Africa	FLIP 80-1

one minute by hand. Grading is done based on the percent of total seeds retained above 8 mm sieve. Size distribution, as a test of uniformity, is also studied and its standard deviation is used to determine the grade. Samples having the largest standard deviation combined with high percentage of the seeds being retained over the 8.0 mm sieve are given highest grade. Using these criteria, the chickpea genetic stocks being developed in the breeding program will be evaluted in the coming seasons.

2.3. Insects and their Control :

2.3.1. Chickpeas have few insect problems in North Africa and West Asia region. The chickpea leafminer, *Liriomyza cicerina* Rond, and the *Heliothis* complex are the most important field pests in the region. In storage *Callosobruchus chinensis* L. is the predominant species. Study of the pest situation during the 1982/83 season revealed that in addition to leaf miner *Liriomyza cicerina* another leafminer, *Phytomyza atricornis* (?) was also present. Both reared on chickpea in the laboratory. The observation is important because this finding clarifies some previous obscure reports in the literature. A survey was then conducted in Syria and Jordan so as to ascertain the presence of more than one species of leafminer and the relative proportion in which they occur. The results (Table 8.6) showed that both species are found throughout Syria and Jordan, *L.cicerina* being most prevalent and accounting for approximately 90% of the total leafminer population. Parasitism by *Opius* was low, ranging from 0 to 3.5%. *Heliothis* infestation in Jordan and Southern Syria was higher than in North and Central Syria.

2.3.2. Chemical Control of Leafminer and Pod Borer :

Attempts were made again to study selective ways of controlling leafminer and pod borer. In a winter trial, low dosages of systemic and contact insecticides were compared with the bacteria *Bacillus thuringiensis* and the previously recommended endosulfan. Due to its inherent susceptibility to most insecticides, *Heliothis* was readily controlled by the organic pesticides tested; *Bacillus* did act selectively on *Heliothis* but it only provided 50% control of the pod borer (Table 8.7). Monocrotophos was the most efficient insecticide against both the leafminer and the pod borer and significantly increased yields by 20.9%.

Proper separation of leafminer and *Heliothis* damage was obtained by means of cages which acted as physical barriers to prevent pod borer oviposition and subsequent larval development. Through this device and the use of *Bacillus* in comparison with dimethoate and endosulfan, yield losses due to *Heliothis* damage in Northern Syria were estimated as being 3.0% (Table 8.8).

2.3.3. Economic Thresholds for Leafminer Control :

Rational use of chemicals for insect control requires the establishment of economic thresholds, that is to say the maximum pest level than can be tolerated before a control action should be taken in order to maximize net returns. The first attempt to establish such level was made during the past season. Spring-planted ILC-482 chickpeas were treated with endosulfan at different leafminer damage levels. Maximum yield increases occurred when the initial spray was done at 30% mining level (Table 8.9); this in turn reflected on maximum net returns. The economic threshold for a crop with these production levels is between 25 and 30% mining which, to be maintained, would require from two to three sprays. This level of larval damage coincided with the onset of the second generation of leafminer adults (a week before flowering). This suggested the possibility of establishing and action threshold for insecticide applications based upon simple adult counts. This will be studied in detail in the coming season.

2.3.4. To measure the levels of resistance detected so far, 18 materials of known reaction to leafminer attack were yield-tested under protected

Table 8.6. Leafminer incidence, leafminer parasitism by *Opius*, and *Heliothis* damage detected in surveys conducted in 54 chickpea fields in Syria and Jordan. May, 1983.

Location	Species composition		% parasitism by *Opius*	% pods damaged by *Heliothis*	
	Liriomyza	*Phytomyza*		Highest	Mean
Northern Syria	89.1	7.4	3.5	11.1	1.3
Southern Syria	93.8	3.3	2.9	31.8	6.4
Northern Jordan	95.6	1.5	2.8	16.4	5.8
Central Jordan	85.0	15.0	0	7.4	1.9
Tel Hadya (North Syria)	88.1	9.6	2.3	1.9	0.6

Table 8.7. Leafminer populations and damage, pod borer damage, and yields of winter - planted ILC 482 chickpea as affected by organic and bacterial insecticides (Tel Hadya, 1982/83 season).

Treatment	Dosage (kg a.i./ha)	Leafminer adults/ 10 sweeps[a)]		Leafminer damage	% pods damaged by *Heliothis*	Yield (kg/ha)	% yield increase
		Liriomyza	*Phytomyza*				
endosulfan	0.70	13.3	15.5	1.0	0.5	2913.3	4.6
Bacillus	1.50[b)]	28.3	22.5	8.0	2.0	2817.1	1.1
dimethoate	0.20	15.3	21.0	1.0	1.5	3102.7	11.4
phosphamidon	0.25	26.5	14.3	2.0	0.8	3043.6	9.3
monocrotophos	0.24	11.3	19.3	1.0	0.9	3366.9	20.9
check	-	30.8	27.0	8.5	4.0	2785.4	-
LSD 5%		13.8	7.8	1.2	1.1	432.2	-
CV (%) for yields = 9.5							

a) Average of 6 scoring dates

b) Commercial product, 3500 spores/mg.

Table 8.8. Yields and percent yield increases obtained in spring-planted (ILC-482) chickpea through differential control of leafminer and *Heliothis*.

Leafminer	*Heliothis* control	Through[a]	yield (kg/ha)	% yield increase
yes	yes	dimethoate	2642.8	13.0
yes	yes	endosulfan	2519.7	7.8
no	yes	cage	2412.9[b]	3.2
no	yes	*Bacillus*	2409.9	3.0
no	no	-	2338.1	-
LSD 5% for yields			176.3	
CV (%) for yields			8.9	

a) Dosages were as follows: dimethoate, 0.20kg a.i./ha, endosulfan, 0.70kg a.i./ha; *Bacillus*, 1.5 p.c./ha.

b) Corrected for cage effect.

Table 8.9. Effect of chemical protection at different levels of leafminer damage on the yields of spring-planted ILC-482 chickpeas (Tel Hadya, 1982/83 season).

Kind of protection	No. of sprays	yield (kg/ha)	% yield increase	Ranking for net benefit
Full	7	2135.7	15.1	4
at 15% mining level[a]	4	2156.6	16.2	3
at 30% mining level[a]	3	2207.2	18.9	1
at 25% mining level[b]	1	2058.6	10.9	2
never sprayed (check)	0	1855.7	-	5
LSD 5% for yields		286.0		
CV (%) for yields		9.0		

a) preflowering

b) pod setting

and non-protected conditions. Table 8.10 illustrates the performance of ten of these genotypes. Pod borer interference was minimal and thus it can be said that yield losses due to leafminer ranged from 3.9% to 23.1%, average for the 18 genotypes being 13.4%. Most materials behaved as expected, showing in some cases high levels of resistance. However, the rank correlation coefficient between visual damage scores and percent yield losses was low (r_s= 0.399; N.S.) suggesting that visual scores, while useful for mass screening purposes, do not by themselves predict yield losses. A case in point is the performance of ILC 3307. This lack of correlation between visual scores and percent yield losses has been found with other insects in several commodities. The alternative is to look for other parameters which might better explain yield and provide a clue as to possible mechanisms of resistnace. Preliminary observations suggested that the rate of defoliation due to leafminer damage might be one such parameter. It was found for example that the most susceptible material (ILC 2512) lost 2.2 times more leaflets due to insect damage than the most resistant material (ILC 726). These studies on the mechanisms of resistance will be continued next season. Simultaneously, a limited breeding program will be initiated with the resistance sources identified so far.

2.4. Production Agronomy :

The advantage of advancing the planting dates into winter as compared to spring planting was evaluated at Terbol and, in coopera-tion with the Agricultural Research Centre of Syria, at Gellien. Plant populations were also varied to determine the optimum date and population combination. Results (Fig. 8.1) showed that advancing the date of planting from spring (March planting) to late winter (December planting) resulted in significant increase in seed yield. Advancing the sowing to early winter from late winter did not register any further advantage because of very cold winters this season (Table 5.4). Increase in the population level increased yield, the yield being maximized at the highest population level of 33.3 plant/m^2.

Table 8.10. Visual damage scores, protected and non-protected yields and comparative yield losses in chickpea cultivars selected for varying degrees of resistance to the leafminer. Means of four replicates.

Cultivar	Visual damage scores		Yields (kg/ha)		% yield loss
	1981/82	1982/83	Protected	Non-protected	
ILC 726	3	3	1803.1	1733.3	3.9
2319	5	5	1670.4	1578.6	5.5
3350	3	3	1673.0	1555.3	7.0
2618	3	5	2051.4	1826.6	10.9
3307	9	9	2103.4	1995.4	5.1
2512	9	9	1966.9	1512.3	23.1
2993	9	9	1598.7	1263.8	21.0
482	7	9	2036.1	1612.0	20.8
562	9	9	2136.1	1709.0	20.0
Local	7	9	2122.5	1923.1	9.4
	LSD 5% for yields		160.8	211.9	
	CV (%) for yields		17.0	12.0	

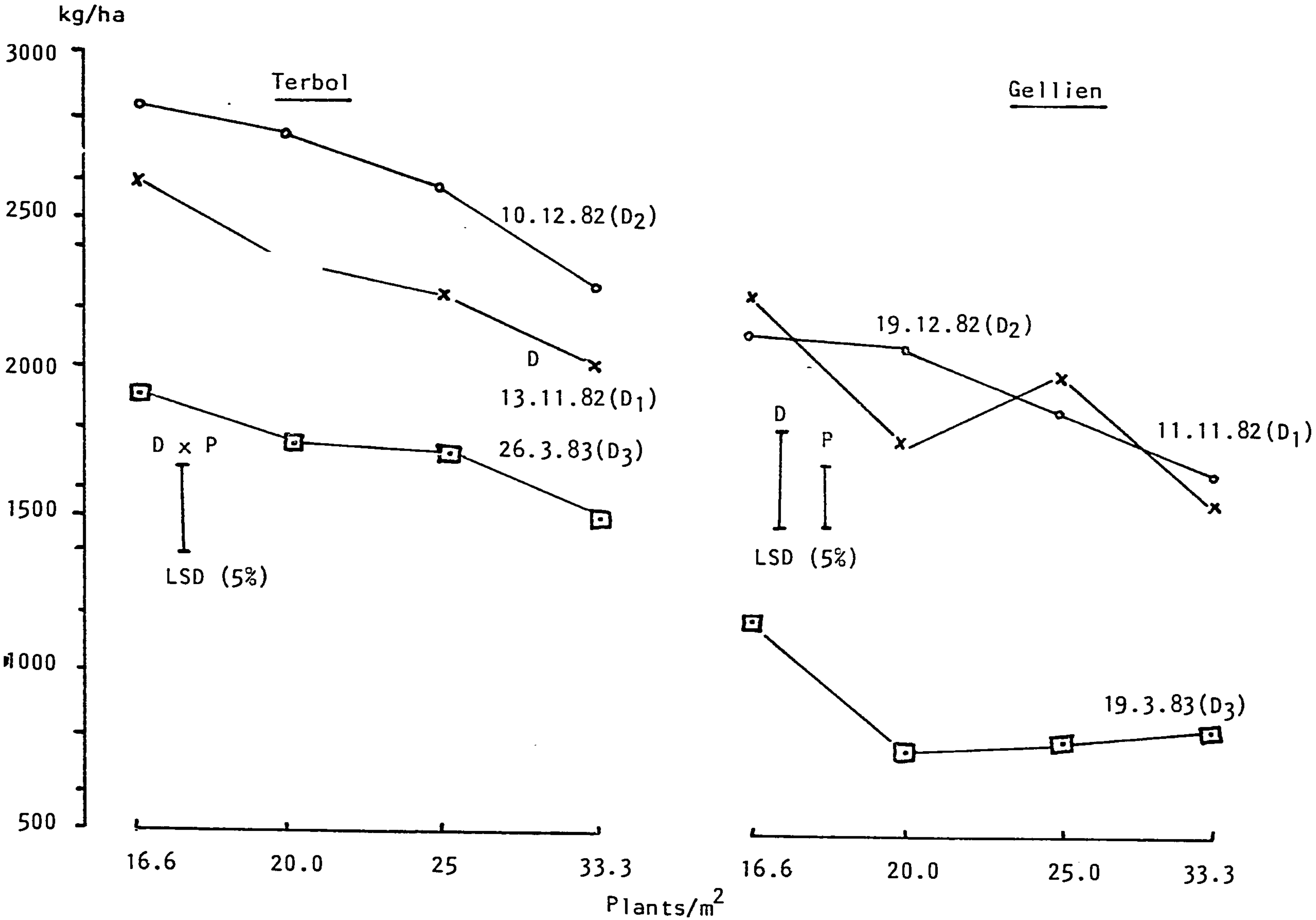


Fig. 8.1. Response of ILC 482 chickpea to date of planting (D) and plant population (P) at Terbol, Lebanon and Gellien, Syria 1982/83.

9. CHICKPEA PROJECT 2 : Development of Improved Kabuli Chickpea Cultivars and Production Technology for Winter Sowing.

1. Objectives :

1.1. To develop high and stable yielding, cold tolerant, ascochyta blight resistant cultivars and genetic stocks of kabuli chickpeas adapted to winter sowing in areas of the Mediterranean region where the crop is presently spring sown and where the climatic conditions are such as to permit winter sowing.

1.2. To develop appropriate agronomic practices and plant protection measures for existing and improved cultivars for winter planting.

2. Research Highlights :

2.1. Development of Genetic Stocks and Cultivars :

Since a prerequisite for success with winter sowing is tolerance to cold and resistance to ascochyta blight, efforts continued for screening germplasm and genetic stocks for these attributes.

2.1.1. Screening for Cold Tolerance :

In an attempt to develop suitable field screening technique for cold tolerance, a set of genotypes ranging from highly resistant to highly susceptible were sown on nine dates starting on 23 October 1982 and ending on 9 March 1983. Fifty three nights had sub-zero temperature during 1982/83 (Table 5.4). The cold injury was observed only in first four sowings but more reliable results were obtained from the first date of sowing. Data for cold tolerance was recorded when susceptible check was completely killed. Advancing sowing dates induces more crop growth and more exposure to cold and thus more reliable for screening for cold tolerance as compared to late sowings.

In the 1982/83 season, promising cold tolerant kabuli lines identified during 1981/82 were sown on 23 October 1982 for rescreening of cold tolerance. Ten lines were found to be highly tolerant (Fig. 9.1). These lines are ILC-666, -668, -1071, -2487, -2505, -3081, -3287, -3470, -3598 and -3789.

2.1.2. Screening for Ascochyta Blight Resistance :

Breeder and pathologist collaborated in screening a large amount of germplasm and breeding material for ascochyta blight resistance spread over an area of 8.5 ha. All the materials were tested against a mixture of four races (races 1, 2, 3 and 4) and the resistance both in the vegetative and podding stages was considered. None of the 468 new kabuli germplasm accessions screened was found resistant. The resistance and tolerance of 17 and 34 germplasm lines, respectively, was confirmed in Syria. A total of 8921 breeding lines/populations were screened for resistance against blight to enable selection of resistant material (Table 9.1).

A large scale screening of the germplasm in the plastic house against the most virulent race of *Ascochyta rabiei* (race 6) helped in the identification of five resistant (ILC 187, 202, ICC 3996, 6988 and Pch 128) and 7 tolerant (ILC 193, 3346, ICC 3840, 3969, 4324, 4475 and 6981) lines.

As the original germplasm sources of resistance to ascochyta blight, such as ILC 72 and ILC 202, have small and intermediate type of seeds and are late maturing, the ascochyta blight resistance has been transferred into good agronomy background with acceptable seed size and typical kabuli seed type, reduced photoperiod sensitivity, etc. (Table 9.2).

Through the Chickpea International Ascochyta Blight Nursery (CIABN-83), 50 lines including kabuli and desi type germplasm accessions and kabuli lines developed through hybridization at ICARDA were tested in blight endemic countries in the region to identify blight

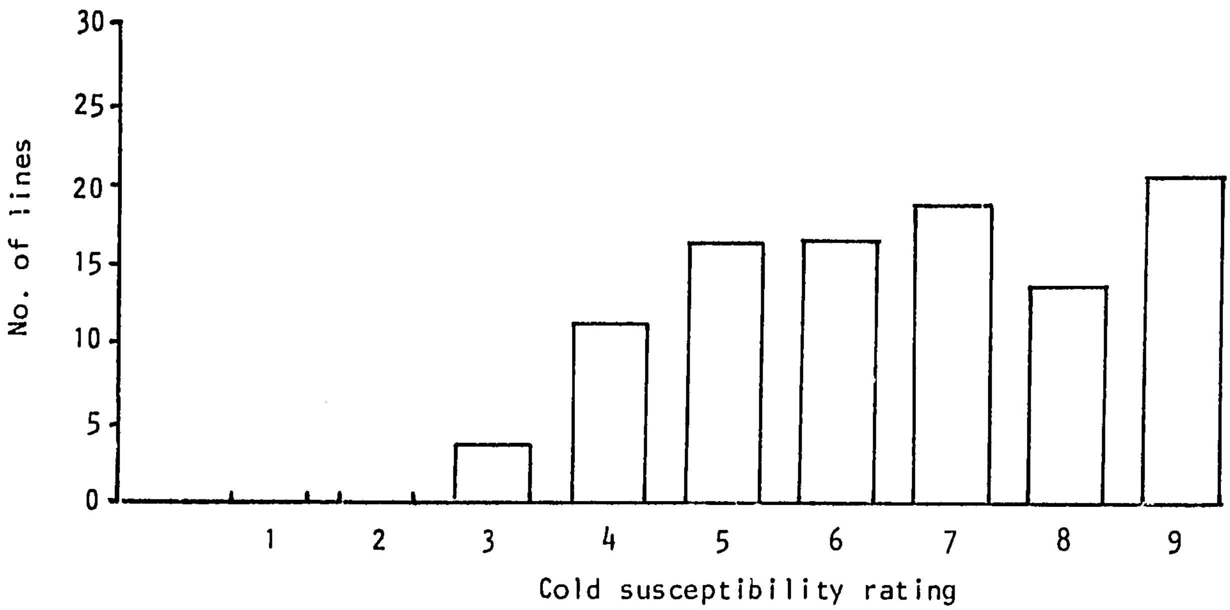


Fig. 9.1. Reaction of promising chickpea lines to cold tolerance at Tel Hadya, 1982/83. Rating scale : 1 = no cold injury; 9 = complete kill.

Table 9.1. List of different breeding materials tested against ascochyta blight during 1982/83 season.

S.No.	Type of materials/testes	No. of entries tested
	Tel Hadya	
1	International yield trials	44
2	Advanced and preliminary yield trials	348
3	Genetics of resistance F_3 progenies	607
4	F_2 populations	631
5	F_3 progeny rows	2310
6	F_4 progeny rows	1212
7	F_5 progeny rows	2167
8	F_6 progeny rows	708
9	F_7 progeny rows	546
10	Large seeded F_4-F_7 progeny rows	126
11	Tall F_5-F_7 progenies	90
	Lattakia	
1	International yield trials	12
2	Advanced yield trials	120

All the yield trials were replicated.

resistant lines in different countries. The lines included are those found resistant at ICARDA for at least past two seasons. A total of 40 sets of this nursery have been distributed and a detailed report will be prepared when results from all the locations are obtained.

2.1.3. Resistance to *Orobanche*:

Orobanche infestation has been observed and it might become a problem in winter sown chickpeas. A total of 504 lines were screened for resistance to *Orobanche* during the 1981/82 season in a naturally infested field and 72 lines were found promising. These were rescreened during 1982/83 and 11 lines showed highly resistant reactions (Table 9.3).

2.1.4. Yield Potential :

Two hundred seventy three newly bred lines were evaluated for yield and adaptation in 5 AYTs and 8 PYTs at Tel Hadya. Three checks, namely ILC 482, a released cultivar for winter sowing in Syria, ILC 1929, a land race grown in spring, and ILC 3279, a tall and ascochyta blight and cold tolerant line , were included in each trial of 24 entries for comparison. A total of 242, 152, and 273 entries exceeded, ILC 482, ILC 3279 and ILC 1929 (Table 9.4). ILC 1929, being susceptible to ascochyta blight, was killed. The highest yielding entries generally produced between 2500 and 3000 kg/ha and exceeded ILC 482 by a margin of 50-12%. At Terbol 189 FLIP lines were tested in 5 AYTs and 4 PYTs against the same three checks. A total of 56, 53 and 62 entries exceeded ILC 482, ILC 3279 and ILC 1929 (Table 9.5). The highest yielding entries produced between 2732 and 3653 kg/ha.

Three highest yielding entries in Advanced Yield Trials at Tel Hadya and Terbol are shown in Table 9.6 along with reaction to ascochyta blight and cold. The results are clear indications of positive gain in yield through breeding. In every trial the top three ranks were occupied by the newly bred FLIP entries. The yield levels were generally over 2500 kg/ha in a year which is considered

Table 9.2. Comparison of plant height, seed type, seed size and days to 50% flowering of some ascochyta blight resistance germplasm accessions and genetic stocks developed through hybridization.

S.N.	Genetic stock/ germplasm lines	Ascochyta blight reaction*	Plant height (cm)	Seed type	Seed size	Days to 50% flowering
1	FLIP 82-64 (ILC80xILC72)x ILC263	HR	58	K	34.2	149
2	FLIP 82-65 (ILC72xILC1922)	HR	52	K	35.3	147
3	FLIP 82-73 (ILC1919xILC202)	R	54	K	31.7	143
4	ILC 72	HR	50	I		147
5	ILC -202	HR	57	I	27.7	147

* R = Resistant, HR = Highly resistant.

Table 9.3. Reaction of 12 chickpea accessions to *Orobanche* at Kafr Antoon, 1981-82 and 1982-83.

Entry	Shoots/plant	
	1981-82 a/	1982-83 b/
ILC 280	0.0	0.0
ILC 348	0.0	0.0
ILC 4074	0.0	0.1
ILC 613	0.0	0.2
ICC 205	0.0	0.2
FLIP 81-293	0.0	0.2
ICC 170	0.0	0.2
ICC 192	0.0	0.2
FLIP 81-61	-	0.2
ILC 229	0.0	0.2
ILC 351	0.0	0.3
Susceptible check	-	1.7

a/ average of 3 replications

b/ average of six replications

Table 9.4. The number of chickpea test entries exceeding the yield (kg/ha) of check in AYT,PYT during winter at Tel-Hadya, 1982-83.

Trial	No. of test entries exceeding check			Highest yield of test entries	Percent of check		C.V.%
	ILC 482	ILC 3279	ILC 1929[a/]		ILC482	ILC3279	
AYT-1	21	11	21	2610	166	117	16.3
AYT-2	21	14	21	2312	164	126	17.0
AYT-3	21	15	21	2407	202	129	17.5
AYT-4	19	6	21	2629	150	109	15.3
AYT-5	21	7	21	2460	184	109	12.4
PYT-1	21	20	21	2967	221	158	19.3
PYT-2	14	17	21	2597	146	166	21.1
PYT-3	19	4	21	2825	169	115	17.6
PYT-4	10	5	21	2081	119	111	17.9
PYT-5	19	10	21	2553	191	129	24.3
PYT-6	21	13	21	2803	202	130	19.7
PYT-7	15	13	21	2806	157	150	14.0
PYT-8	20	17	21	2600	152	127	18.9

a/ ILC 1929 was killed in all the trials.

Table 9.5. The number of chickpea test entries exceeding the yield (kg/ha) of check in AYT and PYT during winter at Terbol, 1982-83.

Trial	No. of test entries exceeding check			Highest yield of test entries	Percent of check			C.V.%
	ILC 482	ILC 3279	ILC 1929		ILC482	ILC3279	ILC1929	
AYT-1	12	5	11	2732	117	107	115	20.4
AYT-2	2	6	6	2881	106	112	111	17.0
AYT-3	1	1	9	2810	100	107	118	14.99
AYT-4	1	6	1	3167	100	109	103	9.4
AYT-5	3	8	10	2841	109	116	121	17.0
PYT-1	15	8	9	3069	128	105	105	13.0
PYT-2	7	4	9	3653	123	119	128	15.0
PYT-3	14	10	7	3500	120	115	112	14.0
PYT-4	1	5	-	3486	103	112	99	13.4

to be one of coldest in the last 50 years. Most of the new lines had a higher level of resistance to ascochyta blight and cold than ILC 482.

The 1982/83 season was the first year when nearly 300 newly bred lines were evaluated during winter and spring and at Tel Hadya and Terbol. The results clearly indicated an impressive progress in cultivar development for winter sowing as far as yield and resistance to cold and ascochyta blight is concerned.

2.1.5. <u>Yield Grain in Tall Types</u>:

An Advanced Yield Trial-Tall was conducted with 21 newly bred FLIP entries and 3 checks, ILC 482, ILC 3279 and ILC 1929 during winter and spring. Nine entries produced higher yield than the tall check ILC 3279 and the highest yielding entries produced 121% of the check (Table 9.7). Of the 21 test entries only 3 were tall and the remaining were mid-tall. FLIP 82-73 was the only one which was tall, true kabuli and with 36 g/100-seed weight and resistance to ascochyta blight. This lines has been produced after making over 200 crosses in the last six years. It will be exploited fully at ICARDA for producing better tall genotypes.

Notwithstanding the quality of seed, the tall type ILC 3279 n Syria and Cyprus and ILC 202 in Jordan are in final stages of testing and might be released as cultivars.

2.2. <u>On-farm Trials with Winter Sowing</u> :

2.2.1. The on-farm trials were jointly conducted by ICARDA and the Agricultural Research Centre of the Ministry of Agriculture and Agrarian Reform, Syria at 24 locations during 1982/83. Three genotypes, namely ILC 195, ILC 202 and ILC 3279 were tested against ILC 482 during winter and four genotypes, namely ILC 195, ILC 202, ILC 482 and ILC 3279,

Table 9.6. Three highest yielding entries of chickpea in AYT during winter at Tel-Hadya (T.H.) and Terbol (Tr.), 1982/83.

Trial/Entries	Yield kg/ha				Evaluation at Tel Hadya		
					A.B.[a]		Cold Toler.[b]
	T.H.	Tr.	Mean	Rank	Veg.	Pod	
AYT-1							
FLIP 81-3	2552	2536	2544	1	2	4	2.3
81-4	2610	2411	2511	2	2	5	2.3
81-11	2424	2577	2501	3	2	5	2.3
ILC 882	1568	2335	1952	23	3	7	2.8
ILC 3279	2235	2542	2389	8	3	2	2.3
ILC 1929	0	2375	1188	24	9	-	5.3
AYT-2							
FLIP 81-293	2033	2863	2448	1	2	3	2.5
FLIP 81-359	1888	2881	2385	2	2	5	2.3
FLIP 81-304	2298	2446	2372	3	2	3	2.8
ILC 482	1406	2720	2063	20	3	7	3.5
ILC 3279	1830	2571	2201	13	3	2	3.0
ILC 1929	0	2589	1295	24	-	-	4.5
AYT-3							
FLIP 82-20	2407	2810	2609	1	4	5	2.5
82-7	2342	2601	2472	2	2	6	2.0
82-17	2310	2411	2361	3	2	3	3.0
ILC 481	1194	2804	1999	20	3	7	3.5
ILC 3279	1862	2637	2250	7	3	2	2.8
ILC 1929	0	2381	1191	24	-	-	4.8
AYT-4							
FLIP 82-29	2624	2929	2777	1	2	5	2.5
82-32	2376	3060	2718	2	2	5	3.0
82-30	2390	3024	2707	3	2	5	3.0
ILC 482	1758	3155	2457	15	3	7	3.3
ILC 3219	2408	2911	2660	5	3	2	2.8
ILC 1929	0	3089	1545	24	-	-	5.5

Continuation Table 12...

Table 9.6. (Continuation)

Trial/Entries	Yield kg/ha				Evaluation at Tel Hadya A.B.[a/]		Cold[b/] Tolerance
	T.H	Tr.	Mean	Rank	Veg.	Pod	
AYT-5							
FLIP 82-53	2406	2841	2641	1	2	5	3.0
82-62	2110	2786	2448	2	4	3	2.7
82.57	2195	2643	2419	3	2	5	3.0
ILC 482	1335	2603	1969	22	3	7	3.7
ILC 3279	2248	2444	2346	6	3	2	3.0
ILC 1929	0	2349	1175	24	-	-	5.7

The underlined figures were in the top significant group.

a/ AB=Ascochyta blight rating on 1-9 sclae , where 1 is free and 9, dead.

b/ Cold tolerance evaluated on 1-9, scale,where 1 is free and 9, dead.

Table 9.7. The number of chickpea test entries exceeding yield(kg/ha) of check in AYT-T during winter and spring at Tel Hadya, 1982/83.

Trial	No. of test entries exceeding check			Highest yield of test entries	Percent of check			C.V.%
	ILC 482	ILC3279	ILC 1929		ILC482	ILC3279	ILC1929	
AYT-T(W)	21	9	21	2313	184	121	-	17.3
	ILC 482	ILC263	ILC 1929		ILC482	ILC263	ILC1929	
AYT-T(S)	7	-	-	1513	117	97	85	15.6

were tested against Syrian land race during spring. The results are summarized in Table 9.8. ILC 482 produced the highest yield both during winter season (2018 kg/ha) and spring season (1367 kg/ha). Thus no genotype was found superior to ILC 482 which is a recommended cultivar for winter sowing in Syria.

ILC 3279 finished second with a yield of 1647 kg/ha. It has better level of resistance for ascochyta blight and cold than ILC 482. Being 50% taller than ILC 482 it is more suited for mechanical harvesting, and thus has a special appeal to the farmers. In the on-farm trial for two years it produced 1640 kg/ha average grain yield and ranked first (Table 9.9). The Ministry of Agriculture has identified this as a promising cultivar and would consider its release after one more year's of testing. In anticipation of release, they have asked ICARDA to increase its seed.

2.2.2. The on-farm trials on winter sowing were also conducted in Jordan and Morocco national programs and the results are reported to be promising.

2.3. Diseases and their Control :

2.3.1. Survey of Diseases :

Survey of diseases on chickpeas was made in Syria, Jordan and Tunisia. In winter sown chickpeas in Syria, ascochyta blight was the major disease. Plants showing the symptoms of stunt (pea leaf roll virus) and bean yellow mosaic were also observed, the incidence of the latter being much higher this year than in the earlier 3 years. The incidence of root knot, cyst and *Pratylenchus* nematodes was also observed. In Jordan, ascochyta was serious but some plants affected by stunt and other viral diseases were also observed. At Amshaqar research station, symptoms of *Pratylenchus* damage were also seen. In Tunisia wilt *(Fusarium oxysporum)* was the major disease, followed by stunt. Because of dry weather, ascochyta blight was not present on farmers fields.

Table 9.8. Mean performance of chickpea cultivars in the on-farm trial in Syria during the winter and spring seasons, 1982/83.

Cultivar	Yiel (kg/ha)[1]		Percent increase of winter yields	
	Winter	Spring	Over spring	Over Syr. local
ILC 195	1616	1001	62	48
ILC 202	1586	1023	55	45
ILC 402	2018	1367	48	85
ILC 3279	1647	1074	53	51
ILC 1929 (Check)	Not sown	1092	-	-

1/ Average of 24 locations.

Table 9.9. Yield performance (kg/ha) of the chickpea cultivar ILC 3279 in the on-farm trials conducted in Syria during 1981/82 and 1982/83.

Year	Winter				Spring				
	ILC					ILC			
	195	202	482	3279	Local	482	195	202	3279
1981-82 1/	1256	1608	1128	1632	259	806	-	-	
1982-83 2/	1616	1586	2018	1647	1092	1367	1001	1023	1074
Mean	1436	1597	1573	1640	676	1087	1001 a/	1023 a/	1074 a/

1/ Average of 3 locations

2/ Average of 24 locations

a/ Only one year result

2.3.2. Studies on *Ascochyta rabiei* :

Fifty samples of chickpeas affected by blight were collected from all over Syria and fungal isolates were studied for cultural and morphological characters and growth rates. Using a set of 18 differential genotypes attempt was made to identify the variability present in the fungus. The population was found to comprise of six physiologic races (Table 9.10). The less virulent races (races 1, 2 and 3) were prevalent in the farmers' fields whereas more virulent races (races 4, 5 and 6) were detected in the experimental sites only. The isolates while accumulating genes for virulence were found to lose their sporulating ability. Many lines when infected by matching virulent isolates showed considerable residual effects of the defeated resistant genes.

A cooperative project with the University of Reading, UK, continued to look at the pathogenic variation in isolates of *A.rabiei* obtained from throughout the chickpea growing regions.

A field experiment to study the blight development in relation to temperature and relative humidity showed that between the mean relative humidity levels of 51.5 and 84.4%, the minimum and maximum temperatures were critical. Blight started to increase rapidly only when minimum and maximum temperatures rose above 5 and 15°C, respectively and the mean temperature was above 15°C (Fig. 9.2). Providing 100% relative humidity (RH) inoculation with ascochyta blight continuousl for 2 days only was found enough for killing a susceptible cultivar at 15-20°C. A minimum period of 100% RH for at least 4 hrs was needed for infection to occur in susceptible genotype at a temperature of 15 to 25°C. Experiment under controlled conditions revealed that with race 3 of *A.rabiei* the incubation period was least (2 days) at 25°C and maximum (10 days) at 10°C. The maximum disease development and sporulation of fungus were recorded at 20°C.

Table 9.10. Reaction of a set of 18 differential varieties of chickpea to 6 races of *Ascochyta rabiei*.

Differential variety of chickpea	Blight reaction					
	Race 1	Race 2	Race 3	Race 4	Race 5	Race 6
ILC -72	R	T	T	R	T	S
-182	T	S	T	T	S	S
-191	T	S	S	S	S	S
-194	R	R	T	T	T	S
-200	R	T	T	T	T	S
-215	R	R	R	S	S	S
-249	R	R	R	S	S	S
-482	R	R	R	T	S	S
-484	R	T	S	S	S	S
-1929	S	S	S	S	S	S
-3279	R	R	R	R	S	S
ICC-1591	R	T	S	T	T	S
-1903	R	R	S	S	S	S
-2232	T	S	S	S	S	S
-3996	R	R	R	R	R	S
-4107	R	R	R	T	T	S
C -235	R	T	R	S	S	S
F -8	R	S	S	S	S	S

R = Resistant, T = Tolerant, S = Susceptible.

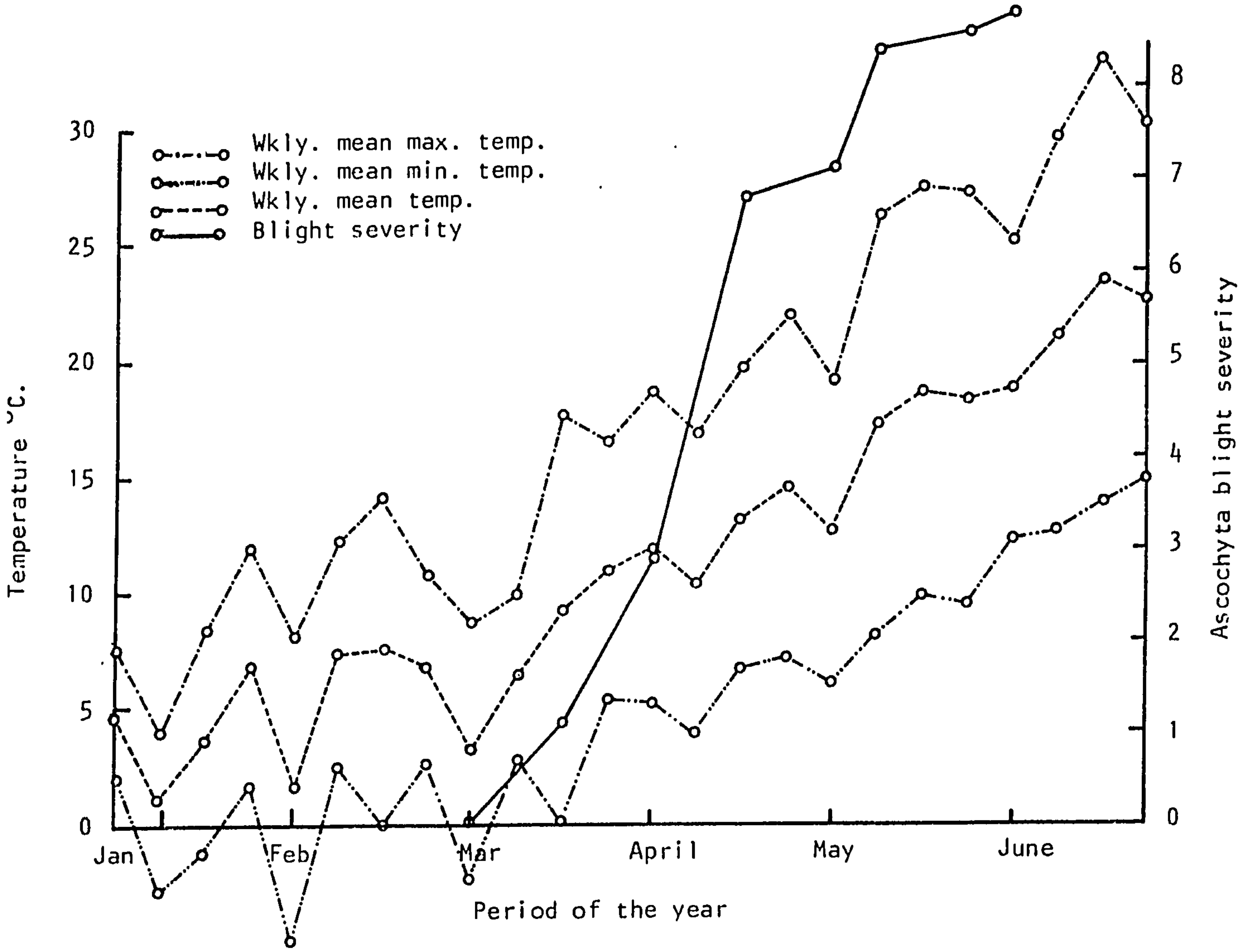


Fig. 9.2. Development of ascochyta blight of chickpea in relation to temperature and relative humidity during 1983.

Attempts to locate or induce the perfect stage of the ascochyta blight pathogen, *Mycosphaerella rabiei* did not succeed.

2.3.3. Chemical Control of Ascochyta Blight :

One foliar application of chlorothalonil (Bravo 500) during early podding stage of a cultivar with good level of vegetative resistance but poor pod resistance gave good control of pod infection of ascochyta blight.

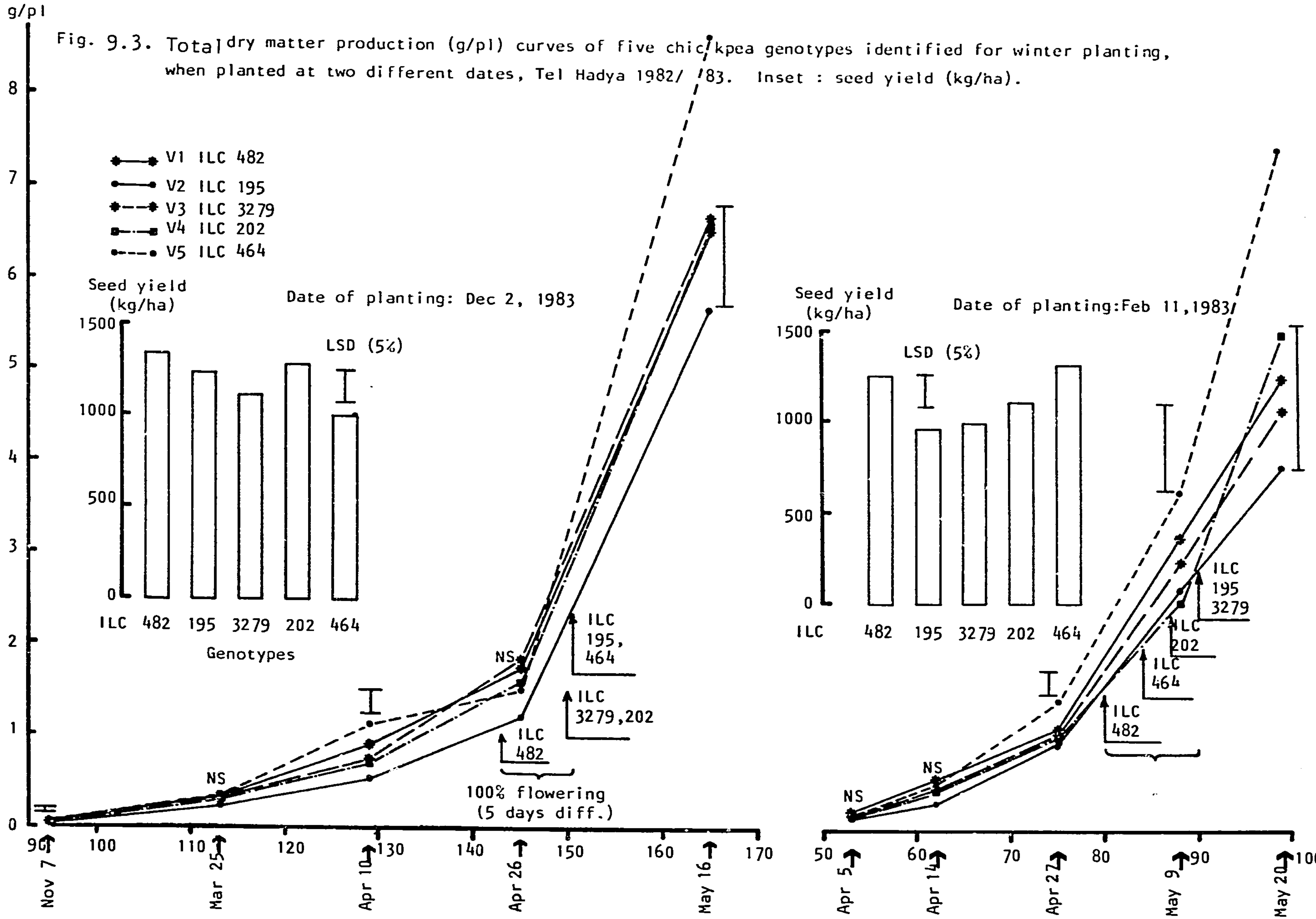
For eradicating the seed borne infection of *A.rabiei*, seed dressing with thiabendazole (Tecto 60) was more effective than calixin M. Even at higher doses Tecto did not have any phytotoxic effect.

2.4. Production Agronomy :

2.4.1. Planting Date :

A study to examine growth and yield response of five new chickpea genotypes of diverse growth habits and seed type to winter vs spring sowing was started in the 1981/82 season. During the 1982/83 season, it was repeated using only 2 dates of sowing (December 2 and February 11). The seed and the total biological yield of the conventional (ILC 482) and tall winter (ILC 135, 202 and 3279) type chickpeas were higher with December than with February sowing although the differences were of smaller magnitude than in the previous year. The total biological yield of the large seeded genotype (ILC 464) was not affected by sowing date and the seed yield was decreased in December sowing in contrast to the February sowing. The higher susceptibility of ILC 464 to frost was probably the main reason for this difference. The total dry matter production per plant in relation to crop age, however, confirmed the pattern obtained last year: the large seeded chickpea (ILC 464) had higher total dry matter per plant than the other genotypes (Fig. 9.3), the difference being particularly conspicuous

Fig. 9.3. Total dry matter production (g/pl) curves of five chickpea genotypes identified for winter planting, when planted at two different dates, Tel Hadya 1982/83. Inset : seed yield (kg/ha).



in February sowing. This growth difference also reflected in the highest yield of ILC 464 in February sowing.

2.4.2. Plant Population and Planting Geometry :

The effect of plant population (30, 50 and 75 plants/m^2) and planting geometry (1:1, 1:2, 1:3) was studied using a conventional type (ILC 482) and a tall type (ILC 3279) chickpea (Fig. 9.4). In case of ILC 482 1:1 planting geometry was superior to rectangular geometry (1:2 or 1:3), particularly at lowest population level (30 plants/m^2). But when population was raised to 75 plants/m^2 the seed yield was highest and the differences in planting geometry were not significant. In the tall type rectangular geometry of 1:2 proportion was better and significantly superior to 1:1 geometry particularly at highest population (75 plants/m^2) which resulted in the highest yield (Fig. 9.4).

2.4.3. Residue Management and Phosphate Application :

Incorporation or burning of the residues of preceding cereal crop had no effect on the performance of winter sown ILC 482 chickpea (Table 9.10). Placement of 50 kg P_2O_5 per ha as triple super phosphate either along with seed or 5 cm below the seed resulted in significant increase in yield when compared to either broadcast application or no phosphate control. The available soil phosphorus in top 15 cm soil layer in this trial ranged from 1.3 to 1.5 ppm P.

The nitrogenase enzyme activity of the root system was studied on 31 March and 24 April, when the growth differences due to phosphate application started to become conspicuous. The data revealed that the nitrogenase activity increased because of placement of phosphate below the seed (Table 9.11).

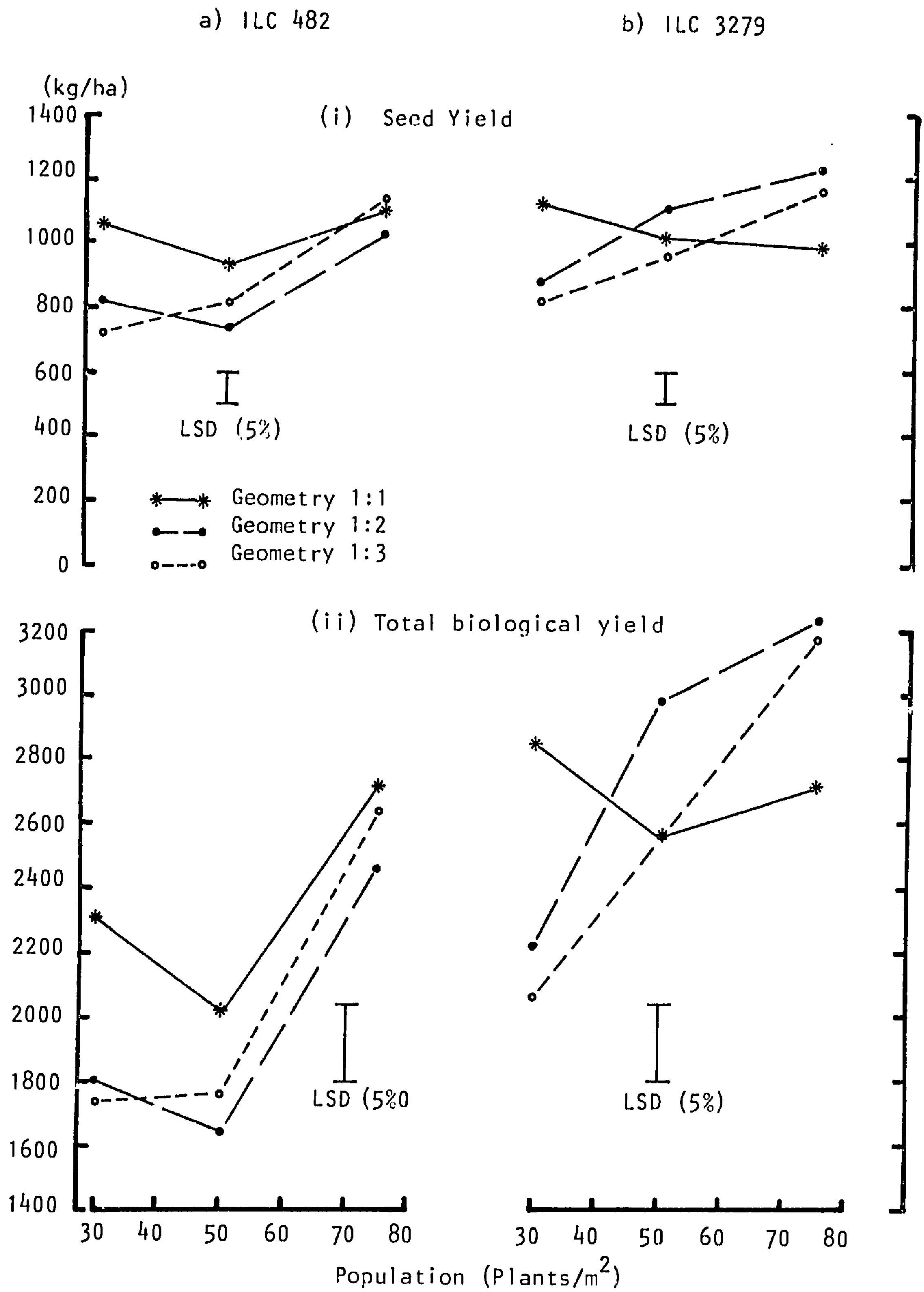


Fig. 9.4. Total biological yield (kg/ha) and seed yield (kg/ha) of ILC 482 and ILC 3279 as affected by plant population and planting genometry, Tel Hadya 1982/83.

Table 9.10. Total recoverable biological yield (TBY, kg/ha) and seed yield (SY, kg/ha) of ILC 482 as affected by different methods of applying P-fertilizer and by different methods of straw management of the previous wheat crop - Tel Hadya, 1982/83.

Phosphate Treatment (P)	TBY			SY		
	Straw incorporated	Straw burnt	P-means	Straw incorporated	Straw burnt	P-means
T - Control	5575	4767	5171	2689	2527	2608
T - 50 kg/ha P_2O_5 broadcasted	5724	5538	5631	2862	2878	2870
T - 50 kg/ha P_2O_5 deep placed	6610	6750	6680	3602	3398	3500
T - 50 kg/ha P_2O_5 mixed with seeds	6460	5902	6181	3290	3062	3176
Straw management mean (B)	6092	5739		3111	2966	
LSD at 5% for	B=NS, P=788, P in B=1114			B= NS, P= 348, P in B = 492		
CV (%) for	main plot(B)=8.1, sub plot (P)=12.7			B=6.9, P= 10.9		

Table 9.11. Nitrogenase activity (μmoles ml^{-1} plant^{-1}) in ILC 482 as affected by different methods of applying P-fertilizer and by different methods of straw management of the previous wheat crop - Tel Hadya, 1982/83.

Phosphate Treatment (P)	μ moles ml^{-1} plant hr^{-1}					
	at 100% flowering			at pod felling stage		
	Straw incorporated	Straw burnt	means for P.	Straw incorporated	Straw burnt	means for P.
Control	4.62±2.30*	5.42±5.76	5.02	33.17±11.29	29.66±11.92	31.42
50 kg/ha P 0 broadcasted	11.18±2.70	6.43±3.38	8.81	28.21± 9.20	22.62±15.08	25.42
50 kg/ha P 0 deep placed	8.42±7.66	15.44±2.75	11.93	62.19± 7.14	50.63± 7.13	56.41
50 kg/ha P 0 mixed with seeds	12.85±5.04	4.90±0.91	8.88	45.34±16.00	27.18±13.05	36.26
Straw management mean (B)	9.27	8.05		42.23	32.52	

* Results are based on means of 18 plants.

2.5. Weed Control :

Importance of controlling the weeds in winter sown crop was evident from the fact that weedy check plots yielded 28.6, 61.9, 62.8 and 76.2% of the yields obtained under weed free conditions at Tel Hadya, Terbol, Jinderis and Prison Farm respectively. Pre-emergence application of cyanazine @ 1.0 kg a.i. per ha proved very effective in controlling weeds and increasing yield at Jinderis and Prison Farm and chlorobromuron @ 1.5 kg a.i./ha at Tel Hadya. Terbutryne @ 3.0 kg a.i./ha proved promising at Terbol.

10. PROJECT : Role of Food Legumes in Dry Land Agriculture.

1. Objectives :

1.1. To estimate the symbiotic nitrogen fixation by different grain legumes in a rainfed two course rotation with cereals (wheat).

1.2. To evaluate the residual effect of preceding legume on the productivity of wheat as compared to 'fallow' or wheat in the preceding season.

2. Research Highlights :

2.1. Studies on this aspect have been conducted in the program since 1978/79 season. Results have consistently shown that a well managed legume crop not only gives high protein yield but also benefits the following cereal crop such that cereal following legume yields nearly the same as a cereal crop following fallow and significantly higher than the yield of cereal following cereal. In the final cycle of this trial, legumes were again planted during 1982/83 to study their residual effect during the 1983/84 season.

2.2. The production of dry matter, seed yield and total nitrogen yield under different treatments is shown in Table 10.1. Carbofuran application marginally improved the lentil seed yield but improved straw yield by 16.8%. Sowing chickpea in winter in contrast to spring increased straw and grain yield by a margine of 59 and 27% respectively. These drymatter increases were also reflected in total nitrogen yields from these crops.

2.3. Highest nitrogen yields were obtained from lentil followed by those from peas, and faba beans and winter sown chickpeas (Table 10.1). Spring chickpea gave the lowest nitrogen yield. An estimate of N derived from symbiotic fixation was obtained by difference method: deducting the nitrogen yield of wheat fertilized with 20 kg N/ha

Table 10.1. Straw, grain and total recoverable biological yield, total nitrogen yield and yield of nitrogen derived from fixation (as estimated by 'difference' method) for different legumes grown rainfed at Tel Hadya during 1982/83 season.

Treatments[1)]	Yield (kg/ha)			Total N yield (kg/ha)	N fixation kg/ha (by difference method)
	Straw	Grain	Total		
1. Lentil (ILL 4401)	4457	1876	6333	120.3	88.0
2. Lentil with carbofuran (1.5 kg a.i./ha)	5206	1887	7092	131.6	99.3
3. Winter sown chickpea (WCP)	2305	1884	4189	63.4	31.1
4. Spring sown chickpea	1450	1477	2927	48.6	16.3
5. Faba bean (ILB 1814)	1306	1809	3115	81.2	48.9
6. Peas (Local)	3469	1518	4987	81.4	49.1
7. WCP intercropped with wheat[2)]	2791	1301	4091	43.6	11.3
8. WCP intercropped with barley[2)]	2867	1954	4721	44.3	12.0
9. Wheat	4588	1055	5643	32.3	-
10. Wheat with 60 kg N/ha	8146	1426	9572	65.5	-
CV (%)	15.0	12.0	11.0	13.8	
LSD 5%	813	279	861	14.2	

1) Crops in all the treatments received 46 kg P_2O_5/ha. Treatments 1-9 received 20 kg N/ha.
2) The yield data are total of chickpea and cereal yields.

from that of the legumes which were also fertilized with 20 kg N/ha. Amongst the pure legumes maximum 'fixation' was obtained in case of lentil and minmum in case of spring chickpea. Of-course the value of 'fixed nitrogen' in case of inter-cropped treatments with winter chickpea was lower than for the pure spring chickpea.

2.4. During 1983/84 season, the residual effect of the legume treatments of the 1982/83 season will be studied at three rates of directly applied nitrogen (0, 30 and 60 kg N/ha). At the 30 kg N/ha level, the estimate of nitrogen enrichment of soil from previous season legumes will be made using N^{15} dilution technique.

11. PROJECT : International Cooperation on the Improvement of Faba Beans, Lentils and Kabuli Chickpeas.

1. Objectives :

1.1. To provide for the widespread dissemination of :

a) elite lines that could have potential as cultivars in West Asia,

b) a range of genetic stocks to other regions for identification and utilisation of the best adapted stocks by national programs,

c) early generation segregating populations for selection under local conditions,

d) material exhibiting special characteristics for evaluation and testing under local conditions.

1.2. To conduct multi-location testing of elite material and thus examine genotypic performance across a range of environments and allow the identification of genotypes having wide adaptability.

1.3. To characterise the major environments in which food legumes are grown.

1.4. To obtain information on agronomic factors which limit crop growth in different regions.

2. Highlights :

2.1. Distribution :

To strengthen the food legume programs at the national level, ICARDA has been playing an important role by distributing the early generation segregating materials, the advanced breeding lines, the improved cultivars and various agronomic trials in the form of international nurseries. The nurseries on kabuli chickpeas were distributed in collaboration with ICRISAT.

A total of 925 sets of 34 different types of nurseries of the three legumes were sent to national programs in more than 40 countries for the 1982/83 season. For 1983/84 season, a total of 937 sets of 38 different nurseries were dispatched in August 1983 to cooperators in 49 countries. Even this number fulfilled only 80% of the actual demand made by the cooperators. The continuous rise in the types of trials and number of sets supplied (Fig. 11.1) is an indication of the growing awareness of the importance of these trials and nurseries to the national programs.

2.2. Diversification :

During the year 1977-78, only two nurseries in each of the three legumes were supplied to the cooperators in different countries. With the development of more materials at ICARDA and the continuous feed back from the national programs, the nurseries are being diversified as per the need of the national programs. The perusal of Table 11.1 reveals the FLIP efforts in the form of nurseries supplied to date. In the year 1983/84, 38 different nurseries covering all the three legumes were distributed to different cooperators. Two new faba bean disease nurseries viz. FBICN, (Faba Bean International Chocolate Spot Nursery) and FBIRN (Faba bean International Rust Nursery) have been added this year. Also CIYT-W has been split in two : one for the Mediterranean region and other for the more southernly latitudes where winter sowing is traditionally practiced. Also the agronomy trials on plant population have been modified

2.3. Reporting of Results :

The results of these trials are analysed at ICARDA and reports printed and distributed. Reports upto the 1980/81 season have been already distributed. The one for the 1981/82 season is in preparation.

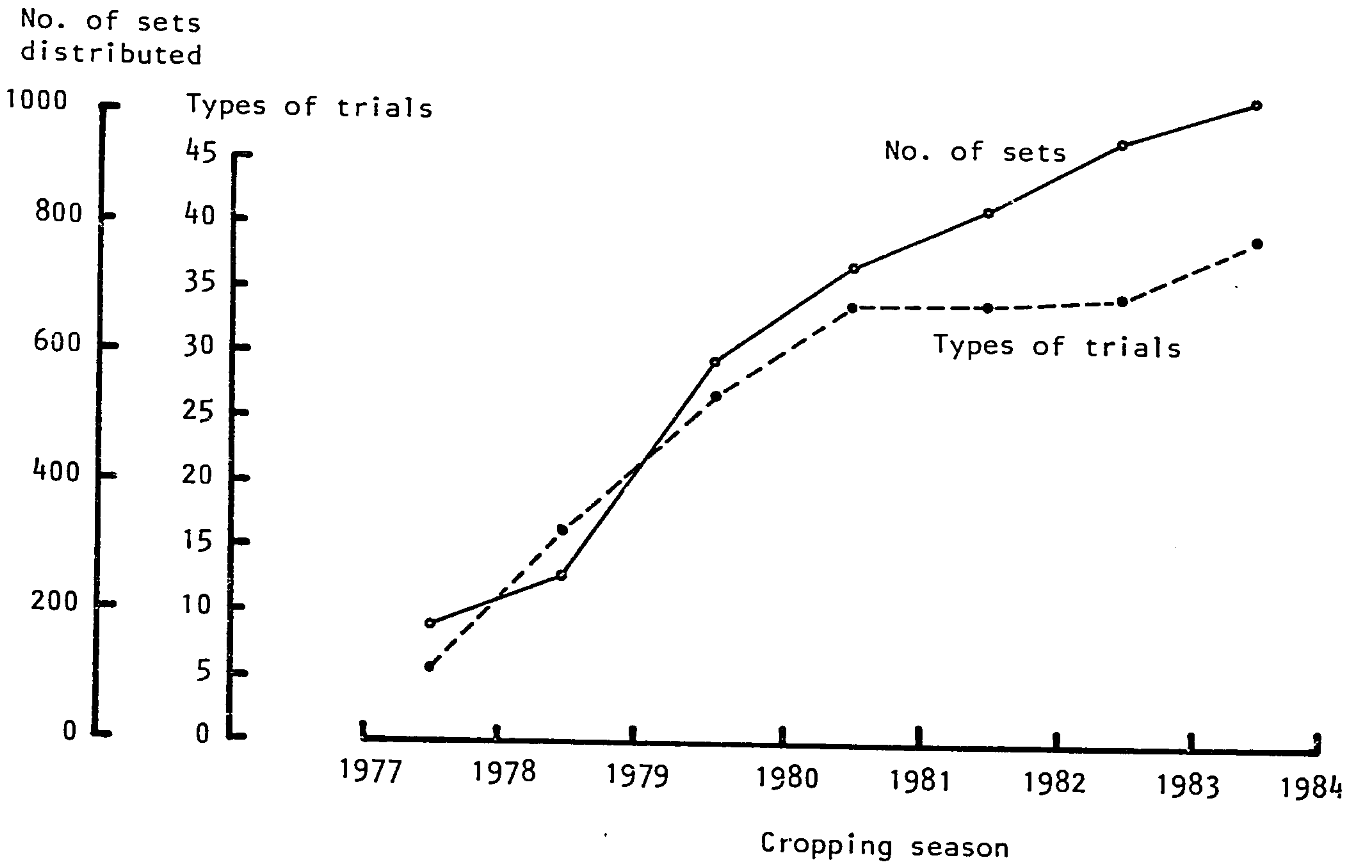


Fig. 11.1. Growth of international testing program on food legumes at ICARDA.

Table 11.1. The type of legume nurseries supplied by ICARDA since 1977/78 to the cooperators in the world.

Season	Faba bean	Chickpeas	Lentil
1977/78	RPYT-S, RPYT-L	RN, RPYT	RN, RPYT
1978/79	AT, ISN, IF3, IABN, FPPT	AT, IYT, ISN, IF_3T, IABN, FPPT	AT, IYT, ISN, IF_3T, FPPT
1979/80	AT, ISN-L, ISN-S, IYT-L, IYT-S, IF4T, IABN, BION, FIT, DPPT	AT, IYT, ISN, IABN, IF4T, IYT-W, DPPT, FIT	At, IYT-L, IYT-S, ISN-L, ISN-S, IF3T, IF4T, DPPT, FIT
1980/81	AT, ISN-L, ISN-S, IYT-L, IYT-S, IF3T, IF3T-E, BION, FIT, DPPT, WCT	AT, IYT, ISN, IABN, IF3T-A IF3T-B, IF3T-C, IYT-W, IYT-L, IABN-D, FIT, DPPT, WCT	AT, IF3T, IYT-S, ISN-L, INS-S, ISN-E, IF3T-E, DPPT, DPPT, FIT, WCT
1981/82	AT, ISN-L, ISN-S, IYT-L, IF4T, BION, FIT, DPPT, WCT	AT, IYT, ISN, IABN, IF3T-A, IF3T-B, IF3T-C, IYT-W, IYT-L, FIT, DPPT, WCT	AT, IF3T, IYT-L, IYT-S, ISN-L ISN-S, ISN-E, IF3T-E, DPPT, FIT, WCT
1982/83	ISN-L, ISN-S, IYT-L, IF3T-E, IYT-S, IF3T, BION, FIT, DPPT, WCT	AT, IYT, ISN, IABN, IF3T-A, IF3T-B, IYT-W, IYT-L, FIT, DPPT, WCT, IET	IF3T, IYT-L, IYT-S, ISN-L, ISN-S, ISN-E, IF3T-E, DPPT, FIT, WCT, LION, LISN-T
1983/84	ISN-L, ISN-S, IYT-L, IYT-S, IF3N, IF3N-E, ION, IABN, ICN, IRN, PPT, FIT, WCT	AT, IYT-SPR, IYT-W-MDR, IYT-W-STR, IYT-L, ISN, IF3T-W, IF3T, IABN, DPPT, FIT, IET, WCT	IYT-L, IYT-S, ISN-L, ISN-S, ISN-E, ISN-T-E, IF3T, IF3T-E, ION, PPT, FIT, WCT

12. PROJECT : The Collection, Evaluation, Maintenance and Distribution of Faba Beans, Lentils and Kabuli Chickpeas Germplasm

1. Objectives :

1.1. To collect germplasm from the region and elsewhere.

1.2. To evaluate the germplasm for various characteristics and to document the information.

1.3. To maintain and distribute the germplasm scientists throughout the world on request.

1.4. To collect and evaluate the usefulness of *Vicia*, *Lens* and *Cicer* species as possible donors of genes for desirable characters.

1.5. To study the crossability of wild species with cultivated species.

2. Research Highlights :

2.1. Faba beans :

The ILB collection stands at 2853 accessions. A total of 523 ILB accessions from China, Cyprus, Egypt, Morocco, Spain and Sudan were multiplied in the screen house for the first cycle of selfing to produce BPL accessions (Table 12.1). Approximately 2634 new BPL accessions will be developed from these ILB accessions. Seed supply was increased of 330 BPL accessions and 560 BPL accessions were advanced one selfing cycle. For ILB accessions 661 were increased under screen houses and 696 were increased in the open.

A total of 1365 germplasm accessions from both ILB and BPL collections were distributed to 18 countries including UK, Sudan, USA, Yemen Arab Republic, Morocco, Tunisia, Egypt, Ethiopia, Peru, and Canada among others.

Evaluation of some of the BPL accessions was done for resistance to ascochyta blight (*Ascochyta fabae*), chocolate spot (*Botrytis fabae*), rust (*Uromyces fabae*) and stem nematodes (*Ditylenchus dipsaci*). Results of evaluation were described in an earlier section. Screening for cooking time was also done. The cooking time ranged from 85 to 320 minutes.

A collaborative project with the University of Reading, UK, continued looking into the crossability of *Vicia faba* with other species of the genus *Vicia*.

2.2. Lentils :

The current germplasm holding amounts to 5420 accessions. A lentil germplasm catalog has been produced which includes passport data on all these accessions and evaluation data for 19 characters for 4550 accessions. A total of 2500 accessions were evaluated for seed protein concentration. A total of 489 new accessions from 14 countries were evaluated for morpho-agronomic characters. The time to flower of the accessions from some countries is shown in Table 12.2. The close relationship between latitude of origin and mean time to flower is noteworthy. Over 200 accessions have been distributed to Canada, Chile, Pakistan, Sudan and UK.

2.3. Kabuli Chickpeas :

The 'Kabuli Chickpea Gene Bank' at ICARDA has a current holding of 5 340 accessions. Of these, 920 accessions were added in the past one year. Of the total 5 340 accessions 840 are those that have been developed at ICARDA through hybridization. The collection represents 34 countries, the largest numbers, in decreasing order, coming from Iran, Afghanistan, Turkey, Chile, Spain, Tunisia and India. Obvious gaps in our collection are from Morocco, Algeria and Mexico.

Table 12.1. Number of lines grown from the faba bean germplasm collections.

No. of lines	Material	Purpose
523	ILB	Develop BPL accession from ILB accessions - 2634 BPL accessions derived.
560	BPL	Generation advance one selfing cycle.
330	BPL	Increase seed supply of advanced generation BPL's.
1257	ILB	Increase seed supply of ILB accessions with low seed stocks.

Table 12.2. Mean time to flower (days) of the new accessions originating from the listed countries.

Country of origin	Mean time to flower	Standard deviation	Number of accessions
Pakistan	105	4.5	5
India	109	5.4	80
Jordan	112	3.4	263
USA	122	3.3	10
Bulgaria	125	3.9	18
Italy	125	2.7	5
Spain	129	3.3	98

Over 3300 collections have been evaluated for 27 descriptors. The evaluation data along with passport information have been computerised using VAX-11/780 system. The information has been published as 'Kabuli Chickpea Germplasm Catalog' and distributed to scientists. Evaluation of germplasm suggests that additional collections from the USSR could be useful for ascochyta blight and frost resistance, late flowering, and tallness; from Spain for large seed size and high biological yield; from Chile for more primary and secondary branches, high harvest index, and high protein content; and from Indian sub-continent for cold tolerance.

One of our major objectives in germplasm resources work has been to distribute the germplasm to the national programs. A total of 6,330 germplasm lines have been distributed (Table 12.3).

Table 12.3. Distribution of Kabuli germplasm accessions to different national programs to-date.

Country	Number of accessions
Canada	180
Egypt	500
Ethiopia	150
France	60
Jordan	26
Lebanon	26
Mexico	125
Morocco	600
Pakistan	780
Turkey	753
U.S.S.R.	60
U.S.A.	661
Others	250
ICRISAT	1833

13. PROJECT : North African Regional Program.

1. Objectives :

1.1. Development of improved cultivars of faba beans, chickpeas and lentils and a superior production technology for the North African Region, that together can ensure the farmer a more stable and higher economic return from the cultivation of these food legume crops.

1.2. For faba beans and chickpeas the aim is to produce cultivars with an increased yield stability by incorporation of resistance/ tolerance to the most important diseases. For faba beans major emphasis will be given to resistance to both *Botrytis fabae* and *Orobanche* spp, and for chickpeas resistance to *Ascochyta rabiei* and the pathogens associated with the wilt/root rot complex.

1.3. For lentils the incorporation of attributes facilitating mechanical harvesting into a heavy yielding background will be the main objective.

2. Research Highlights :

2.1. ICARDA/Tunisia Cooperative Project :

In this cooperative project between ICARDA and INRAT, the food legume breeder from ICARDA worked along side the Tunisian legume scientist to identify superior genotypes and production techniques for all the three food legumes.

2.1.1. Faba Bean Improvement :

Aside from the disease nurseries, in which very little disease development occurred, the program involved the testing of 46 advanced breeding lines and 23 F_3 populations in ICARDA derived international yield trials, and 66 entries in advanced and preliminary yield trials, (AYT and PYT respectively). Within the ICARDA trials only six small seeded lines at one of three test locations significantly out yielded the local check cultivar (Table 13.1). In the AYTs and PYTs only one large seeded entry at one of two test locations showed a significant improvement over the check (Table 13.1).

The above results are some improvement on last season's, in which no entry significantly exceeded the local check, but particularly disappointing was the performance of the F_3 populations. The aim of these is to supply a pool of genetic variation for selection under local conditions, but their usefulness is limited as not only did none significantly out yield the local check at three locations but many were considerably lighter yielding. Both seasons have involved the testing of either genetic material selected at ICARDA for inclusion in international yield trials or imported cultivars from Europe. The failure of this strategy to so far produce significant and consistent yield improvements suggests that faba bean genotypes/cultivars exhibit a limited adaptation. To counter this it would seem necessary that the future breeding strategy must involve the testing and selection under local environmental conditions of a wide range of early generation breeding lines and populations, and of material contained in ICARDA's germplasm collection.

However, yield improvements per se will be of little value if not combined with resistance/tolerance to the commonly occurring diseases. Thus in the future disease screening work will have to have equal importance to breeding for improved seed yield.

2.1.2. Chickpea Improvement :

Although work by ICARDA in Syria and neighbouring countries has shown that winter planting of chickpeas can produce large yield increases over spring planting, this was not evident in Tunisia last

Table 13.1. Seed yield (sy) in kg/ha and as a % of the local check (%) of superior yielding faba bean entries in international (IYT), preliminary (PYT) and advanced (AYT) yield trials.

Trial	Entry	Location						Mean	
		Beja		El-Kef		Mateur			
		sy	%	sy	%	sy	%	sy	%
IYT	ILB 1217	2269[1]	152	2509	135	2700	103	2493	125
	1820	2144	144	2400	129	1931	73	2158	108
	146	2800	187	2228	120	2038	77	2355	118
	1816	2244	150	2412	130	2788	106	2481	124
	407	2325	156	2400	129	1094	42	1940	97
	5	2138	143	2175	117	2106	80	2140	107
	Tunisian Local	1494	100	1862	100	2631	100	1996	100
	SE±	283.9		133.8		292.1			
	CV%	20.5		12.2		18.7			
AYT and PYT	ILB 398	2531	138	2012	101			2272	108
	Tunisian Local	1840	100	2000	100			1920	
	SE±	241.5		174.1					
	CV%	26.6		20.5					

(1) Values underlined significantly exceeded the local.

season owing to the confounding effect of diseases. However, this season at one location (El-Kef), where diseases were not a problem, an agronomic trial, comparing winter and spring sowing of three genotypes, showed the winter sowing to have a 91% yield advantage over that in spring. However, ascochyta blight resistant genotypes are a prerequisite for successful winter planting, and unfortunately this season the nearly complete lack of naturally occurring blight precluded any screening for resistance, both in disease nurseries and winter planted yield trials.

The only significant improvement in seed yield over the local check in winter planted trials occurred in one of the two F_3 population trials (A and B). In trial B, 14 out of 15 of the test entries significantly out yielded the check at the El-Kef location, whereas only one did so at the Beja location; yield data for the six heaviest yielding entries across locations is given in Table 13.2. In two other international and one advanced yield trial no entry significantly exceeded the local check, but a number out yielded the check at more than one location, and the performance of five heaviest yielders across locations is given in Table 13.3. Although further testing of the superior entries and populations is required, reselection in the latter holds promise for future potential improvements.

Mild to severe symptoms of *Fusarium* wilt are commonly observed in farmer's fields, and this pathogen is considered to be as a big constraint to increasing chickpea production as ascochyta blight. It was therefore encouraging that in two spring planted international yield trials, which were planted at Beja in land heavily infested with wilt, there were six entries which showed a significant improvement over the local check for both *Fusarium* resistance (1 to 9 scale; 1 = resistant, 9 = complete kill), and seed yield (Table 13.4). However, the significant yield advantage of these entries was not maintained at other locations where *Fusarium* symptoms were not evident.

Table 13.2. Seed yield (sy) in kg/ha and as a % of the local check (%) of superior yielding F_3 populations of chickpea in the F_3 population trial B.

Entry/ F_3 population	Location				Mean	
	Beja		El-Kef			
	sy	%	sy	%	sy	%
X 81 TH 29	1550	132	1859	149	1705	141
48	1763[1]	150	1954	157	1859	154
171	1563	133	1563	125	1563	129
203	1200	162	2111	169	1656	137
123	1288	110	1796	144	1542	127
190	1075	91	2025	163	1550	128
Tunisian local	1175	100	1246	100	1211	100
SE ±	188.3		162.8			
CV %	23.3		14.9			

(1) Values underlined significantly exceeded the local.

Table 13.3. Seed yield (sy) in kg/ha and as a % of the local check (%) of superior yielding chickpea entries in an international yield trial.

Entry	Location				Mean	
	Beja		El-Kef			
	sy	%	sy	%	sy	%
ILC 195	1965	115	2133	136	2049	125
482	1850	108	2506	160	2178	133
484	2215	129	2199	141	2207	135
FLIP 81-41W	2253	132	2048	131	2151	131
56W	2203	129	2365	151	2284	139
Tunisian local	1713	100	1563	100	1638	100
SE ±	195.0		207.8			
CV %	20.3		20.1			

Table 13.4. Fusarium rating (fr), seed yield (sy) in kg/ha and as a % of the local check (%) of superior yielding chickpea entries in the two international yield trials (IYT 1/2).

Trial	Entry		Beja fr	Beja sy	Beja %	El-Kef sy	El-Kef %	Mateur sy	Mateur %	Mean sy	Mean %
IYT 1	ILC	237	1.5 (1)	1450	346	1575	101	1756	127	1594	142
		493	3.8	1138	272	1481	95	1431	103	1350	120
	FLIP 81	-52	4.0	1194	285	1488	97	1600	115	1427	127
		-54	3.5	1656	395	1369	88	1479	107	1501	134
		-65	3.3	1619	386	1519	98	1344	97	1494	133
	Tunisian local		5.0	419	100	1556	100	1388	100	1121	100
	SE ±		0.31	92.7		169.0		124.1			
	CV %		11.7	26.5		24.5		16.5			
IYT 2	ILC	136	2.0	1000	254	1194	100			1097	138
	Tunisian local		5.0	394	100	1194	100			794	100
	SE ±		0.58	113.0		106.7					
	CV %		14.3	53.3		19.2					

(1) Values underlined significantly exceeded the local.

Of particular interest in Table 13.4 are the two entries ILC 136 and ILC 237. In wilt infested land at Beja the former entry out yielded the local check last season by 89% and this season by 154%, and had a 100 seed weight of 60.2g, which was 38% heavier than that of 43.8g for the local Tunisian Cultivar Amdoun (which is the local check in the trials). Much of the material derived from ICARDA's crossing program, and tested in international trials and nurseries, is too small seeded to meet consumer preference's in Tunisia. Thus this genotype could be particularly useful as a source of *Fusarium* wilt resistance and increased seed size.

The longer term aim is to breed a cultivar combining resistance to ascochyta blight and *Fusarium* wilt. The entry ILC 237 was a parent of one of the populations in the F_3 population trial A, the other parent being an ascochyta resistance type. There is thus the possibility of selecting within this population plants combining the two types of resistance, and a start will be made on this next season.

It was also encouraging to note that progenies from single plants that were selected last season for resistance to *Fusarium* wilt within a population of the local cultivar Amdoun, maintained a high level of resistance this season in a wilt sick plot. These progenies can therefore be considered as a source of material that could provide a future replacement for the local cultivar.

2.1.3. Lentil Improvement :

In last seasons trials 21% of the entries tested in international yield trials showed considerable and significant yield increases over the local check. This was somewhat unexpected as lentils are generally considered to have a relatively narrow adaptation, but this season's results have amplified those of the first season.

In an international yield trial of 20 entries, 20 and 14 entries significantly out yielded the local check at the Beja and El-Kef locations respectively, although none did so at a third location. The seed yield of the five heaviest yielders across locations is shown in Table 13.5. Furthermore, in an advanced and a preliminary yield trial nine entries showed a significant yield increase over the local check at one or more locations; the performance of the top five is shown in Table 13.6.

Although quality considerations of seed size and colour can eliminate some entries, it would seem clear that there is a range of genetic material that after further testing could be considered as a replacement for the existing cultivar(s). A start has also been made to try and improve the mechanical harvesting attributes of the crop by screening 60 entries which are tall enough to be harvested with a cutter bar. The best of these will be tested in replicated yield trials next season.

2.1.4. Performance across Locations :

In the data presented for the three crops a number of entries did not show a consistent yield performance across locations in relation to the local check. To investigate this further a combined analysis of variance across locations was undertaken on the seed yield of all entries in a number of trials of each crop. The results of these analyses are set out in a simplified form in Table 13.7, which shows the number of trials for each crop that attained a particular level of probability (P) for the interaction mean square (entry x location).

The results must be treated with some caution as in some cases the error variances did differ markedly between locations. However, on the assumption that an interaction has some practical significance at $P \leq 0.10$, the analysis suggests that genotypes of both faba beans

Table 13.5. Seed yield (sy) in kg/ha and as a % of the local check (%) of superior yielding lentil entries in a large seeded international yield trial.

Entry		Location						Mean	
		Beja		El-Kef		Mateur			
		sy	%	sy	%	sy	%	sy	%
ILL	8	1449 [1]	192	1363	120	2917	285	1910	197
	20	1625	216	1388	123	2883	281	1965	202
	193	1449	192	1280	113	3000	293	1910	197
	4523	1400	186	1483	131	2917	285	1933	199
	4606	1500	199	1671	147	2525	246	1899	196
Tunisian local		754	100	1133	100	1025	100	971	100
SE ±		65.5		138.1		357.8			
CV %		8.1		17.3		28.1			

(1) Values underlined significantly exceeded the local check.

Table 13.6. Seed yield (sy) in kg/ha and as a % of the local check of superior yielding genotypes in a preliminary yield trial.

Entry		Location				Mean	
		Beja		El-Kef			
		sy	%	sy	%	sy	%
ILL	241	2311 [1]	155	1249	115	1780	138
	346	2400	161	1371	126	1886	146
X75TA	49	2128	143	1304	120	1716	133
ILL	857	2166	146	1443	133	1805	140
	7	2211	149	1455	134	1833	142
Tunisian local [2]		1487	100	1088	100	1288	100
SE ±		140.5		103.4			
CV %		13.4		14.1			

(1) Values underlined significantly exceeded the local check

(2) Mean of four different local checks

Table 13.7. Number of trials of each crop that attained a particular level of probability for the interaction mean square in an analysis of variance for seed yield across locations.

Probability level of the interaction mean square	Crop		
	Faba beans	Chickpeas	Lentils
> 0.10	3	4	-
≤ 0.10 - > 0.05	2	-	1
≤ 0.05 - > 0.01	-	-	-
≤ 0.01 - > 0.001	1	-	-
≤ 0.001	2	1	2
Total number of trials analysed	8	5	3

and lentils are more likely to exhibit a varied performance across locations than these of chickpeas. Although more such analyses are required the results reinforce the need to ensure adequate multi-location testing of breeding material.

2.2. North African Regional Project :

A research proposal was prepared for developing a North African Regional net-work for research on food legumes. The proposal has been submitted to the IDRC for funding. It is hoped that the requested funding may soon be forthcoming. This will hasten the progress towards developing a strong North African Regional Program on food legumes.

14. PROJECT : Nile Valley Faba Bean Project.

1. Objectives :

1.1. To test recommended cultivars and cultural practices on farmers fields in Egypt and Sudan in order to evaluate both the practicality and potential contribution of these factors at the farm level and to provide feed-back to the scientists in areas requiring further research.

1.2. To conduct back-up research on experiment stations in order to improve current recommendations and to solve new problems identified in the on-farm trials and surveys.

1.3. To encourage a multi-disciplinary approach to research and to increase collaboration between the various research organizations involved both within and between Egypt and Sudan.

1.4. To strengthen the capacity of the national programs to undertake research through training, visits, consultancies, conferences, meetings, literature exchanges etc.

1.5. To provide the necessary equipment, supplies and facilities required to meet the above objectives.

2. Research Highlights :

2.1. During the 1982/83 season, Phase I of this special project was completed and the first of the three years of Phase II started. A multidisciplinary team of national scientists from the two countries continued to be responsible for the planning and execution of the project with the technical and logistic support from ICARDA using funds provided by IFAD. During the 1982/83 cropping season, some aspects of research on the improvement of lentils were also included in the program of work for Sudan, in view of increasing demand and limited supply of this important food legume there.

2.2. On-farm Trials in Egypt :

At 28 sites in Kafr El-Sheikh and 18 sites in Minia provinces of Egypt, on-farm trials were carried out to test recommended levels of plant population, fertilizer, weed control, irrigation and disease control. A set of factors were evaluated in different trials depending on the special agronomic needs of different areas of faba bean production.

The recommended package of plant population and fertilizer showed significant increase in seed yield in several sites. Averaged over cotton-faba bean and corn-faba bean rotations, increases with the improved package were of 480 kg seed and 820 kg straw per hectare. In another trial in rice-faba bean rotation, the average improvement in seed and straw yield with recommended package was 660 kg and 1210 kg per hectare under tilled conditions in contrast to 430 kg and 1170 kg, respectively, under untilled condition.

Use of Igran to control weeds increased yield. On an average of 4 trials in cotton and 8 trials in rice rotation, the increase in yield with Igran was 240 kg seed and 430 kg straw per ha. Ronilan fungicide to control *Botrytis fabae* in the on-farm trials in Kafr El-Sheikh increased seed yield by 230 kg/ha under tilled system and by 330 kg/ha under zero tillage system.

Economic analysis of the on-farm trial results was also carried out. In most of the trials the recommended package gave a higher net benefit than the farmers practices and the increased ranged from Egyptian Lira 18.9 to 207.8 per ha. Recommended levels of seed and fertilizer rates combined had the highest contribution in Samalot and Kafr El-Sheikh districts. This was followed by weed control in Motobus and Samalot districts.

2.3. On-farm Trials in Sudan :

Both farmer managed and researcher managed on-farm trials were conducted in the irrigation schemes of Aliab, Selaim and Zeidab areas in North Sudan. Results of farmer managed trials (Table 14.1) in which planting date, irrigation, insect control and weed control at recommended level were compared with farmers practice, significant increase in yield and economic returns was obtained. Effect of factorial combination of two levels (recommended and farmer's) of each of seed rate, planting method, and weed control was evaluated in Aliab and Shendi area, using 7 and 6 sites respectively, in researcher managed trials. At Aliab significantly higher yield was obtained with the combination having recommended levels of planting and weed control and farmers level of seed rate. At Shendi the effect was non-significant.

2.4. Back-up Research in Egypt and Sudan :

Back-up research was carried out in 10 disciplines in Egypt and 11 in Sudan. Most of the studies were carried out at the Research Stations. Emphasis in the back-up research in Sudan was on development of agronomic practices and identification of suitable genotypes of faba beans for expansion of faba bean cultivation to non-traditional areas south of Khartoum. Also studies were carried out on different aspects of improvement of lentils, with emphasis on the production practices.

Table 14.1. Grain yield (kg/ha) and economic returns from recommended (R) vs. farmer's (F) level of management of date of planting, irrigation, and insect and weed control in farmer managed trials in three irrigation schemes in Sudan.

Location	No. of trials	Treatments	Seed yield (kg/ha)	Economic returns (S.L./ha)
Aliab	7	R	2831	1229 ± 344
		F	2316	1054 ± 223
		R-F	515	175 ± 217
		SE ±	116	
Zeidab	6	R	3583	1846 ± 518
		F	2464	1314 ± 515
		R-F	1119	532 ± 267
		SE ±	143	
Selaim	4	R	3439	1942 ± 55
		F	2875	1694 ± 187
		R-F	564	249 ± 163
		SE ±	142	

III. TRAINING & COMMUNICATIONS

The Training and communication activities of the program aim at improving the applied technical skills of the researchers for the food legume research programs in the ICARDA region and out-side. They also aim at establishing a net-work of food legume workers interested in the improvement of the productivity of faba beans, lentils and kabuli chickpeas. Communication efforts are directed to improve the dissemination of research information in this network.

1. Training :

1.1. During the 1982/83 cropping season, a total of 17 trainees from 10 countries (Chile, Djibuti, Egypt, Ethiopia, Iran, Pakistan, North Yemen, South Yemen, Sudan and Syria) were trained in the field and laboratory techniques for the improvement of food legumes in a six month residential training course. The individual needs and aspirations of the trainee were considered in providing them specialized attention in addition to the general coverage. This was achieved through assigning to each trainee a simple project and let him go through the process of designing and conduct of experiment, data collection and processing and preparing a report.

1.2. A short term (two weeks) in-country course was held on faba bean improvement at the Sakha Research Station in Egypt during March/April 1983 as a part of ICARDA/IFAD Nile Valley Project for Egypt and Sudan. A total of 17 technicians from Egypt and Sudan participated. The course focussed on the improvement of faba bean through a series of theoretical and practical classes. Egyptians, Sudanese and ICARDA scientists instructed in the course. A training manual in Arabic has been developed based on the lectures given in this course.

1.3. In addition to the above mentioned formal training courses, the program provided opportunity to some of the national scientists and their support staff for individualised training. A microbiologist from Sudan stayed with the program for a month and an entomologist from Jordan for a week as Senior Research Fellow. One training research associate from Tunisia and one from Jordan had training in legume agronomy and two from Egypt were trained in pathology.

2. Communications :

2.1. The program continued to run the Faba bean Information Service and published 2 issues of FABIS (Volume 6 and 7). The Lentil Experimental Service was also continued in collaboration with the University of Saskatchewan and two issues of LENS (Vol. 10, No. 1 & 2) were published. Faba bean and Lentil Abstracts were continued to be distributed to the food legume scientists through the Commonwealth Agricultural Bureau, UK.

2.2. Two workshop conferences were organised by the program. The first, held from May 16-20, 1983 was an international workshop conference entitled 'Faba beans, kabuli chickpeas and lentils in the 1980's'. It was attended by 56 delegates from 17 countries besides the ICARDA scientists. The progress todate in the research on the improvement of the three legumes and future research strategies were examined. The second was a regional workshop on 'Potential of Field beans (*Phaseolus* sp.) in West Asia and North Africa' organised jointly by CIAT and ICARDA with support from the Ford Foundation. Proceedings of both these workshops will be published and distributed to the scientists.

IV. LIST OF PUBLICATIONS OF THE FOOD LEGUME IMPROVEMENT PROGRAM 1983

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V. FOOD LEGUME IMPROVEMENT PROGRAM STAFF

The following lists the staff of the Food Legume Improvement Program, other ICARDA programs, consultants and students conducting research on food legumes as of October 31, 1983. Unless otherwise indicated, the staff are based at Aleppo. The list does not include scientists and other staff involved with the Nile Valley Project in Egypt and Sudan.

A) FLIP RESEARCH STAFF

Senior Scientists :

1.	Mohan Saxena	Program Leader, Agronomist
2.	Bhup Bhardwaj	Director-Administration (NVP-Cairo)
3.	Cesar Cardona	Entomologist
4.	William Erskine	Lentil Breeder
5.	Howard Gridley	Legume Breeder (Tunisia)
6.	Salim Hanounik	Plant Pathologist (Lattakia)
7.	Habib Ibrahim	Training Officer
8.	M.V.Reddy	Chickpea Pathologist (ICRISAT)
9.	Larry D.Robertson	Faba bean Breeder
10.	K.B.Singh	Chickpea Breeder (ICRISAT)

Post Doctoral Research Fellows :

1.	R.S.Malhotra	Chickpea breeding
2.	M.V.Murinda	Agronomy
3.	Mohamed El-Sherbeeny	Faba Bean breeding (NVP)

Research Associates :

1.	Ahmed Hamdi	Lentil Breeding
2.	Patrick Houdiard	North Africa Project (Tunisia)
3.	Abdullah Sayegh	Faba bean breeding
4.	Munir Turk	Agronomy

Research Assistants :

1. Mohamed Y.Agha	Agronomy
2. Ibrahim Ammouri	Faba bean Breding
3. Roger Azzo	Statistics
4. Samir Hajjar	Chickpea Breeding
5. Siham Kebabeh	Pathology
6. Munzer Kabakibji	Faba bean Breeding
7. Gaby Khalaf	Chickpea Breeding
8. Lina Khoury	Lentil Breeding
9. Nuhad Maliha	Faba bean Breeding (Lattakia)
10. Hani Nakkoul	Nutritional Quality
11. Osama Obaji	Lentil Breeding
12. Abdullah Juby	Entomology
13. Nabil Trabulsi	Agronomy
14. Bashar Baker	On-farm Trials
15. Hiyam Kabalan	Nutritional Quality

Research Technicians :

1. Riad Ammaneh	Agronomy
2. Raafat Azzo	Chickpea Breeding
3. Bernadette Jallouf	Legume Quality
4. Aida Djandji	Faba bean Breeding
5. Amir Farra	Chickpea Breeding
6. Mariette Franjieh	Agronomy
7. Ali Ismail	Lentil Breeding
8. Murhaf Kharboutly	Agronomy
9. Pierre Kiwan	Food Legumes (Terbol)
10. Omar Labban	Lentil Breeding
11. Ahmed Obaji	Faba bean Breeding
12. Abdul Rahim Osman	Faba bean Breeding
13. Mohamed Maarawi	Entomology
14. Aida Naimeh	Food Legumes (Terbol)

15. Diab Ali Raya	Entomology
16. Fadwa Zabalawi	Lentil Breeding
17. Samir Zahran	Agronomy
18. Mahmoud Hamza	Lentil Breeding
19. Elias Zod	Food Legume (Lattakia)

B) FLIP SUPPORT STAFF :

Secretaries :

1. Gulizar Haidar	Senior Secretary
2. Rania Barrimo	Secretary
3. Nawal Saroukhan	Secretary
4. Hasna Boustani	Secretary
5. Sossi Ayanian	Secretary

Drivers :

1. Naaman Adjanji
2. Ibrahim Mustafa

C) SENIOR COLLABORATING SCIENTISTS :

1. Peter Cooper	Soil Physicist, FSP
2. Dyno Keatinge	Crop Physiologist, FSP
3. S.Kukula	Weed Specialist, FSP
4. T. Nordbloom	Agric. Economist, FSP
5. Marlene Diekmann	GRU
6. J.Witcombe	GRU
7. J.Diekmann	Farm Manager
8. Phil Williams	Cereal Techonologist (Consultant)
9. Samir Ahmed	National Research Coordinator (International Cooperation).
10. J.H.Stephens	Microbiologist, FSP

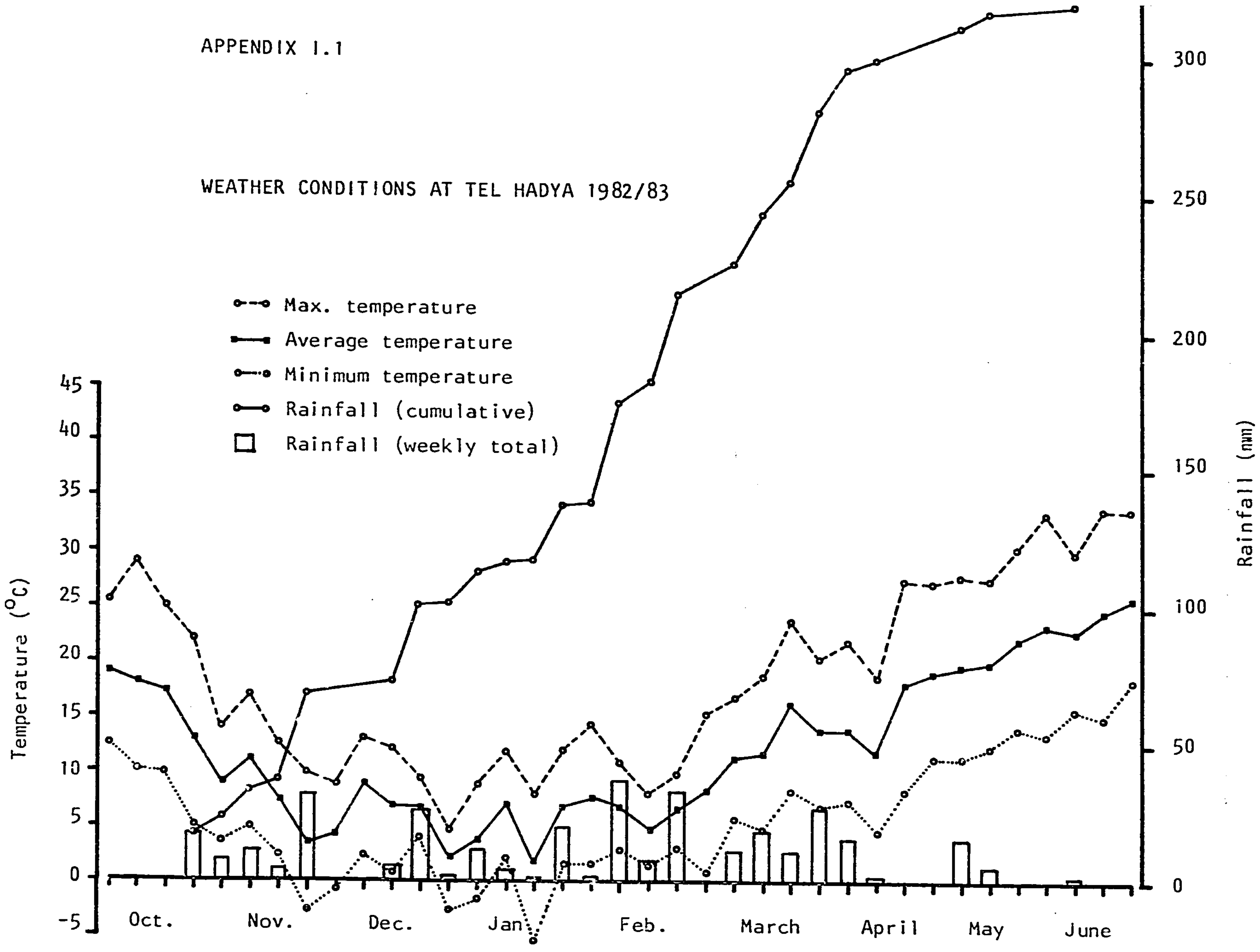
D) STUDENTS WORKING AT ICARDA :

Ph.D. & M.Sc. Degree :

1. Eckhard George	Phosphate Nutrition of Food Legume and Barley, registered for Ph.D. at Hohenheim, W.Germany
2. Oreib Tahhan	Bruchus resistance in Faba beans; registered for PhD at University of Reading.
3. Nuhad Maliha	Botrytis studies in Faba beans; registered for MSc. at AUB,Beirut.
4. Jassem Issawi	Field plot techniques in lentil breeding; registered for MSc. at Aleppo University.

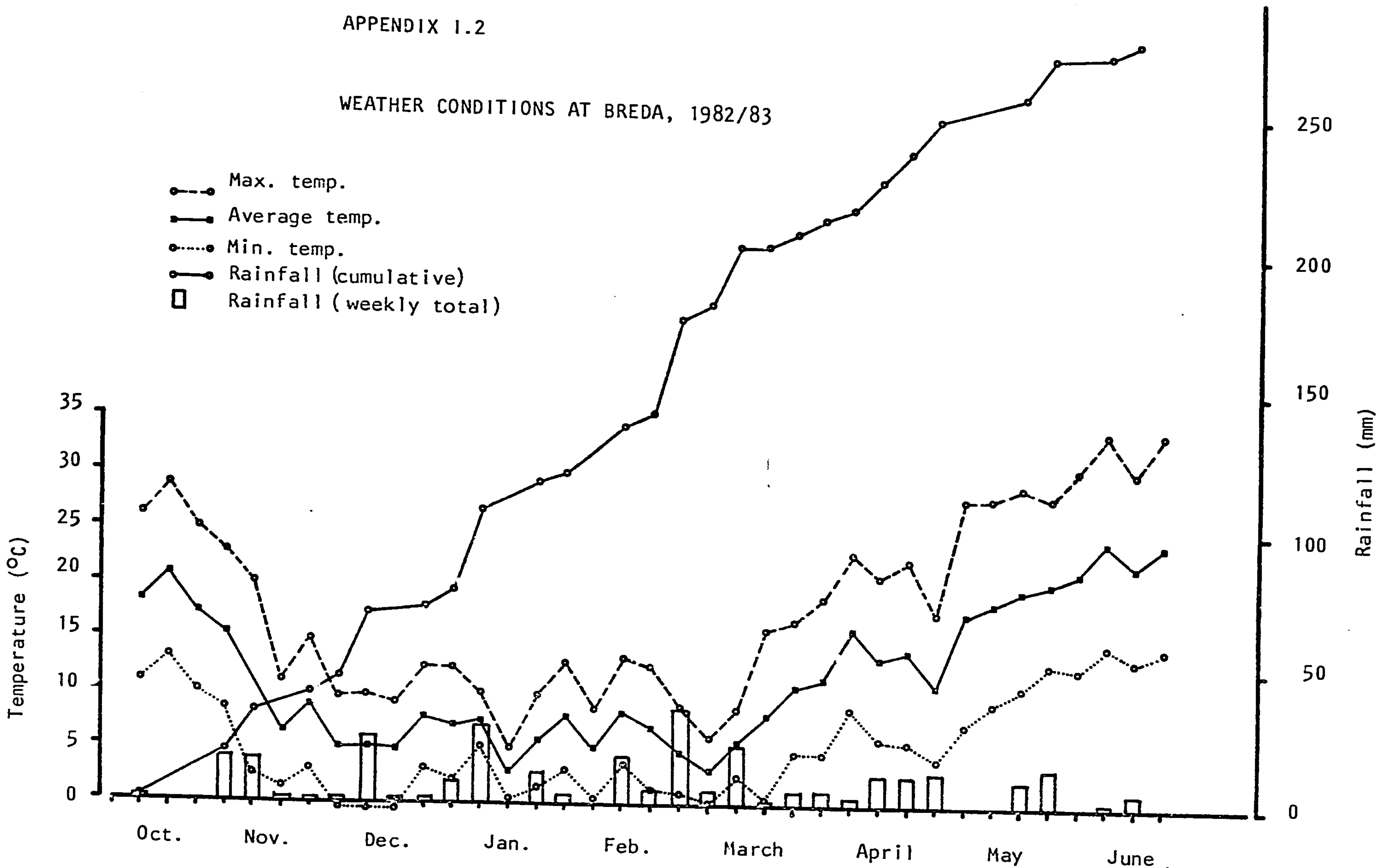
APPENDIX 1.1

WEATHER CONDITIONS AT TEL HADYA 1982/83



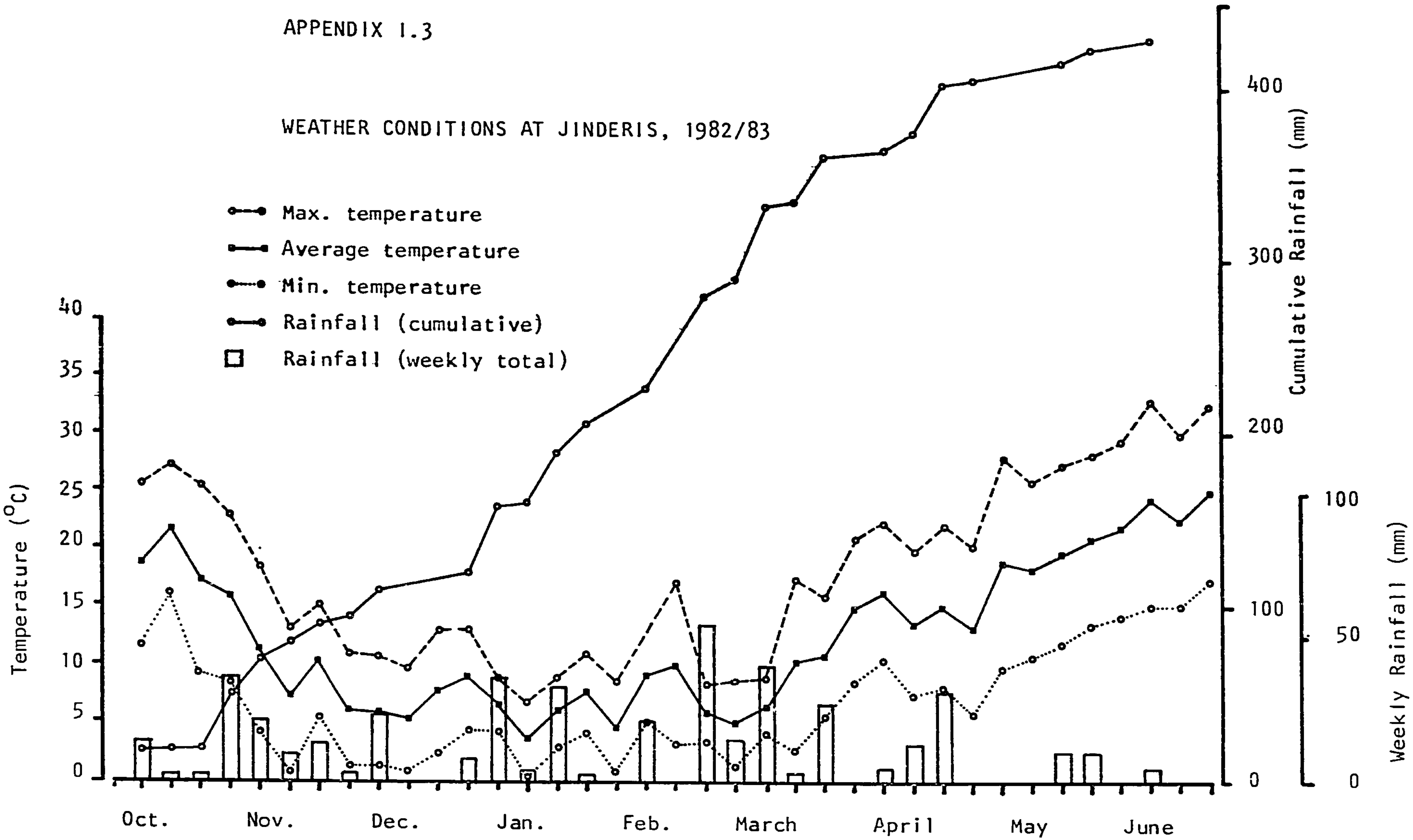
APPENDIX 1.2

WEATHER CONDITIONS AT BREDA, 1982/83



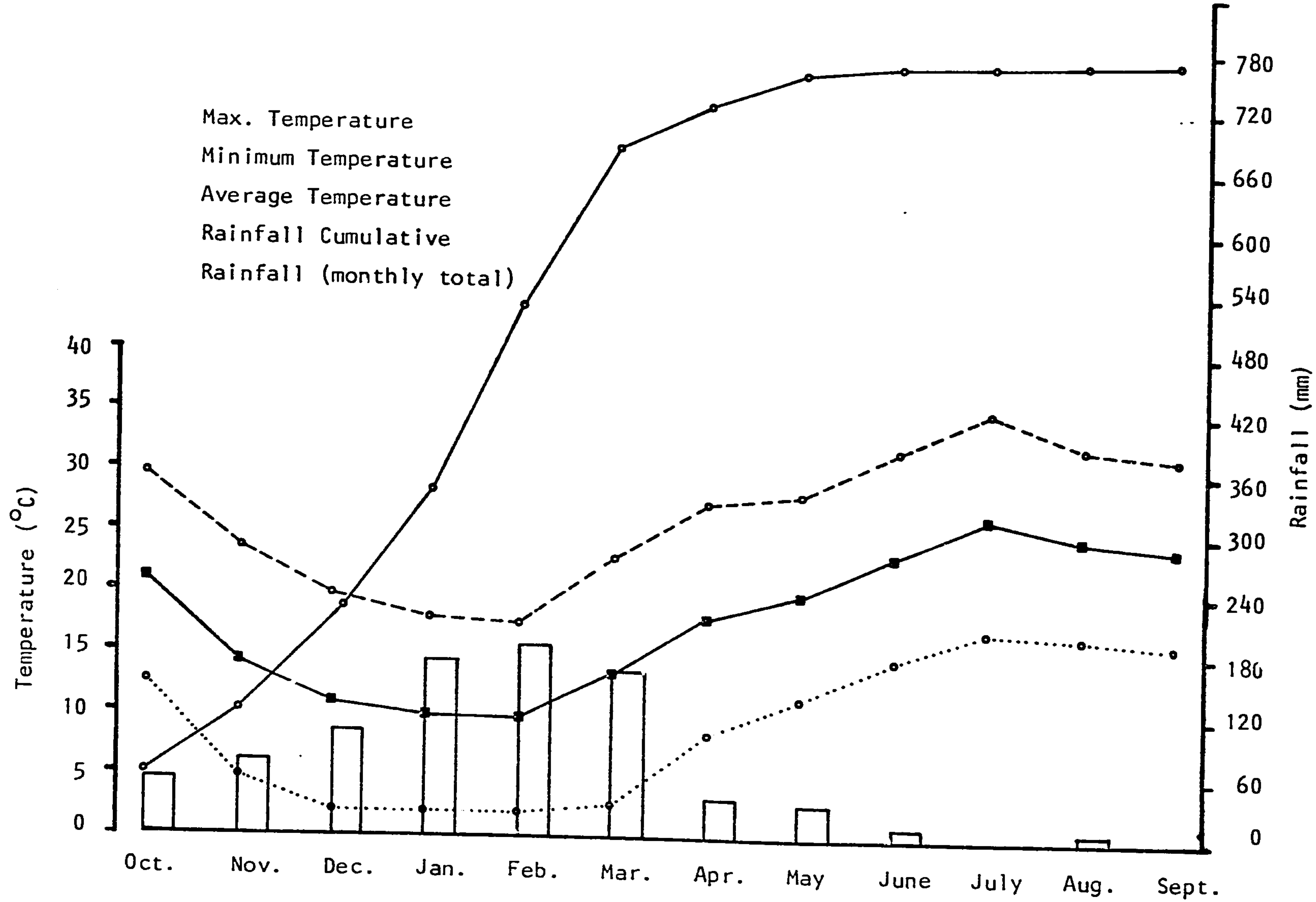
APPENDIX 1.3

WEATHER CONDITIONS AT JINDERIS, 1982/83



APPENDIX 1.4

WEATHER CONDITIONS AT LATTAKIA 1982/83



Appendix II

Soil Analyses for the sites where food legume agronomy experiments were conducted during the 1982/83 season.

Location & sampling depth (cm)	Trial	pH (1:1)	Olsen's P (ppm)	Oxidi-sable organic Carbon (%)	O.M. (%)	EC ms/cm (1:1)
Tel Hadya 0-20	Phosphate application & residue management	8.28	1.56-1.78	0.37	0.83	0.23
20-40		8.29	0.94-1.44	0.30	0.66	0.30
Prison Farm Muslimiyeh 0-15	CFIT-83	8.16	12.20	0.58	1.33	0.30
15-30		8.19	6.68	0.41	0.94	0.26
0-15	LFIT-83	8.24	16.78	0.58	1.33	0.26
15-30		8.19	5.37	0.41	0.94	0.28
Jinderis 0-15	CFIT-83	8.09	1.15	0.53	1.22	0.23
15-30		8.04	0.56	0.49	1.13	0.22