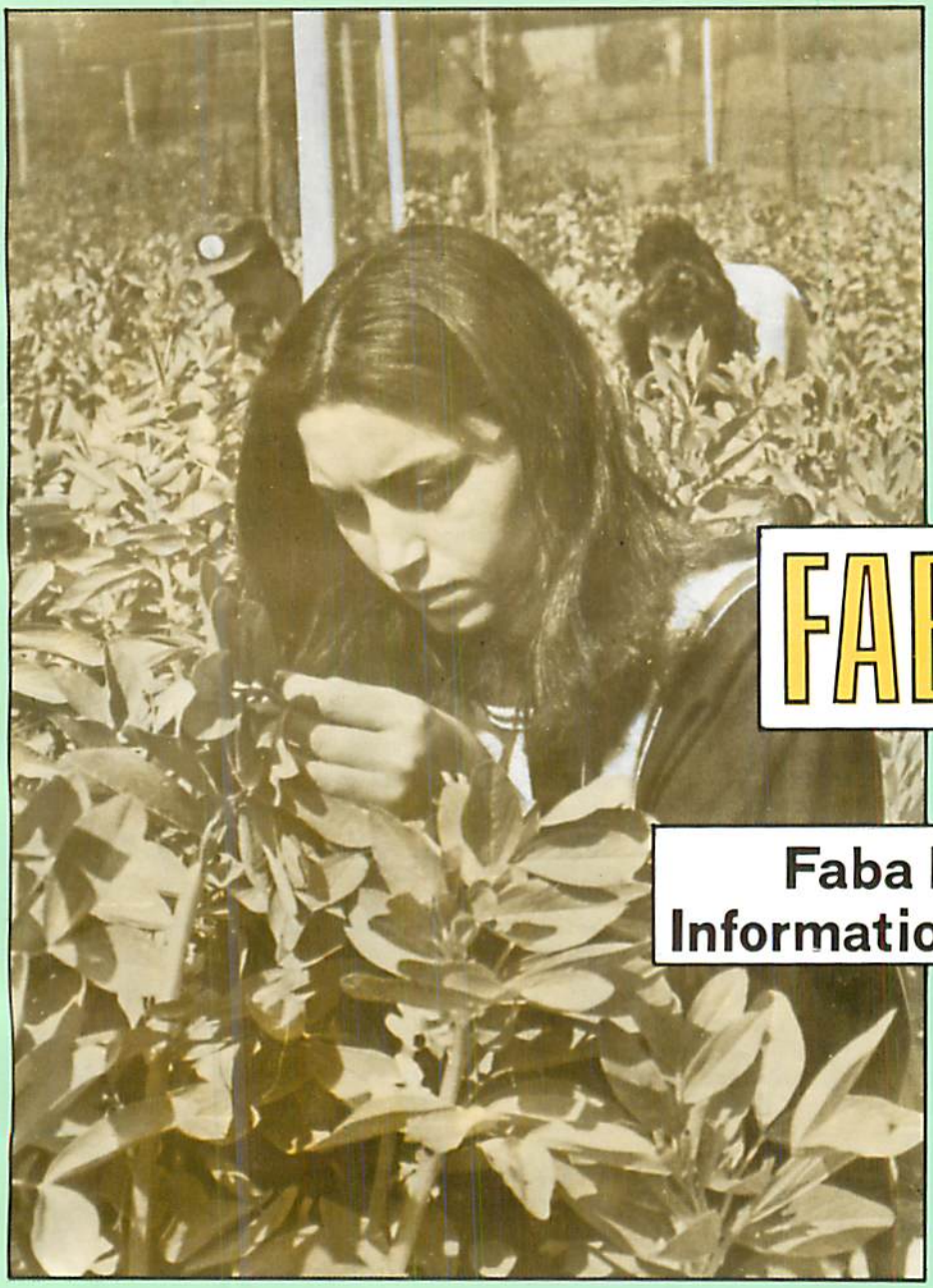

FABIS

Faba Bean Information Service

NEWSLETTER
No.16
December 1986

INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS

(ICARDA)

ICARDA and CGIAR

The overall objective of the International Center for Agricultural Research in the Dry Areas (ICARDA) is to increase agricultural productivity and food availability in both rural and urban areas, thus improving the economic and social well-being of people in developing countries, particularly in North Africa and West Asia. The center focuses mainly on winter rainfall areas with 200-600 mm annual precipitation. When appropriate, research also covers environments with monsoon rainfall or irrigation.

ICARDA is a world center for the improvement of barley, lentil, and faba bean, and a regional center for improving wheat, chickpea, farming systems, livestock, and pasture and forage crops. The training of agricultural researchers from developing countries and the communication of research results are an important part of ICARDA's activities.

ICARDA is a non-profit research center established in 1977 by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR, an informal association of donors including governments, organizations, and private foundations, supports agricultural research worldwide to improve food production in developing countries, through a network of 13 international research institutions, including ICARDA. The network covers crop and livestock systems that supply three-quarters of the food of the developing world.

FABIS

FABIS Newsletter is produced three times a year at ICARDA with the financial support of the International Development Research Center (IDRC), Ottawa, Canada. FABIS, the newsletter of the Faba Bean Information Service, is a forum for communicating faba bean research results. Short research articles provide rapid information exchange, and comprehensive reviews are invited regularly on specific areas of faba bean research. The newsletter also includes announcements. The Faba Bean Information Service provides information on faba bean research free of charge through a question and answer service, photocopies, and searches of a faba bean document collection.

DEADLINE: Contributions must reach FABIS for No. 18 by 30 June, for No. 19 by 31 October 1987 and for No. 20 by 28 February 1988.

SUBSCRIPTIONS: FABIS Newsletter is available free to faba bean researchers under an IDRC grant. To subscribe, write: FABIS/Documentation Unit/ICARDA/P.O. Box 5466/Aleppo, Syria.

COVER PHOTO: Crossing faba beans at ICARDA's sub-station in Lattakia, Syria. Several genetic stocks with multiple disease resistance have been developed.

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FABIS

Faba Bean Information Service

NEWSLETTER No. 16 December 1986

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Pests and Diseases

SHORT COMMUNICATIONS

Breeding and Genetics

Isoenzymatic Polymorphism of Superoxide Dismutase (SOD) in Vicia faba and its Systematic Implication

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Abstract

Polyacrylamide gel electrophoresis was carried out on superoxide dismutase variants of 48 inbred lines of *Vicia faba* from the groups *major*, *equina*, *minor*, and *paucijuga*. The electrophoretic patterns showed three different loci for the enzyme each with two codominant alleles producing dimeric enzymes and which form heterodimers in heterozygotes. In *minor* and *paucijuga*, the patterns were the same while in *major* and *equina* they were similar but not the same. This suggests that the *paucijuga* and *minor* groups evolved separately from the populations which formed *equina* and *major*.

Introduction

The systematic relationship between the four botanical groups of *Vicia faba* is not clearly understood. Isoenzymatic polymorphism studies using polyacrylamide gel electrophoresis may help in this regard. This paper describes results of such a study.

Materials and Methods

Forty-eight inbred lines of the four botanical groups of *V. faba* were analyzed electrophoretically for superoxide dismutase (SOD) variants according to the method described by Shaw and Siciliano (1976) and using polyacrylamide gels. The samples were prepared following the method described by Gates (1978). Plants homozygous for the different variants were crossed with each other to study the genetic control of SOD. The lines of group *major* originated in Spain (6), France (5), Hungary (1), Cyprus (1), and Japan (2); group *equina* in Spain (3), Italy (1), UK (1), Hungary (1), Egypt (3), Crete (1), Ethiopia (2), Syria (2), Tunisia (1), Algeria (1), Iran (1), and China (1); group *minor* in France (2), Germany (2), Sudan (2), USSR (1), and Canada (1); and group *paucijuga* in India (7).

Patterns of variation

Fig.1 shows the banding patterns of the material studied. There are three zones of activity with Rf of 0.49, 0.59, and 0.75. These zones are all polymorphic.

Table 1 shows the frequency of these patterns in the material studied and the average frequencies of the "fast" (F) and "slow" (S) alleles of the polymorphic zones in each of the four groups.

The pattern was the same in *minor* and *paucijuga*, indicating that only the alleles S_I, S_{II}, and F_{III} are present. Pattern 1 and the alleles S_I and S_{II} are most frequent in *major* and *equina* which are very similar in their genetic structure in zone III but differ in zones I and II. It is clear from the electrophoretic patterns of SOD that *major* and *equina* form a distinct entity as do *minor* and *paucijuga*.

Inheritance of the electrophoretic bands

Table 2 shows the results of the crosses between plants homozygous for the different patterns detected. The crosses 1x2 and 1x4, together with the structure of the hybrid, show that in the case of zones I and II both alleles, F and S, are codominant and that in the hybrid a dimeric enzyme is formed. Similar results were obtained for zone III, even when there is an excess of the homozygote FF. The significance of this excess, also detected in other enzymatic systems, is not clear.

Discussion

The different electrophoretic patterns of SOD in *V. faba* are due to three different loci. Each has two codominant alleles producing dimeric enzymes and which

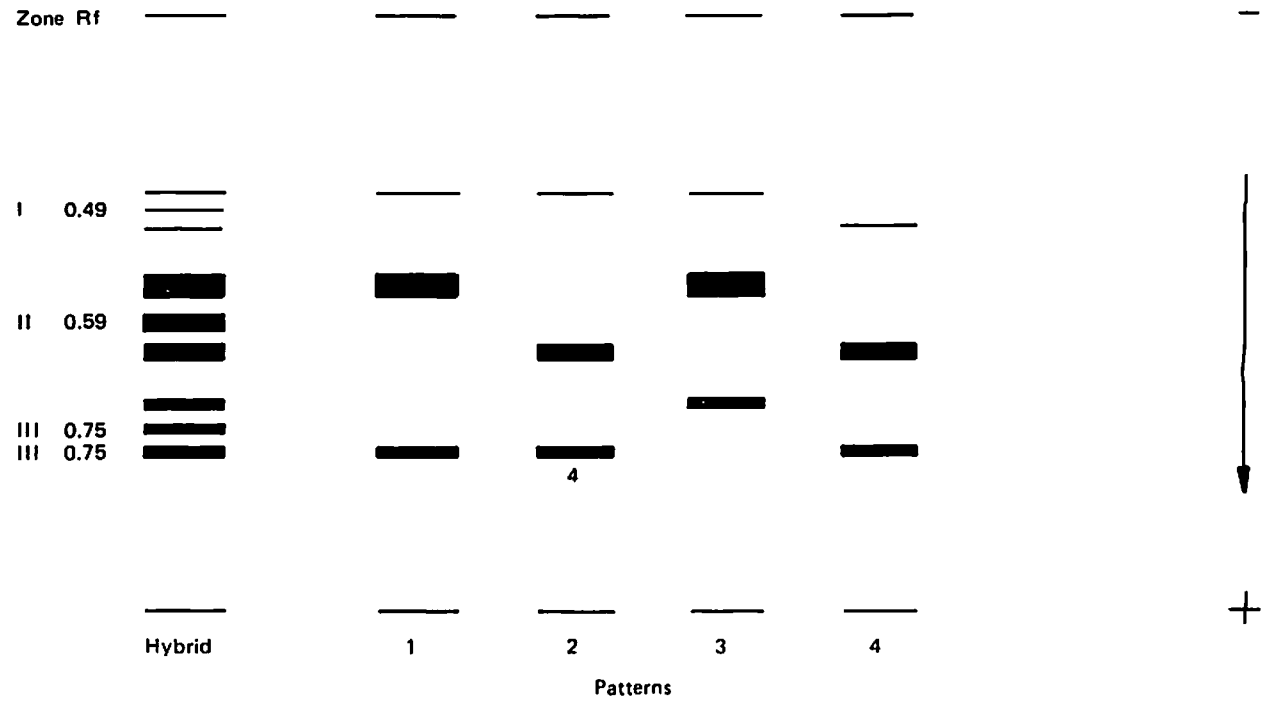

Fig. 1. SOD zymograms of the material studied.

Table 1. Frequency of electrophoretic patterns of SOD and average frequency of the F and S alleles.

Group	Pattern				Zones					
					I		II		III	
	1	2	3	4	F	S	F	S	F	S
Major	0.53	0.21	0.20	0.06	0.06	0.94	0.22	0.78	0.79	0.21
Equina	0.72	0.06	0.22		0	1	0.06	0.94	0.78	0.22
Minor	1				0	1	0	1	1	0
Paucijuga	1				0	1	0	1	1	0

form heterodimers in heterozygotes. Dimeric isozymes of SOD have also been found in other species, such as *Hordeum spontaneum* and *Silene maritima* (Gottlieb 1981).

Bearing in mind the restrictions inherent in the material studied, some questions arise about the systematic relationships between the four botanical groups, and this may be a basis for future work.

The most common patterns and alleles are the same in the four groups recognized in *V. faba*, indicating a close relationship between them. A similar conclusion was obtained by Polignano and Splendido (1979) and Pignone and Attolico (1979), studying flavonoids. The fact that in both *minor* and *paucijuga* the alleles S_I, S_{II} and F_{III} are fixed could support the taxonomy proposed by Hanelt (1972) who recognized two subspecies, *minor* (including Muratova's *minor* and *paucijuga*) and *faba* (including *equina* and *major*). But crosses are possible between these taxa (Cubero and Suso 1981), ruling out the existence of *two separate* subspecies if the biological concept of species is used.

Table 2. Inheritance of electromorphs.

Cross	Phenotypes			X^2	Probability
	FF	FS	SS	(1:2:1)	
1 x 2	13	27	7	2.6	0.3 > p > 0.2
1 x 3	17	19	14	3.2	0.2 > p > 0.1
1 x 4	13	29	13	0.16	0.95 > p > 0.9

The existence of more variation in *equina* and *major* than in the two other groups confirms previous studies at the morphological level (Cubero 1973; 1974). This variation can be explained by supposing that from the *early domesticated* materials in the Fertile Crescent, *paucijuga* off-shoots migrated eastwards. Later, *minor* forms migrated southwards to Ethiopia, before the incorporation of the new variation necessary to create a new form like *equina* (Cubero 1984). The results presented here support this hypothesis, i.e., the early separation of *paucijuga* and *minor* groups from the populations that evolved to form *equina* and *major*.

References

Cubero, J.I. 1973. Evolutionary trends in *Vicia faba* L. Theoretical and Applied Genetics 43 (2): 59-65.

Cubero, J.I. 1974. On the evolution of *Vicia faba* L. Theoretical and Applied Genetics 45: 47-51.

Cubero, J.I. 1984. Taxonomy, distribution and evolution of faba beans and its wild relatives. Pages 131-144 *in* Genetic Resources and Their Exploitation-Chickpeas, Faba Beans and Lentils (Witcombe, J.R. and Erskine, W., eds). Martinus Nijhoff, The Hague, The Netherlands.

Cubero, J.I. and Suso, M.J. 1981. Primitive and modern forms of *Vicia faba*. Kulturplanze 29: 137-145.

Gates, P.J. 1978. The use of isoenzymes as an aid to the breeding of faba beans (*Vicia faba* L.). Ph.D. thesis. University of Durham, Durham, England.

Gottlieb, L.D. 1981. Electrophoretic evidence and plant populations. Progress in Phytochemistry 1: 1-46.

Hanelt, P. 1972. Die infraspezifische Variabilitat von *Vicia faba* L. und ihrer Gliederung. Kulturpflanze 20: 75-128.

Pignone, D. and Attolico, M. 1979. Comparison of karyotypes of four *Vicia faba* groups. Pages 277-289 *in* Some Current Research on *Vicia faba* in Western Europe (Bond, D.A., Scarascia Mugnozza, G.T., and Poulsen, M.H.,eds). The Commission of European Communities, Luxemburg.

Polignano, G.B. and Splendido, R. 1979. Chromatographic separation of subspecies and populations of *Vicia faba*. Pages 266-276 *in* Some Current Research on *Vicia faba* in Western Europe (Bond, D.A., Scarascia-Mugnozza, G.T., and Poulsen, M.H. eds). The Commission of European Communities, Luxemburg.

Shaw, C.R. and Siciliano, M. 1976. Separation and visualization of enzymes on gels. Pages 185-190 *in* Chromatographic and Electrophoretic Techniques. Vol.II. (Smith, I. ed.). Heinemann, London, UK.

Geographical Patterns of Allozyme Variation in a Germplasm Collection of Faba Bean (Vicia faba L.)

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Abstract

The allozyme polymorphism of the two enzymes phosphoglucose isomerase (PGI) and glutamate oxaloacetate transaminase (GOT) was studied electrophoretically in 283 accessions of faba bean (*Vicia faba* L.) from ICARDA (263 accessions) and USDA (20 accessions). A total of 1415 plants were studied, representing 23 countries from diverse geographic regions and climatic zones. PGI was encoded by a single locus with two alleles and GOT by two loci, Got-1 and Got-2. Got-1, the more polymorphic of the two GOT loci, has six alleles including a null allele, while Got-2 has three alleles. Some of the alleles scored for Got-1 were non-randomly distributed over geographic areas and were restricted to two climatic zones. This could indicate major regions of genetic diversity of the crop.

Introduction

Faba bean (*Vicia faba* L.) is an important pulse crop in North Africa, the Middle East, and in some Asian countries where it is the cheapest available source of protein in the human diet. In other countries where the crop is grown, fresh, dried, or preserved seed is used as animal feed. The crop is also used as fodder, green manure, and as a beneficial break from cereals in rotations.

The evolutionary history of the crop is incomplete and the origin and probable time of domestication and cultivation are yet to be determined. Among the known species of the genus *Vicia*, six are said to be polyploids with basic chromosome numbers ranging from x=5 to x=7 (Raina and Rees 1983). *V. faba* is a diploid species (2n=12) with no known polyploids and it is known only in cultivation. The domesticated forms are divided into four partially distinct but overlapping groups: *major*, *equina*, *minor*, and *paucijuga*. The small-seeded taxa, *minor* and *paucijuga*, are generally

considered to be closest to the missing wild ancestor of *V. faba* than other species of *Vicia* (Pickersgill *et al.* 1983).

Based on morphological characters, genetic variation within the species has been reported (Abdalla 1976; Chapman 1981; Hobbs and Burnett 1982). Salem (1982) evaluated 16 cultivars of faba beans for various morphological characters and found significant differences between the *equina* and *minor* groups. He obtained positive correlations between seeds/pod and pod length, and between seeds/pod and 100-seed weight.

Using complete diallele crosses to examine the genetic control of morphological and yield characters in three *V. faba* L. populations from Afghanistan, USSR, and Europe, Hobbs and Burnett (1982) showed that there is greater genetic variability in the species than is evident by examining plant phenotypes. This is quite striking because of the assumption that the species has a narrow genetic base due to the complete absence of gene flow between the cultivar and its hypothesised near relatives.

The present study was carried out to determine genetic variation in a germplasm collection of accessions of *V. faba* L. and geographic distribution of alleles scored at the various loci using electrophoretic techniques.

In the literature on electrophoresis, the two terms, isozymes and allozymes are used interchangeably. The former refers to enzymes which share a common substrate but differ in electrophoretic mobility and are coded for by two or more loci. Zymograms produced by these multiple loci are usually not interpreted genetically. In contrast, allozymes are the protein products of a single genetic locus which differ in electrophoretic mobility and whose segregational behavior in populations follows Mendelian patterns. The zymograms of allozymes are interpreted genetically. On the whole, electrophoretic studies in *Vicia* spp. have so far dealt with isozymes.

The amount of data on electrophoretically detectable allozyme and isozyme polymorphism in tissue extracts of various plant species is increasing. Electrophoresis is useful in evaluating plant genetic resources (germplasm) as it detects genetic differences at the DNA level (Brown 1978). For example, starch gel electrophoresis has been used to study differences between isozyme patterns in various cultivars of *V. faba* L. and several of its related species (Yamamoto *et al.* 1982; Yamamoto and Plitman 1980; Gates and Boulter (1979). Bassiri and Rouhani (1977) used isozyme patterns of esterases and peroxidases to differentiate between 40 faba bean cultivars. A total of 10 and 17 medium to darkly stained bands were obtained for esterase and peroxidase systems, respectively but no genetic interpretation was made of the observed zymograms. Gates and Boulter (1979) used non-specific esterase and glutamate oxaloacetate transaminase (GOT) isoenzymes on acrylamide gel to identify inbred lines of faba beans and study the level of outcrossing between the lines. Work on isozyme polymorphism in *Vicia* spp. (Yamamoto and Plitman 1980) has identified four variable enzymes (GOT, IPO, amylase, and esterase). Among these loci, GOT was less variable and species which were polymorphic in other characters revealed more enzymatic polymorphism.

In the present study, genetic interpretations are made of all loci enabling the estimation of allele and genotype frequencies. Morphological polymorphism has been studied extensively in field beans and studies at the gene level in germplasm collections should provide a further valuable insight into the nature of genetic variation in this crop.

Materials and Methods

The plant material used was obtained from the world collection at the International Center for Agricultural Research in the Dry Areas (ICARDA) in Syria and the United States Department of Agriculture Plant Introduction Station in Washington, USA. In the ICARDA material there were 201 BPL (Faba Bean Pure Line) accessions and 62 ILB (ICARDA Legume Bean) accessions from which the BPL accessions were derived as selections in the ICARDA breeding program. Twenty accessions came from USDA.

Five seeds per accession were grown at room temperature in plastic trays containing standard seed compost. Leaf samples were taken 7 days after germination, homogenized in 100 ul of 2% phenoxylethanol, and centrifuged at low speed for 5 min. The supernatant was absorbed in filter paper strips and immediately subjected to horizontal starch gel electrophoresis at 5°C, the plates being covered with thin plastic film and a box of ice placed on the plastic. Electrophoresis was carried out at 50mA for 6 h then the gel was sliced lengthwise into two slices, one of which was used for GOT and the other for PGI. The exposed cut surfaces were stained using the stains and buffers shown in Table 1. The stain was poured over the gel and incubated at 37°C for 20-30 mins.

Table 1. Buffers and stains for *V. faba* allozymes.

Enzyme	Tray buffer	Gel buffer	Staining solution
Phosphoglucose isomerase (PGI)	60.57g Tris/l H_2O 5.99g EDTA 15.0g Boric acid pH 8.5	Dilute Tb* 1:10	5mg NADP 7mg MIT 25mg $MgCl_2$ + PMS 40ml Tris HCl pH 8.0 30 units G6PDH 20 mg fructose-6-phosphate
Glutamate oxalo-acetate transaminase (GOT)	60.57g Tris/l H_2O 15.0g Boric acid pH 8.5 5.99g EDTA	Dilute Tb 1:10	20mg PVP 15mg Pyridoxal 5mgα-aspartic acid 40mg Ketoglutamic acid 700mg Tris 40ml H_2O Incubate for 30 minutes add fast blue BB or RR in 10ml H_2O

*Tb indicates tray buffer.

Results

The banding patterns of the three enzyme loci studied are shown in Figs. 1 and 2. Fig. 1 shows the polymorphism for Got-1 (faster, more anodal system) and Got-2 (slower system), while Fig. 2 shows segregation at the PGI locus.

Variation at the PGI locus is represented by the action of two alleles, one coding for a faster migrating protein (F) and the other a slower migrating protein (S). Heterozygotes at the PGI locus are characterized by the appearance of a third band of intermediate mobility. This suggests that the enzyme is a dimer.

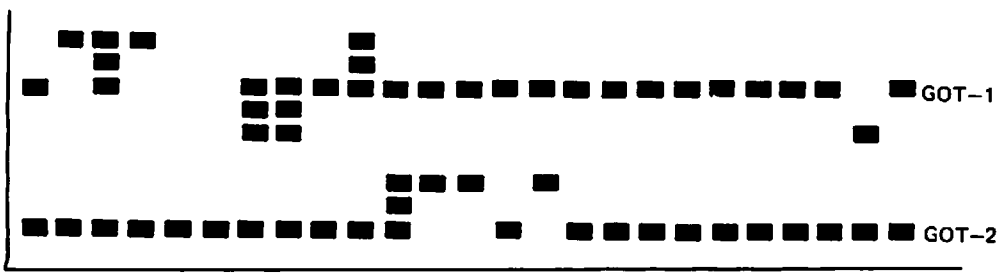

Fig. 1. Diagrammatic representation of electrophoretic banding patterns for GOT in 25 faba bean plants. The faster, more anodal system is Got–1: the slower system is Got–2. From left to right, the genotypes at Got–1 are M/M, F/F, M/F, F/F, 2 plants null homozygotes M/S, M/S, M/M, M/F, the next thirteen are M/M, S/S, M/M. From left to right, the genotypes at Got–2 are 10 plants M/M, M/F, F/F, F/F, M/M, F/F, the rest M/M.

Fig. 2. Diagrammatic representation of electrophoretic banding patterns for PGI in 25 faba bean plants. From left to right the genotypes are F/S, S/S, F/F, 6 plants S/S, F/S, the rest S/S.

GOT is coded for by two independent loci (Got-1 and Got-2) as shown in Fig. 1. Of the two, there was much more variation in Got-1 in virtually all of the accessions assayed. Got-1 had six alleles each with different mobilities. The alleles have been called very slow (VS), slow (S), medium (M), very fast (VF), and fast (F). There was also a null allele, the product of which had no enzymatic activity. Among these alleles, the M allele was most common with the VS, S, F, and null alleles being rare variants. Got-2 had three alleles coding for slow, medium, and fast migrating bands. Heterozygotes at both loci had intermediate bands, again indicating a dimeric structure.

Allele frequency

Among the 1415 plants assayed electrophoretically, the genotypic proportions for PGI were PGI^S/PGI^S (911 plants), PGI^F/PGI^S (133 plants), and PGI^F/PGI^F (371 plants) (Table 2). The overall allele frequencies for PGI^S/PGI^S are 0.69 and 0.31, respectively. In a species where the breeding system is between autogamy and allogamy, a deficiency of heterozygotes is usually an indication of a subdivided population or a high degree of selfing. Similarly, we can use the same approach in estimating allele frequencies at the Got-1 locus. The values used in the calculation are shown in Table 3, where the genotypes were pooled into three groups, M/M (1034 plants), M/* (113 plants), and */* (268 plants). M/* denotes the frequency of all heterozygote genotypes which have the M allele. */* denotes the frequency of all other genotypes without the M allele. The overall allele frequencies are p=0.77 and q=0.23.

Table 3. Cross tabulation of Got-1 genotypes by accession.

Got-1 genotypes		Accessions			
		BPL	ILB	USDA	Total
VS/VS	O	10	3	0	13
	E	9.23	2.85	0.92	
S/S	O	32	15	2	49
	E	34.80	10.73	3.46	
M/*[1]	O	5	3	2	10
	E	7.10	2.19	0.71	
M/S	O	18	18	1	37
	E	26.28	8.11	2.61	
M/M	O	721	229	84	1034
	E	734.40	226.53	73.07	
M/F	O	40	18	8	66
	E	46.88	14.46	4.66	
F/S	O	7	3	0	10
	E	7.10	2.19	0.71	
F/F	O	172	21	3	196
	E	139.21	49.94	13.85	

[1] All heterozygotes have the M allele and a rare allele.
O= observed; E= expected.

Table 4 shows a cross tabulation of $Got\text{-}2^M$ by accession type. The allele frequencies for $Got\text{-}2^M$ and $Got\text{-}2^F$ are p=0.99 and q=0.01, respectively. Substantial genetic polymorphism occurred within many of the accessions despite the non-randomness in the distribution of certain alleles. In all the accession types (Tables 2, 3, and 4) there is a deficit of heterozygotes but, on average, the ILB accessions have a higher frequency of heterozygotes and are more variable than the BPL and the USDA accessions.

Table 2. Cross tabulation of PGI genotypes by accession type.

PGI genotypes		Accessions			
		BPL	ILB	USDA	Total
S/S	O	628	303	80	911
	E	647.03	199.58	64.38	910.99
F/S	O	55	65	13	133
	E	94.46	29.14	9.40	133
F/F	O	322	42	7	371
	E	263.50	81.28	26.22	271

O= observed; E= expected.

Table 4. Cross tabulation of Got-2 genotypes by accession.

Got-2 genotypes		Accessions			
		BPL	ILB	USDA	Total
M/M	O	993	303	100	1396
	E	991.51	305.84	98.66	
M/F	O	2	7	0	9
	E	6.39	1.99	0.63	
F/F	O	10	0	0	10
	E	7.10	2.19	0.71	

O= observed; E= expected.

Geographic and climatic patterns of allele distribution

The sites from which the germplasm materials were collected represent a variety of geographic and climatic regions and the populations sampled from these sites differ markedly in the degree of polymorphism. The sampled geographic regions are shown below.

Region	Country
North Africa	Algeria, Egypt, Ethiopia, Morocco, Tunisia, Sudan
South East Asia	Afghanistan, Bangladesh, India, Japan, Pakistan, Australia, Republic of China, Nepal
South America	Argentina, Bolivia, Peru
Middle East	Iran, Lebanon, Syria
Europe	Greece, The Netherlands, Spain, Turkey, United Kingdom, Italy, Yugoslavia, France, Sweden

Appropriate statistical tests were carried out to determine the association between the various loci and regions. Genotype distribution at the *PGI* locus for the various regions is given in Table 5. There was a non-significant association between locus ($G_8=14.9045$, $P>0.05$). On average, the European region had a higher number of heterozygotes but this was not significant. Table 6 shows the distribution of genotypes at the Got-2 locus for the five regions and in this case there was a significant association between locus and region ($G_4=9.6568$, $P<0.05$). Some of the accessions, from Afghanistan, Algeria, Argentina, Spain, United Kingdom, Lebanon, and The Netherlands, were polymorphic at this locus. The accessions from The Netherlands were much more variable at the Got-2 locus. Table 7 gives genotypic frequencies at the Got-1 locus for the different regions. This locus, which is the most polymorphic of the three, had some alleles that are rare. These rare alleles (VS, S, F) were concentrated in Egypt and Spain and the association between locus and region was highly significant ($G_{16}=40.3652$, $P<0.001$). This reflects the dependency of alleles and genotypes on the various regions.

An analysis of variance was carried out to test the variation in allele frequency between regions using country frequencies as the variates and variation between countries within regions as the error. A non-significant F-value was obtained.

The countries in the various climatic zones are shown below.

Table 5. Genotype frequencies at the PGI locus for the five geographic regions.

Region		PGI genotypes			
		S/S	F/S	F/F	Total
North Africa	O	260	43	57	360
	E	273.03	39.50	47.45	
South East Asia	O	100	17	18	135
	E	102.38	14.81	17.80	
South America	O	23	3	4	30
	E	22.95	2.63	3.95	
Middle East	O	68	11	21	100
	E	75.84	10.97	13.19	
Europe	O	406	50	49	505
	E	302.83	55.42	66.59	

O= observed; E= expected.

Table 6. Genotype frequencies at the Got-2 locus for the five geographic regions.

Region		GOT-2 genotypes				
		M/S	M/M	M/F	F/F	Total
North Africa	O	0	358	0	2	360
	E	0.63	353.95	2.87	2.55	
South East Asia	O	0	134	1	0	135
	E	0.24	132.13	1.07	0.96	
South America	O	0	28	1	1	30
	E	0.05	29.50	0.24	0.21	
Middle East	O	1	99	0	0	100
	E	0.18	98.32	0.71	0.71	
Europe	O	1	492	7	5	505
	E	0.89	496.51	4.02	3.58	

O= observed; E= expected.

Zone	Country
Mediterranean	Algeria, Ethiopia, Greece, Lebanon, Morocco, Egypt, Spain, Tunisia, Turkey, Yugoslavia, France, Italy, Sudan, Syria.
Tropical Monsoon	Argentina, Bolivia, Peru, Afghanistan, Bangladesh, India, Iran, Japan, Pakistan, Australia, Republic of China, Nepal.
North temperate	The Netherlands, Sweden, United Kingdom.

Table 8 shows the distribution at the PGI locus for the climatic zones. The association between locus and zone was not significant ($G_6=3.1577$, $P>0.05$). The various genotypes occurred at a higher frequency in the Mediterranean climate but this is not significant. Also, this region had nearly all of the alleles that

Table 7. Genotype frequencies at the Got-1 locus for the five geographic regions.

Region	Got-1 genotypes										
	VS/VS	S/S	M/VS	M/S	M/M	M/F	M/F+	F/VS	F/S	F/F	Null
North Africa	7	13	0	12	262	14	0	0	6	43	0
South East Africa	0	3	1	11	112	4	0	0	0	4	0
South America	0	0	0	1	24	2	0	0	0	2	1
Middle East	0	8	0	3	79	6	0	1	0	3	0
Europe	10	18	0	10	419	19	1	1	4	29	1

were recorded in the study (including other loci). This may be evidence for the controversy that surrounds the origin and place of domestication. The distribution of Got-1 genotypes in the four climatic zones is shown in Table 9. The association between genotype and climatic zone in a 4 (climatic zone) x 4 (pooled genotypes) correlation analysis was tested and a G_9 value of 30.9690 ($P<0.001$) was obtained. Got-2 was omitted because of its monomorphic nature.

Table 8. Genotype frequency at the PGI locus for the four climatic zones.

Zone		Genotypes			Total
		S/S	F/S	F/F	
Mediterranean	O	583	80	92	755
	E	572.59	82.85	99.55	
Tropical	O	23	3	4	30
	E	22.75	3.29	3.96	
Monsoon	O	108	17	25	150
	E	113.76	16.46	19.78	
North Temperate	O	143	24	28	195
	E	147.89	21.40	25.71	

O= observed; E= expected.

Discussion

The results from this study complement previous findings from studies based on morphological characters (Abdalla 1976; Chapman 1981), quantitative traits (Salem 1982; Hobbs and Burnett 1982), and isozyme patterns (Bassiri and Rouhani 1977; Gates and Boulter 1979; Yamamoto and Plitman 1980; Yamamoto *et al.* 1982) of faba bean. It also disproves to some extent the hypothesis that the species has a narrow genetic base due to the selection pressure exerted by breeders over the years and the low level of response to selection when compared with other leguminous crops. The data suggest that all the potential genetic variation within the gene pool of faba bean has not been fully exploited. In other studies, many enzyme loci have revealed considerable stores of genetic variability within the species and between its plausible relatives, although there is a lack of crossability between faba bean and its relatives.

Genetic variation as related to environmental variation has been documented by Dobzhansky (1951) and Powell (1971). Further investigations have strengthened this observation (Nevo *et al.* 1982; Bekele 1983; Chern and Katayama 1982). In many instances,

Table 9. Distribution of Got-1 genotypes in the four climatic zones.

Climatic zone	Genotypes										
	VS/VS	S/S	M/VS	M/S	M/M	M/F	M/F*	M/VS	F/S	F/F	Null
Mediterranean	12	32	0	20	571	37	1	4	10	68	0
Tropical	0	0	0	1	24	2	0	0	0	2	1
Monsoon	0	5	1	12	124	4	0	0	0	4	0
North temperate	1	5	0	3	175	2	0	1	0	7	1

* A rare fast variant.

this variation leads to the adaptation and differentiation of alleles over ecogeographic zones.

At the PGI locus the S/S allelomorph, which is common to all of the regions studied, occurred at a higher frequency in North Africa and Europe. There might be a hidden bias in this observation because of the unequal number of accession samples that were assayed for the various regions. The null allele occurred in the tropical and north temperate zones and there was a gradual decline in most of the alleles from east to west in the Mediterranean region. Such variation has been reported in *Pseudotsuga menziessi* (Yen and O'Malley 1981), *Oryza sativa* (Chern and Katayama 1982), and barley (Bekele 1983).

The distribution of alleles over geographic regions and climatic zones suggests that all the alleles scored, with the exception of the null allele, were endemic to the Mediterranean region. The accessions from this region were very variable both at the phenotypic and the molecular level. The richness of the Mediterranean gene pool could give some indication of the origin and place of domestication of the crop.

The results presented here could serve as an aid to conserving the genetic resources of the faba bean. Marshall and Brown (1975) have argued that the alleles which deserve priority in sampling are those which have restricted or localized occurrence, but have a high frequency. Furthermore, the rare alleles could help in selection programs and in choosing variable accessions for physiological and disease resistance studies. Choosing rare alleles in some instances might help in the conservation of linked rare polygenes.

Hartley (1963) and Rick and Fobes (1975) have proposed environmental matching as the guiding principle of plant exploration for agricultural purposes. This principle states that the most likely source of superior germplasm for a specified need is that population from an environment which is *physiogeographically* most similar (similar climatic conditions) to the local one for which the improvement is sought. This principle has been adhered to in transferring disease resistance genes from many diverse geographic and climatic zones into several of our cultivated crops.

In that case, the rare variants that were restricted to the regions mentioned could be used in future breeding programs.

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References

Abdalla, M.M.F. 1976. National variability and selection local and exotic populations of field beans. Zeitschrift fuer Pflanzenzuechtung 76: 334-343.

Bassiri, A. and Rouhani, I. 1977. Identification of broad bean cultivars based on isozyme patterns. Euphytica 26: 279-286.

Bekele, E. 1983. Some measures of gene diversity analysis on land race populations of Ethiopian barley. Hereditas 98: 127-143.

Brown, A.H.D. 1978. Isozymes, plant population genetic structure, and genetic conservation. Theoretical and Applied Genetics 52: 145-157.

Chapman, G.P. 1981. Genetic variation in *Vicia faba*. Paper presented at the International Faba Bean Conference, 7-11 March 1981, Cairo, Egypt. ICARDA, Aleppo, Syria.

Chern, J.L. and Katayama, T. 1982. Genetic analysis and geographical distribution of acid phosphatase isozyme in cultivated rice, *Oriza sativa* L. Japanese Journal of Genetics 57: 143-153.

Dobzansky, T. 1951. Genetics and the Origin of Species. Columbia University Press, New York, USA.

Gates, P. and Boulter, D. 1979. The use of seed isozymes as aid to the breeding of field beans (*Vicia faba* L.). New Phytologist 83: 783-791.

Hartley, W. 1963. The phytogeographical basis of pasture plant introduction. Genetica Agraria 17: 135-146.

Hobbs, S.L.A. and Burnett, J.H. 1982. The genetic control of morphological characters in *Vicia faba* L. Theoretical and Applied Genetics 62: 9-15.

Marshall, D.R. and Brown, A.H.D. 1975. Optimum sampling strategies in genetic conservation. Pages 53-80 *in* Crop Genetic Resources for Today and Tomorrow (Frankel, O. H. and Hawkes, J. G. eds). Cambridge University Press, Cambridge, England.

Nevo, E., Golenberg, E., and Beiles, A. 1982. Genetic diversity and environmental association of wild wheat *Triticum dicoccoides*. Theoretical and Applied Genetics 62: 241-252.

Pickersgill, B., Jones, J.K., Ramsay, G., and Stewart, H. 1983. Problems and prospects of wide crossing

in the genus *Vicia* for the improvement of faba bean. Pages 57-70 *in* Proceedings of the International Workshop on Faba Bean, Kabuli Chickpeas, and Lentils in the 1980's (Saxena, M. C. and Varma, S. eds). ICARDA, 16-20 May 1983, Aleppo, Syria. ICARDA, Aleppo, Syria.

Powell, J.R. 1971. Genetic polymorphism in varied environments. Science 1974: 1035-1036.

Raina, S.N. and Rees, H. 1983. DNA variation between and within chromosome complements of *Vicia* species. Heredity 51: 335-346.

Rick, C.M. and Fobes, J.F. 1975. Allozymes of Golapagos tomatoes: Polymorphism, geographic distribution and affinities. Evolution 29: 335-346.

Salem, S.A. 1982. Variation and correlation among agronomic characters in a collection of beans (*Vicia faba* L.). Journal of Agricultural Science 99: 541-545.

Yamamoto, K. and Plitman, U. 1980. Isozyme polymorphism in species of the genus *Vicia.* Japanese Journal of Genetics 55: *151-164.*

Yamamoto, K., Moritani, O., and Ando, A. 1982. Karyotypic and isozymatic polymorphism in species of the sector faba. Technical Bulletin of the Faculty of Agriculture of Kagawa University 34: 1-12. Kagawa University, Kagawa, Japan.

Yen, F. CH-H; O'Malley, D. (1980). Enzyme variation in natural populations of Dougas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, from British Columbia. 1. Genetic variation patterns in coastal populations. Silvae Genetica 29: 83-94.

Physiology and Microbiology

Canopy Development and Efficiency of Foliar Light Interception in Winter Faba Bean

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Abstract

A French pure line of faba bean, 29H, was planted at three densities, 4, 17, and 55 plants/m^2, to study the limiting factors in leaf canopy development, how competition affects yields, and which yield components are affected by competition. The leaf area, dry matter of different plant parts, number of stems per plant, and several climatic observations were recorded. Leaf area, leaf index, transmitted and incident PAR, interception efficiency, and dry matter were all affected by density.

Introduction

This report describes some of the work undertaken in the past few years by the agronomy and plant breeding stations of the Rennes Agronomy Center. The main aims were to determine how the faba bean canopy works and the limiting factors in its development, how competition between individuals in a population affects yield, and which yield components are affected by this competition.

Materials and Methods

The faba bean variety used in this trial was a French pure line, 29H, which is highly autofertile. Initially, plants were sown at three densities (5, 20, and 60 plants/m^2) but these were reduced to 4, 17, and 55 plants/m^2 in the spring. The different densities were created by altering the distance between plants within the row while the distance between rows was constant. This was done to induce morphological variability in the plants, and so modify the yield parameters.

The experimental design was randomized Fisher's blocks in triplicate. One of the blocks in each replicate was larger than the others to allow for the agrometeorological instruments.

Approximately every 15 days from mid-April until harvest, 10 plants per plot were randomly collected from each density.

For light interception studies, the following parameters were measured: leaf area (using an integrator planimeter), dry matter of different plant parts (after drying at 108°C for 48h), and the number of stems per plant.

Climatic observations and measurements

A MOLL thermopile was used to measure global incident radiation. Global transmitted radiation was measured using linear pyranometers. Reflected radiation (total energy reflected by soil and canopy) was measured by sensor captors which integrate photonic variations for wavelengths.

All these instruments were connected to an automatic data integrator. Using these measurements the following parameters were calculated.

PAR= Photosynthetically active radiation
Incident PAR= 0.48 x global radiation
Intercepted PAR= 2.02 x global radiation
Albedo= Reflected PAR/Intercepted PAR
Transmitted PAR= 0.9 x global radiation transmitted to soil x (0.5 - 0.029 LAI)
LAI= Leaf area index

Interception efficiency is the ratio of absorbed PAR to incident PAR i.e.,

ΣI = absorbed PAR/incident PAR

$\Sigma I = A\,(1-E^{-K}.IF)$

where,
A= maximum interception coefficient for the crop
K= extinction coefficient.

For our experiment

$\Sigma I = 0.93\,(1-E^{-0.69}.IF)$

Results

Leaf area development

During the growing stage, there were large differences in leaf development according to plant density (Fig.1).

With four plants/m^2 the leaf area was almost 0.5 m^2/plant. The maximum leaf surface was reached by the first half of June, remaining constant for 3 weeks, then decreasing about mid-July. The two other densities resulted in smaller leaf areas per plant. The difference between maxima in densities 1 and 2 was similar to the difference between densities 2 and 3.

At the high density (55 plants/m^2) the leaf area index was as high as seven, while at the low density (4 plants/m^2) it was never greater than two (Fig.2). For the medium density (17 plants/m^2) the index was intermediate and reached a maximum 15 days after the two other densities.

Winter type faba beans have a tillering ability which varies according to plant density. In this trial there were 3.2, 2.4, and 1.3 stems/plant at 4, 17, and 55 plants/m^2, respectively.

As each stem develops a leaf system, the observed leaf surface fluctuates with the density. Also, with increasing density, the number of nodes does not change and, the number of leaves per stem remains practically constant, so an increase in stem number per plant results in increased leaf area per individual plant.

Therefore, variations in stem number per plant or per m^2 explain the differences in leaf area index among densities and are the main cause of variation in the canopy.

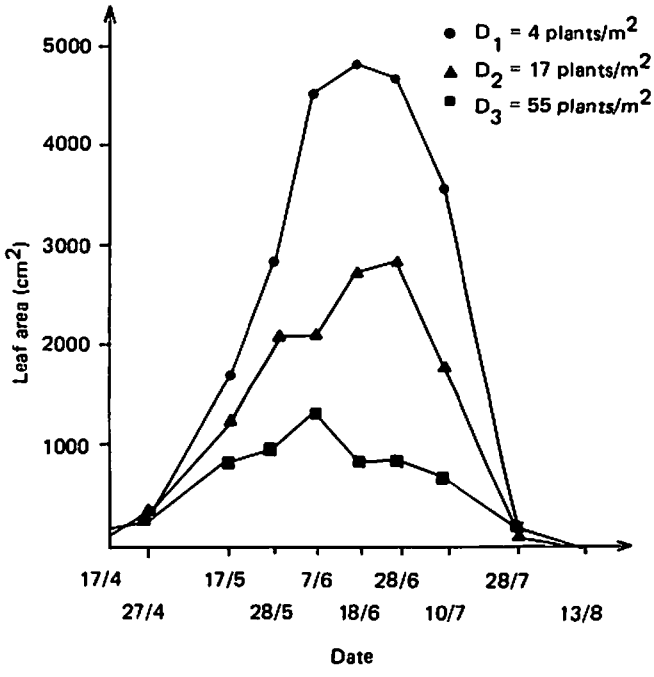

Fig. 1. Leaf area evolution at three plant densities.

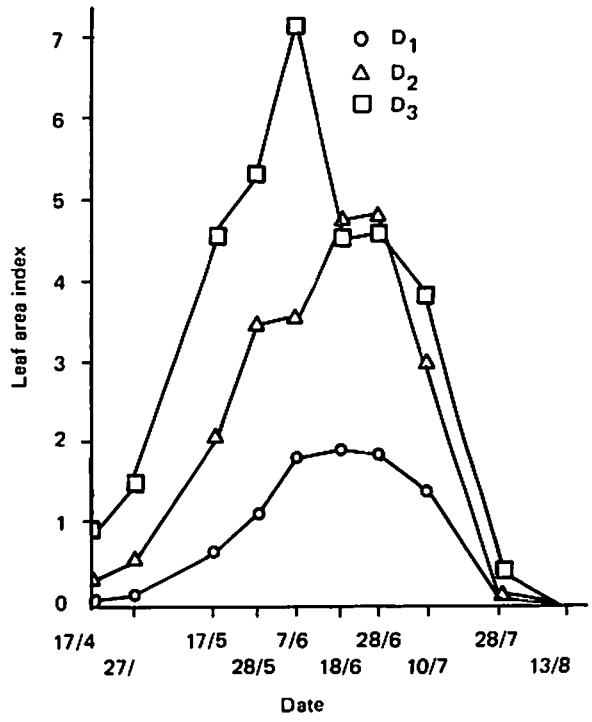

Fig. 2. Leaf area index evolution at three plant densities.

Energy intercepted by the crop

Albedo

Albedo is expressed as the percent of incident PAR (Photosynthetically Active Radiation) and has been studied in relation to time and canopy development.

As a function of time, albedo decreased from 20% to 5% (Fig. 3). There were differences among densities in the values of albedo at the beginning of the study which can be attributed to differences in leaf cover by the different densities. The minimum value for albedo was obtained for a leaf area index of about two (Fig.4) and this did not vary with increasing leaf area index.

On and after 80 days, increases in albedo values for all the densities corresponded to natural leaf

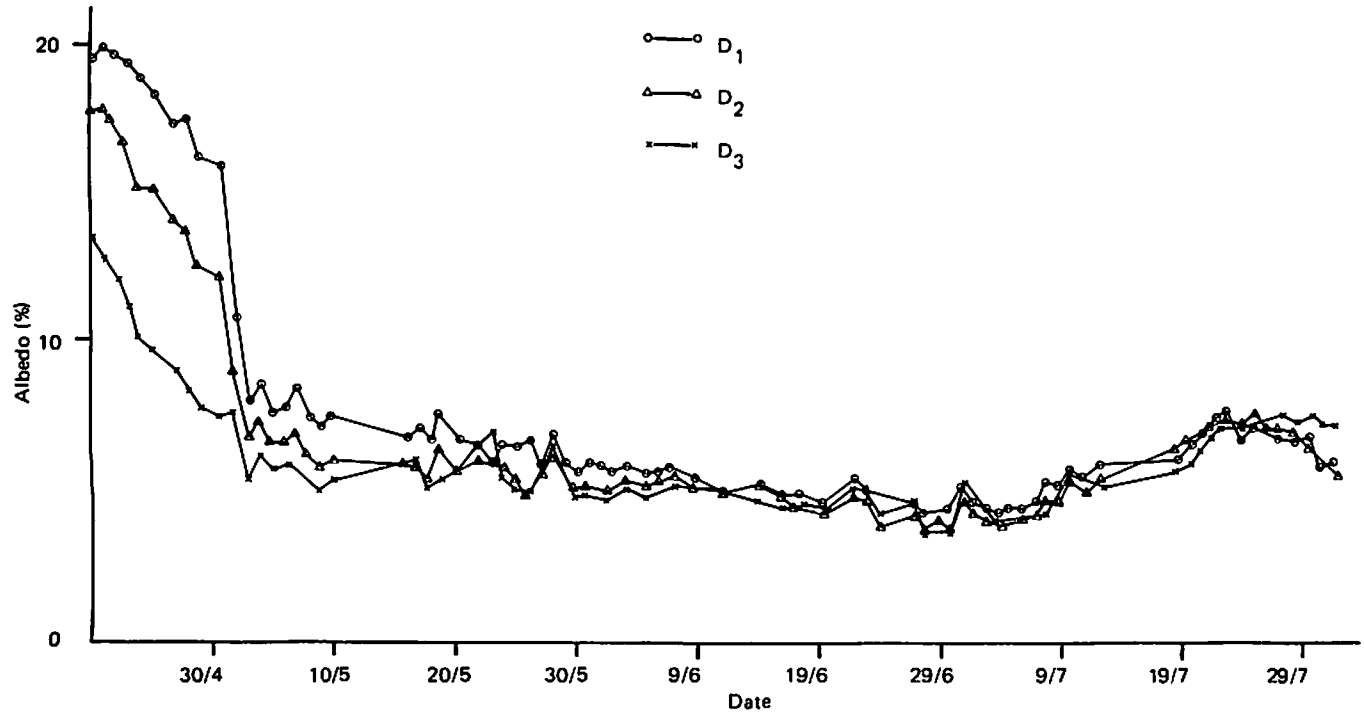

Fig. 3. Evolution of albedo with time.

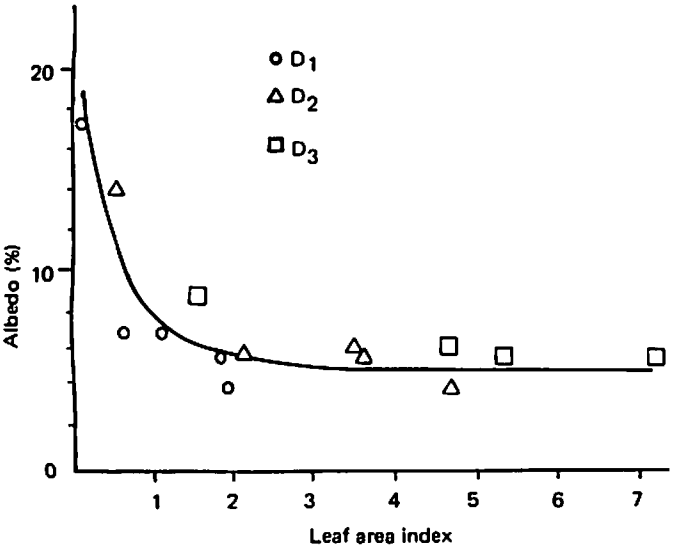

Fig. 4. Relationship between albedo and leaf area index.

loss. The leaf area index showed similar behavior for all densities, indicating that the optical properties of leaves are not affected by variations in density.

Unlike other crops, flowering in faba bean does not induce an increase in albedo, perhaps because the flowers are positioned under the leaf shoots.

Transmitted PAR

Transmitted PAR is expressed as a percentage of incident PAR. For the two highest densities it decreased rapidly with time, reaching a plateau at 4% (Fig.5). The transmitted PAR of the lowest density decreased more slowly and did not fall below 17%. This may be due to less soil cover by the leaves in the lowest density.

As the radiation retained by plants is proportional to the density of leaves through which it passes, transmitted radiation decreases as leaf area index increases (Fig.6). The minimum value for transmitted PAR was obtained for a leaf area index of about four.

The differences in the evolution of transmitted PAR in the three different canopies studied are similar to those noted for variations in the establishment of leaf area.

Consequently, when the leaf index is less than two, leaf cover is insufficient and the values for albedo and transmitted PAR are high as observed at 4 plants/m^2. At leaf area indices between two and four poor leaf cover limits radiation interception, as is the case at 17 plants/m^2. Above four, the leaf area index allows maximum radiation absorption.

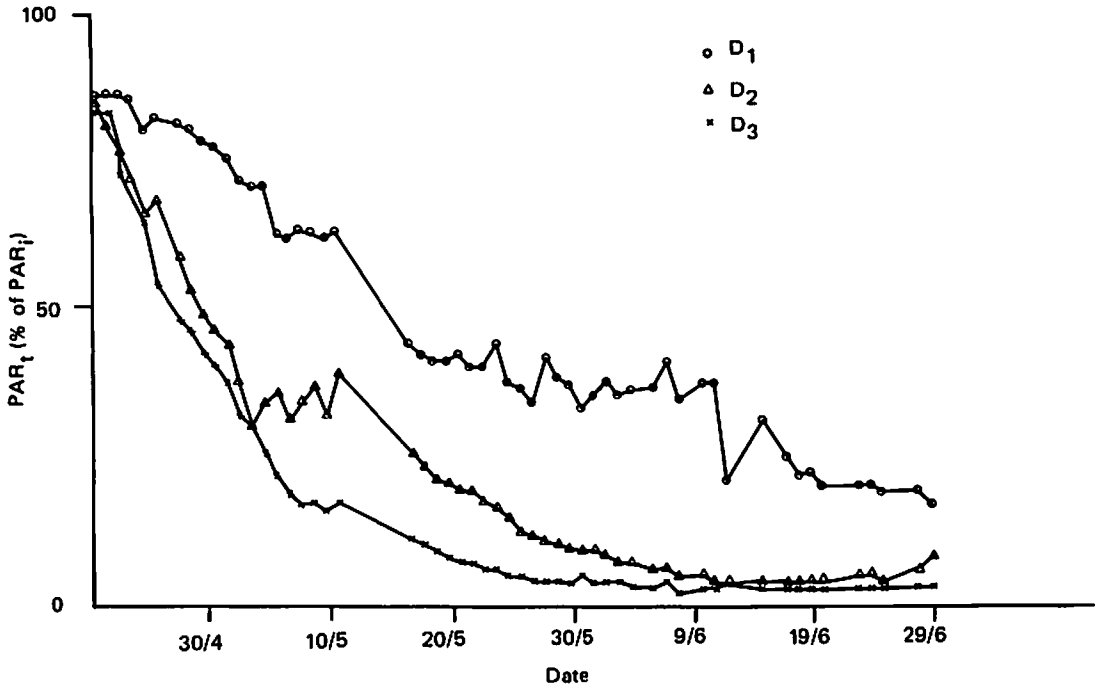

Fig. 5. Evolution of soil-transmitted PAR with time.

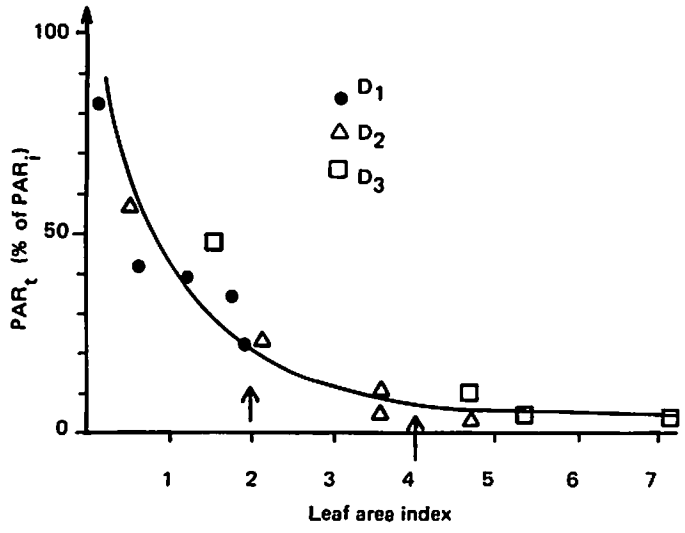

Fig. 6. Relationship between soil-transmitted PAR and leaf area index.

Interception efficiency

In relation to time (Fig. 7)

For the highest density, maximum interception efficiency (0.93) was obtained by the beginning of May, and continued until the beginning of leaf abscission (mid-July). Therefore, maximum interception lasted at least 2 months during the period in which global radiation was maximum. During this time, the leaf area index was always above four, suggesting that inside the canopy there is a leaf level which never receives any incident radiation and which uses energy for respiration but is not involved in transformation.

In the medium density, the value of 0.93 for interception efficiency was also obtained but later and for a shorter period than for the high density. For the lower density, efficiency increased very slowly, reaching a maximum of 0.80 by the end of June. As leaf abscission occurred at the same time as for the other densities, the duration of maximum efficiency was restricted to about 30 days in a period when the photoperiod was decreasing.

High values of interception efficiency remaining after leaf drop were probably due to the green stems which were still photosynthetically active.

In relation to leaf area (Fig. 8)

Interception efficiency increased rapidly with leaf area index, the maximum value occurring at a leaf area index of about 4.

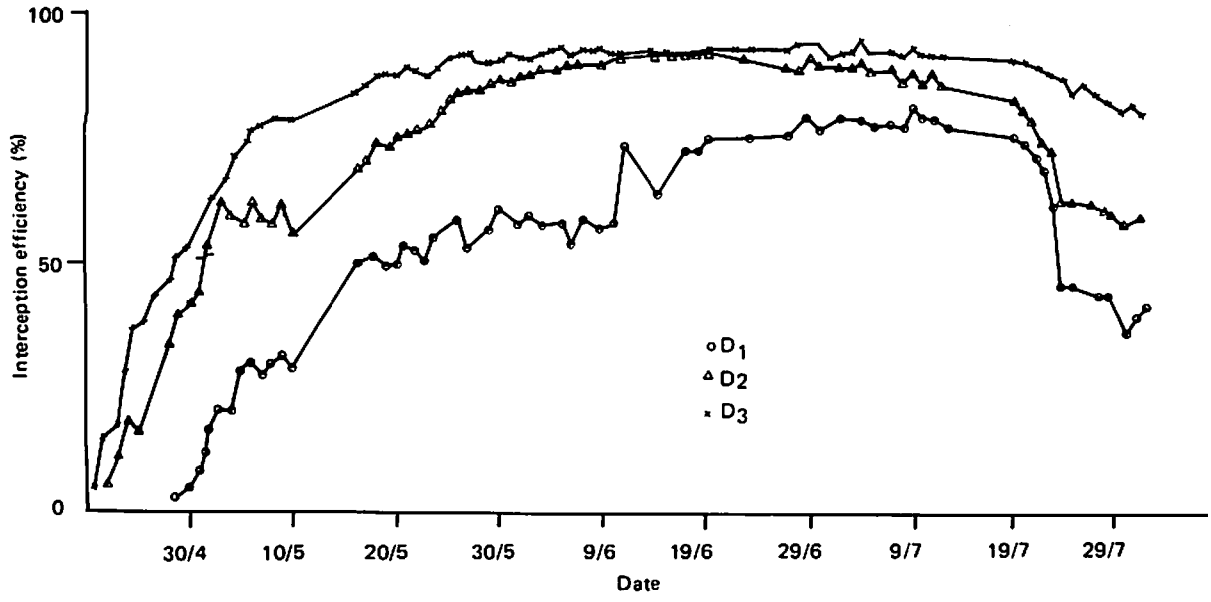

Fig. 7. Evolution of interception efficiency with time;

The curve in Fig. 8 may be obtained by applying Beer's law to the leaf canopy. This gives a general equation connecting interception efficiency to leaf area index. The value of 0.93 obtained is one the best among several crops. According to Varlet-Granchet (1982), the value for *Vigna* sp. does not exceed 0.90 and for alfalfa, 0.78.

Dry matter elaboration

The dry matter varied according to plant density. From the beginning of vegetation (April 17) to the beginning of pod filling (June 28) the weight increases were 6.5, 12.8, and 16.7 g/day/m^2 at 4, 17, and 55 plants/m^2, respectively. During this period, the contribution of the stems to this dry matter increase was 46, 55, and 57% for the three densities, respectively.

At harvest, the dry matter distribution (Fig. 9) was 59, 48, and 41% at 4, 17, and 55 plants/m^2, respectively. Under these conditions, the yield was 3000, 5250, and 4700 kg/ha for the three densities, respectively.

Following Monteith's equation relating dry matter production (MS) to total intercepted radiation (GIR), $MS = a.\ GIR + b$, the calculated equation for faba bean is MS= 0.90x - 1.67 (with r= 0.938), where x is the intercepted total radiation (MJ) and MS is dry matter production (g).

The 'a' coefficient is of the same order as for other crops and is close to the coefficient for alfalfa. These results (Fig. 10) suggest that there is a variable relation between each of the various densities. As a general rule, the higher the density, the higher the coefficient 'a'.

At 17 plants/m^2 the coefficient is very close to that of *Vigna sinensis* (0.81) which is given as characteristic for legumes, while at 55 plants/m^2 the coefficient is very high and comparable to that of fescue (0.94).

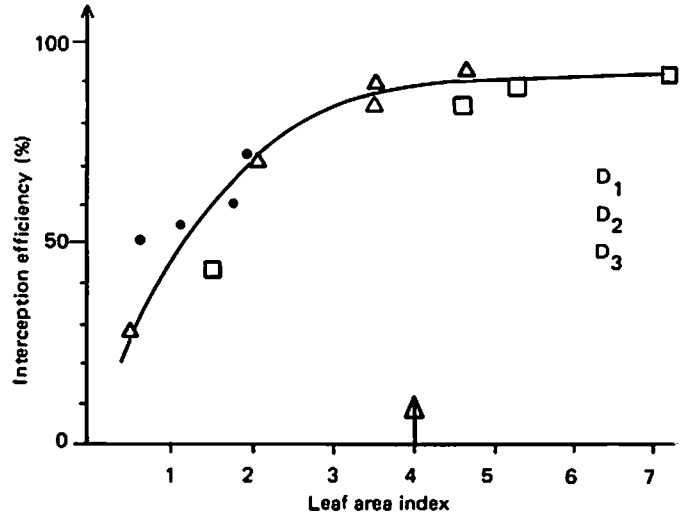

Fig. 8. Relationship between interception efficiency and leaf area index.

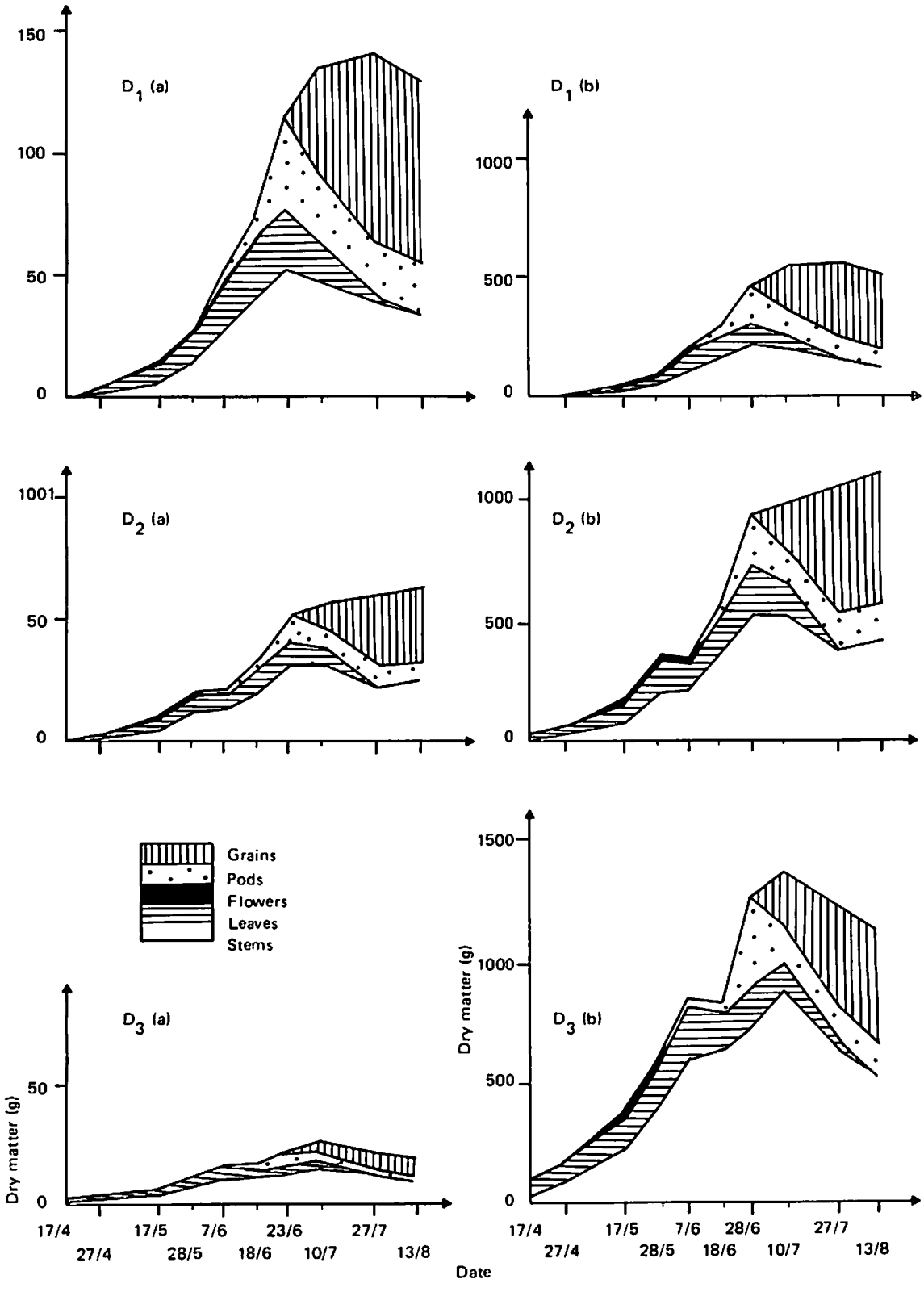

Fig. 9. Evolution of dry matter distribution (a) per plant; (b) per m^2.

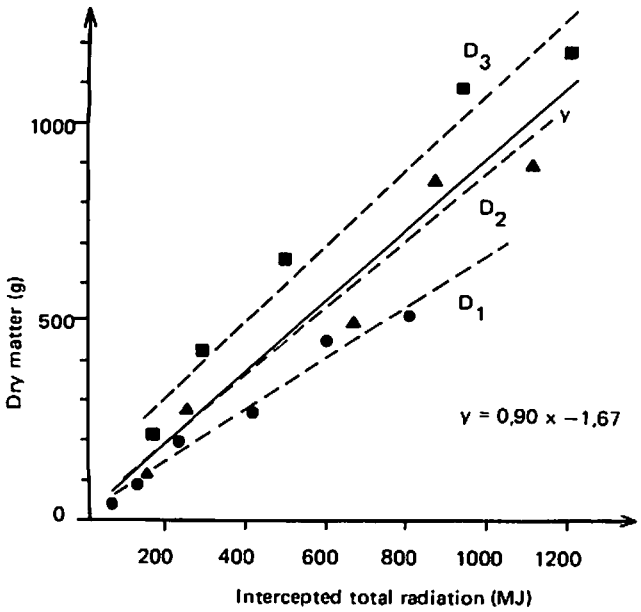

Fig. 10. Relationship between synthesized dry matter and intercepted total radiation.

So, for the same quantity of energy effectively absorbed, the three canopies do not make the same quantity of dry matter. Variations in density induce *not only* changes in light interception but also lead to differences in photosynthesis.

There are a number of hypotheses to explain these observations but we suggest that microclimatic variations in each density produce very different values for several parameters (Poulain, unpublished). For very high densities, the climatic conditions in which plants grow may increase the rate of photosynthesis or reduce respiration and photorespiration resulting in better net photosynthesis. Also, plant physiology may differ according to the ratio of *source* and *sink* levels in the plant. As an example, at low densities, plants with an insufficient sink will not use only photosynthetic assimilates, and this may explain the reduction in dry matter synthesis.

Reference

Varlet-Granchet, C. 1982. Analyse du rendement de la conversion de l'energie solaire par un couvert vegetal. These Doctorat es Sciences Naturelles. *Universite* Paris-Sud, France. 139pp.

Agronomy and Mechanization

Effect of Soil Bulk Density and Moisture Tension on the Mineral Composition and Nutrient Uptake of Faba Bean Plants

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Abstract

In a pot experiment the effects of three levels each of soil bulk density (1.2, 1.35, and 1.5 g/cm^3) and moisture tension (15-80, 2-5 and 0 kPa) on the structure, mineral composition, and nutrient uptake of *Vicia faba minor* cv Bonus were studied. Soil bulk density had a significant effect on plant height and seed weight/plant. Increasing the moisture tension from 0 to 2-5 kPa significantly improved most characters but further increase to 15-80 kPa affected them adversely. Optimum seed yield, mineral composition, and nutrient uptake were reached when the soil bulk density and the soil moisture tension were 1.20-1.35 g/cm^3 and 2-5 kPa, respectively.

Introduction

Faba bean can be grown in heavy soils. It produces a better yields in firm and moist soils because its roots have a lower oxygen requirement. The optimum value of oxygen microdiffusion in soil is 20 µg $O_2/m^2/s$ (Dechnik *et al.* 1986).

The objective of this study was to determine the effects of soil bulk density and moisture tension on faba bean yield components, mineral composition, and nutrient uptake at maturity.

Materials and Methods

The experiment was carried out in pots containing 6.5 kg brown loess soil and using *Vicia faba* L. var *minor*, cv Bonus. The treatments were three soil bulk density levels (1.20, 1.35, and 1.50 g/cm^3) and three soil moisture tension values (15-80 kPa, 2-5 kPa, and 0 kPa). The soil characteristics and methods used were described by Dechnik *et al.* (1986). Records were made of plant height, number of pods/plant, number of seeds/plant, seed weight/plant, stem weight/plant, leaf weight/plant, pod weight/plant, and root weight/plant.

Results and Discussion

The main effects of various treatments on different attributes of faba bean are shown in Table 1. The soil bulk density (SBD) had a smaller effect on the crop structure than the soil moisture tension (SMT). Soil bulk density significantly affected the plant height and seed weight/plant, and an increase in SBD from 1.20 to 1.50 g/cm^3 decreased the seed yield by 22%. The soil moisture tension, however, had a significant effect on most of the characters examined except the pod weight/plant, and an increase in soil moisture increased the seed yield by 7% with the lowering of soil moisture tension from 15-80 kPa to 2-5 kPa.

The average contents of mineral elements in different plant parts are presented in Table 2. The mineral content of seeds varied only slightly due to the factors examined. There was, however, a marked decrease in the N content when the soil was flooded. This may be because flooding hinders oxygen accessibility to the roots, resulting in decreased respiration of the roots which reduces the supply of energy to absorb mineral elements from the soil. This is confirmed by the results of Dechnik *et al.* (1985) and Stepniewski and Labuda (1986).

The average nutrient uptake by faba bean plants is presented in Table 3. With an increase in the soil bulk density there was a decrease in the uptake of all nutrients examined. Increasing soil moisture increased uptake but at O kPa uptake was reduced. The greatest uptake of mineral elements was at a soil bulk density of 1.20 g/cm^3 and moisture tension of 2-5 kPa.

Conclusions

Faba beans require scarified soil with a bulk density of 1.20 - 1.35 g/cm^3 and a moisture tension of 15-5 kPa to achieve good development.

Table 1. Average values of faba bean characteristics as affected by soil bulk density and moisture tension.

Treatment		Plant height (cm)	Number of pods/ plant	Number of seeds/ plant	Seed weight/ plant (g DM)	Stem weight/ plant (g DM)	Leaf weight/ plant (g DM)	Pod weight/ plant (g DM)	Root weight/ plant (g DM)
Soil bulk density (g/cm^3)	1.20	130.09b*	7.91a	24.93a	14.50b	7.53a	3.28a	3.94a	1.08a
	1.35	126.14b	7.52a	23.60a	13.46ab	6.72a	2.76a	3.61a	1.01a
	1.50	114.93a	7.10a	20.95a	11.34a	5.97a	2.95a	3.28a	1.33a
Soil moisture tension (kPa)	15-80	120.29a	7.75ab	23.85ac	13.76b	5.68ab	3.53b	3.63a	1.29ac
	2-5	135.35b	8.18b	25.41bc	14.77b	7.78ac	3.40b	3.93a	0.77a
	0	115.52a	6.60a	20.22a	10.77a	6.76abc	2.07a	3.27a	1.37bc

* The same letters indicate non-significant differences between means ($P < 0.05$).
DM = dry matter

Table 2. Average content of mineral elements in the different parts of faba bean plants expressed in % dry matter.

Plant parts	Element	Soil bulk density (g/cm^3)			Soil moisture tension (kPa)		
		1.20	1.35	1.50	15-80	2-5	0
Seeds	N	4.50	4.42	4.32	4.74	4.62	3.88
	P	0.41	0.41	0.38	0.42	0.42	0.35
	K	0.91	0.94	0.94	0.92	0.97	0.89
	Ca	0.09	0.09	0.09	0.09	0.09	0.10
	Mg	0.06	0.07	0.03	0.06	0.07	0.08
Stems	N	0.60	0.55	0.55	0.61	0.59	0.51
	P	0.03	0.03	0.03	0.03	0.03	0.02
	K	0.70	0.60	0.49	0.66	0.65	0.44
	Ca	0.95	0.91	0.95	0.99	0.84	0.94
	Mg	0.05	0.05	0.03	0.06	0.06	0.06
Leaves	N	1.81	1.79	1.83	1.83	1.94	1.66
	P	0.09	0.09	0.09	0.09	0.09	0.07
	K	1.10	1.08	1.01	1.23	1.15	0.91
	Ca	3.32	4.09	3.96	3.44	3.87	4.69
	Mg	0.41	0.43	0.46	0.49	0.44	0.38
Pods	N	0.79	0.83	0.87	0.83	0.85	0.85
	P	0.02	0.03	0.04	0.03	0.03	0.04
	K	2.17	2.16	1.97	2.13	2.10	2.06
	Ca	0.49	0.54	0.53	0.49	0.51	0.56
	Mg	0.10	0.11	0.09	0.07	0.11	0.12
Roots	N	0.83	0.82	0.90	0.94	0.92	0.99
	P	0.07	0.08	0.08	0.10	0.09	0.08
	K	0.30	0.32	0.39	0.40	0.41	0.41
	Ca	0.70	0.51	0.58	0.86	0.46	0.47
	Mg	0.01	0.01	0.01	0.01	0.01	0.02

Table 3. Average nutrient uptake by whole faba bean plants (mg/plant).

Element	Soil bulk density (g/cm^3)			Soil moisture tension (kPa)		
	1.20	1.35	1.50	15-80	2-5	0
N	308.00	273.42	249.90	304.77	320.62	213.47
P	21.17	18.45	18.37	22.60	24.77	14.60
K	208.47	183.02	155.52	191.47	202.22	145.65
Ca	227.55	201.92	201.40	209.60	226.95	187.20
Mg	23.42	21.62	19.27	20.80	26.55	18.27

References

Dechnik, I., Glinski, J., Labuda, S. and Stepniewski, W. 1985. Model investigation of soil compaction and waterlogging effects on yield and nutrient uptake by rye. Pages 51-54 *in* Proceedings of the 9th World Fertilizer Congress, Vol 2 (Welte, E. and Szaboles, I., eds). Budapest, Hungary, 1984. Goettingen, West Germany.

Dechnik, I., Labuda, S., Glinski, J. and Stepniewski, W. 1986. Response de feverole et lupin jaune a l'accessibilite de l'oxygene aux racines. Zeszyty Problemowe Postepow Nauk Rolniczych 312: 105-113.

Stepniewski, W. and Labuda, S. 1986. The influence of soil oxygen deficiency in different development stages of barley on its yield and nutrient uptake. Transactions of the Thirteenth Congress of the International Society of Soil Science, Hamburg 3: 979-980.

Effects of Differential Irrigation on the Growth and Yield of Faba Bean in the Selaim Basin of Sudan

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Abstract

The objective of this work was to find the most productive irrigation interval for faba bean grown in the Selaim Basin. The treatments were three preflowering (14, 21, and 28 days) and two post flowering irrigation intervals (10 and 14 days). Plant height was significantly affected by the treatments only when the plants were 90 days old. The treatments had highly significant effects on seed yield, consumptive water use, and water use efficiency. Watering at an interval of 2 weeks throughout the growing season was the most productive irrigation regime in terms of seed yield, consumptive water use, number of irrigations, and water use efficiency for faba beans grown in the Selaim Basin.

Introduction

The Selaim Basin is considered to be the most important area for faba bean production in the Sudan. The beans produced there have the highest yield per unit area and the best quality in the country.

One of the major results obtained by the scientists of the Nile Valley Project working at Hudeiba Research Station is that a watering interval of 7-10 days is required for high yields (Ageeb 1983). This has been substantiated by experiments on irrigation according to soil moisture depletion carried out at Hudeiba Research Station (Ibrahim 1983; 1984). This watering interval has now been recommended to the farmers in the Nile and Northern Provinces. However, the experience of farmers in the Selaim Basin and observations of on-farm trials in the area show that this interval is too short and thus it is not realistic for the area. This is because of the milder weather conditions in Selaim area compared with those in the Nile Province (e.g.Hudeiba).

The objective of this work was to determine the most productive irrigation interval *(before and after* flowering) for faba bean production in Selaim area.

Materials and Methods

The experiment was carried out on a clay soil which had a high pH and was nonsaline and nonsodic. The organic matter of this soil is significantly higher than that of the soil at Hudeiba Research Station (Table 1).

The treatments used were:

Treatment	Irrigation interval (days)	
	Preflowering	Postflowering
A_1	14	10
A_2	14	14
B_1	21	10
B_2	21	14
C_1	28	10
C_2	28	14

Treatments were replicated four times in 21.0 m^2 (4.2 x 5.0 m) plots and set up in a randomized complete block design, using faba bean var Selaim local. The first (basal) irrigation was applied on the day of sowing (5 Nov 1985) and the plots were weeded twice, on 15 Dec 1985 and 4 Jan 1986. There was considerable flower shedding in the second week of January due to bird attack. Plant height was measured every 14 days from 4 Dec. to 3 Feb. To estimate the moisture use, soil samples were taken 2h prior to irrigation and 1 day after irrigation, weighed, then dried in an oven at 110°C and reweighed. The crop was harvested on 24 Feb.

Table 2 shows the weather conditions at two sites in Selaim area and also at Hudeiba Research Station. Researchers at Selaim usually use the weather data of Dongla meteorological station (Dongla is on the western bank of the Nile, whereas Selaim Basin is on the eastern bank). Karma meteorological station lies on the same bank as the Selaim Basin and is only 2-3 km from the northeastern border of the Basin. Thus the

Table 1. Chemical and physical properties of the top 30 cm of the experimental soil.

pH	E.C. (mmho/cm)	Field capacity (%)	Permanent wilting point (%)	Total N (ppm)	Bulk density (g/cm^3)	Sand	Silt	Clay
							(%)	
7.9	2.7	36.0	20.3	1029	1.2	30	21	49

Table 2. Meteorological data (means) for Dongla, Karma Basin, and Hudeiba Research Station, November 1985-February 1986.

	Nov	Dec	Jan	Feb
Dongla				
Max. temp. °C	32.7	28.6	26.9	31.2
Min. temp. °C	16.3	13.1	9.8	11.8
Evaporation (Piche, mm)	16.9	14.3	14.5	17.3
Relative humidity (%)	31	39	36	27
Karma Basin				
Max. temp. (°C)	33.3	29.0	27.9	31.8
Min. temp. (°C)	14.3	11.3	8.9	9.5
Evaporation (Piche, mm)	8.9	8.3	8.9	11.2
Relative humidity (%)	28	33	28	18
Hudeiba Research Station				
Max. temp. (°C)	34.8	30.9	30.4	33.4
Min. temp. (°C)	19.6	15.7	14.1	14.9
Evaporation (Piche, mm)	12.6	12.6	12.9	15.0
Relative humidity (%)	30	47	42	34

weather conditions at Karma are closer to those in the Selaim Basin than those at Dongla. The weather conditions at Hudeiba Research Station are presented for comparison.

Results and Discussion

The plants in treatment C1 were the first to flower (9 Dec). Plants in the other treatments started to flower after 12 Dec and by 25 Feb most plants in all the treatments had flowered.

Plant height was taken as an index of growth (Table 3). The treatments had no significant effect on plant height during the period 4 Dec to 16 Jan. However, the treatments significantly affected the plant height measured on 3 Feb. Plants of treatment A2 were the tallest and those of C1 were the shortest (Table 3).

The treatments had no significant effects on straw yield but grain yield was significantly (P=0.01) affected (Table 4). Treatments A2 and C1 had the highest and the lowest seed yields, respectively. The consumptive water use was 270-390 mm and the differences were highly significant. Treatments A1 and B1 had the highest and treatment C2 the lowest consumptive water use (Table 4). The number of irrigations received by the different treatments ranged between 10 (treatment A1) and 7 (treatments B2 and C2). There were highly significant treatment effects on water use efficiency, and treatments A2 and C2 had the highest and the lowest water use efficiency, respectively.

Table 3. Effects of irrigation interval on height of faba bean plants (cm) grown in the Selaim Basin.

Treatment	Date of measurement				
	4 Dec 85	18 Dec 85	2 Jan 86	16 Jan 86	3 Feb 86
A_1	26	48	68	81	100
A_2	25	48	73	90	108
B_1	27	50	68	80	100
B_2	28	47	63	77	91
C_1	28	49	61	70	84
C_2	26	44	58	67	85
SE ±	1.91	3.30	4.75	4.99	4.92**

** Significant at P = 0.01.

Table 4. Effects of irrigation interval on straw and seed yields, consumptive water use, number of irrigations, and the water use efficiency of faba beans in the Selaim Basin.

Treatment	Yield (kg/ha)		Consumptive water use (mm)	Number of irrigations	Water use efficiency (kg seeds/m^3)
	straw	seed			
A_1	5377	3387	391	10	0.866
A_2	6550	4148	313	8	1.340
B_1	7005	3350	392	9	0.876
B_2	5294	3125	286	7	1.091
C_1	5489	2308	250	9	0.661
C_2	5770	3007	270	7	1.125
S.E. ±	637.5	259.6**	17.6**		0.074**

** Significant at P= 0.01.

These results, when compared with those obtained at Hudeiba Research Station for previous seasons (Ibrahim 1983; 1984), clearly show that the faba beans produced at Hudeiba require a larger number of irrigations at short intervals. The yields and water use efficiency at Hudeiba in the past (Ibrahim 1983; 1984) have been lower than those obtained at Selaim Basin in this experiment. This can be explained by the differences in weather and other environmental conditions in the two areas. In particular, the temperature minima are significantly lower at Selaim than at Hudeiba for the months November to February. In addition, the hours of sunshine are longer at Hudeiba than at Selaim. Consequently, the magnitude of evaporation (Table 2) and probably transpiration is much greater at Hudeiba than at Selaim. The results clearly show that treatment A2 (i.e., watering the crop at 14 day intervals throughout the growing season) is the best as it produces the highest grain yield and gives best water use efficiency.

References

Ageeb, O.A.A. 1983. Water relations studies in Sudan. Pages 92-94 *in* Faba Bean in the Nile Valley, Report on the First Phase of the ICARDA/IFAD Nile Valley Project (Saxena, M.C. and Stewart, R., eds). Martinus Nijhoff, The Hague, The Netherlands.

Ibrahim, H.S 1983. Effect of irrigation at different levels of the available soil moisture depletion on the growth and yield of faba beans. Paper presented at the Fourth Annual Coordination Meeting, ICARDA/IFAD Nile Valley Project, 10-14 Sept 1983, Khartoum, Sudan. ICARDA, Aleppo, Syria.

Ibrahim, H.S. 1984. Effect of irrigation at different levels of the available soil moisture depletion on the growth and yield of faba beans. Paper presented at the Fifth Annual Coordination Meeting, ICARDA/IFAD Nile Valley Project, 13-17 Sept 1984, Cairo, Egypt. ICARDA, Aleppo, Syria.

Intercropping Faba Bean with Maize in Denmark

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Abstract

Intercropping of faba bean (*Vicia faba* L.) with maize (*Zea mays* L.) was studied in two field experiments in Denmark. Faba bean was the stronger competitor in the intercrops, especially when it was sown earlier than maize and interplanted maize, grown at the same density as in pure stand. Maize developed slowly in spring, which may have been a disadvantage in the competitive situation. N fertilization with 50 kg N/ha, either broadcast or sidedressed to maize rows, did not significantly influence the competition between the intercrop components. The combined intercrop yields of dry matter, nitrogen, and Land Equivalent Ratios indicated that intercropping faba bean with maize was not advantageous compared to growing pure stands.

Introduction

Intercropping of grain legumes like *Phaseolus* bean, soybean, cowpea, or pigeon pea with maize is a common practice among farmers in the tropics. Intercropping legumes with cereals may be advantageous compared to cultivating in pure stands, because the components can utilize different sources of nitrogen (Willey 1979). The cereal may be more competitive than the legume for soil mineral N, but the legume can fix N_2 symbiotically if effective strains of *Rhizobium* are present in the soil. Furthermore, intercropping of species which differ in the time of their maximum demands on the environmental resources, extends the duration of resource exploitation (Willey 1979). Besides the potential of improved biological efficiency in the utilization of N sources, intercropping maize with legumes may be one way to increase the protein content of maize silage (Daniel 1983). The intercropping of faba bean with spring wheat and pea with barley was studied in Denmark (Andersen *et al.* 1983; Jensen 1986). Such intercrops exploited the environmental resources more efficiently than the pure stands. The aim of the present study was to evaluate row intercropping of maize with faba bean (*Vicia faba* L.) compared to growing pure stands under temperate growth conditions.

Materials and Methods

The field experiments were carried out at Riso in 1980 and 1981 on a sandy loam soil. Fertilizer (30 kg P and 50 kg K) was applied prior to planting. Faba beans (*V. faba* L. *minor*) and maize (*Zea mays* L. cv Fronica) were planted in pure stands and in row intercrops. The faba bean cultivars used were the late Diana and the early ripening Mikko in 1980 and 1981, respectively. Faba bean and maize were sown on 21 Apr and 12 May, respectively, and harvested on 29 Sept 1980. In 1981, both crops were sown on 5 May and faba bean was harvested on 14 Sept and maize on 6 Oct. The planting densities in the pure stands were 70 faba bean and 12 maize plants per m^2 in 1980. The numbers in 1981 were 40 and 9, respectively. The row arrangements in pure stand and intercrop plots are shown in Fig. 1. Nitrogen fertilizer was applied as calcium nitrate at rates of 0 and 50 kg N/ha. The fertilizer was either broadcast or sidedressed for maize. The different fertilizer treatment x crop combinations were arranged in a randomized block design with three replicates. Weeds were controlled by hand weeding.

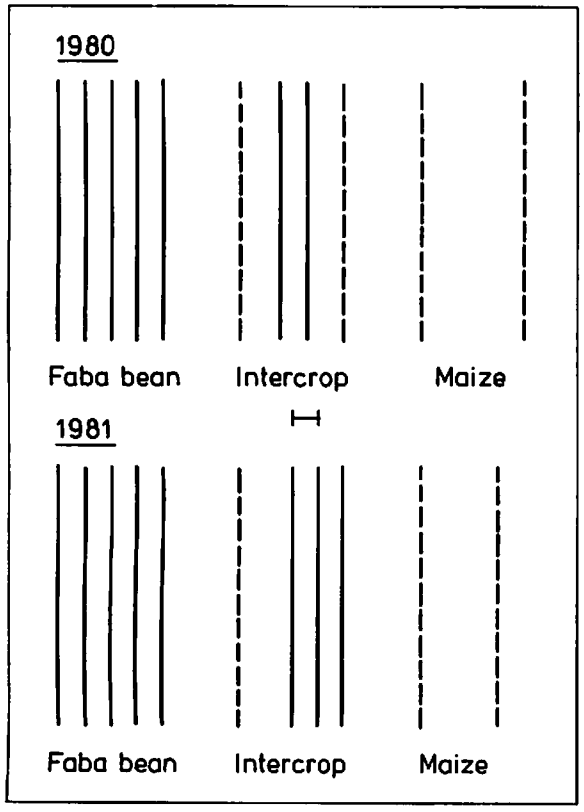

Fig. 1. Row arrangement in pure stands and intercrops of faba bean and maize.

After hand harvesting, maize was separated into cobs and stems, and faba bean into beans and straw. Samples were taken for dry matter (80°C for 20 h) and Kjeldahl nitrogen determinations.

Intercropping advantages were evaluated by calculating the Land Equivalent Ratio, LER (Willey 1979; 1985),

$$LER = \frac{Y_{mb}}{Y_{mm}} + \frac{Y_{bm}}{Y_{bb}}$$

where Y_{mb} and Y_{bm} are the yields of maize and bean, respectively, in the intercropped treatment and Y_{mm} and Y_{bb} are the pure stand yields of maize and faba bean, respectively. Analysis of variance was carried out on the data. LSD (P = 0.05) was used to compare means if F-tests showed significant treatment effects.

Results and Discussion

Maize grown in pure stand was the higher yielding crop in both years, irrespective of the supply of N fertilizer (Figs. 2 and 3). Supplying 50 kg N/ha at sowing did not significantly influence faba bean yield, but increased the total dry matter production of pure maize by 20-30% (Figs. 2 and 3). Side-dressing the fertilizer to the maize rows did not significantly influence the pure stand yield of maize compared to broadcasting the N fertilizer.

The combined intercrop yields were intermediate to the pure stand yields, and the combined intercrop yield was only increased by N fertilization in 1981 (Figs. 2 and 3). The effect of intercropping on both crops was different in the 2 years. In 1980, faba bean was a very strong competitor in the intercrops. This was due to the earlier sowing of faba bean, the slow early development of maize under Danish conditions, and because faba bean was interplanted with maize without changing the maize plant population. This resulted in shading and a reduced maize yield in the intercrop (Fig. 2). Using an 'additive' design (Willey 1979) as in the 1980 experiment, Enyi (1973) and Allen and Obura (1983), found that interplanting legumes (e.g., cowpea) decreased maize yield. In 1981 when a replacement design (de Wit 1960) was used and the intercrop components were sown simultaneously, the competition from faba bean was less harmful to maize, and the yield per maize plant was almost the same in intercrops and pure stands (Fig. 3). Consequently, maize constituted a much higher proportion of the combined intercrop yield in 1981 than in 1980 (Figs. 2 and 3). Beets

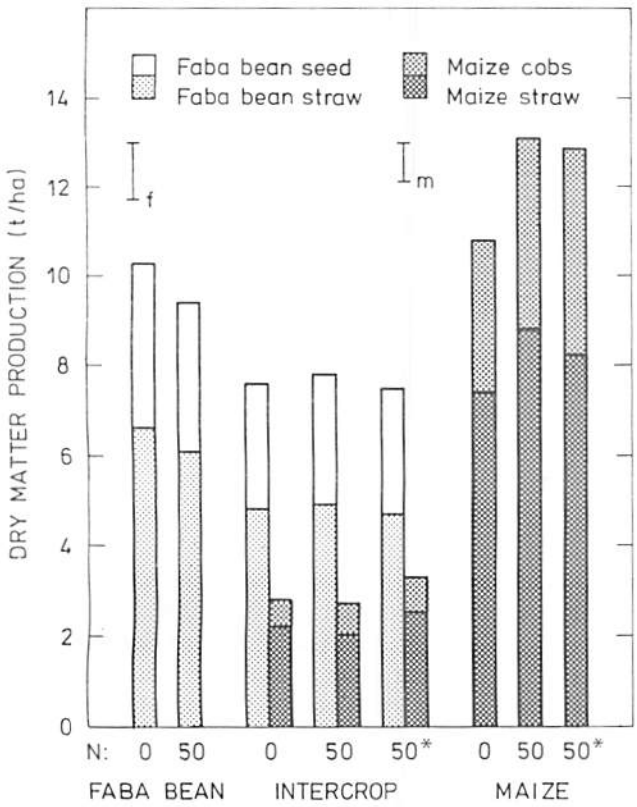

Fig. 2. Dry matter production of faba bean, maize, and row intercrops in 1980. *:N fertilizer sidedressed to maize rows (otherwise broadcasted). Bars indicate $LSD_{0.05}$ for comparison of total faba bean (f) and maize (m) dry matter yields.

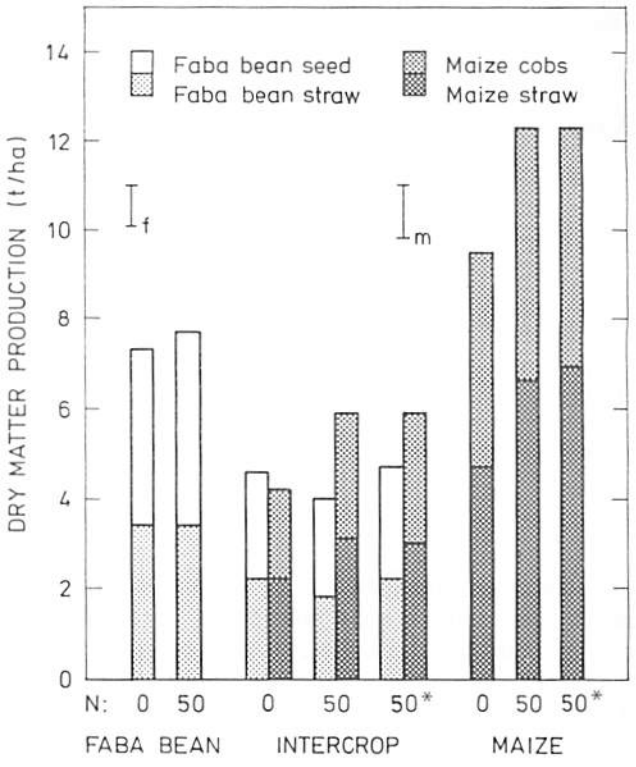

Fig. 3. Dry matter production of faba bean, maize, and row intercrops in 1981 *:N fertilizer sidedressed to maize rows (otherwise broadcasted). Bars indicate $LSD_{0.05}$ for comparison of total faba bean (f) and maize (m) dry matter yields.

(1977) similarly found that maize performed equally well in pure stand and in intercrops with soybean when a 'replacement' design was used. The yield/bean plant was higher in the intercrops than in pure stands in both years.

The nitrogen contents of faba bean straw and seed were not significantly influenced by intercropping and N fertilization (data not shown), but intercropping significantly increased the nitrogen content of maize straw and cobs (Table 1). It was only in the intercrops, which received N fertilizer, that the nitrogen uptake per maize plant was slightly higher in the intercrops than in pure stand (Table 2). In intercrops of faba bean and spring wheat, the individual spring wheat plants took up more soil mineral N than plants in pure stand, indicating a high competitive ability for soil N in wheat (Jensen 1986). Eaglesham *et al.* (1981) found that intercropping of maize with cowpea resulted in a significantly higher nitrogen uptake per maize plant in the intercrops compared to pure stands. In the present experiments, maize was not able to utilize a more than proportional share of the soil N pool. The low competitive ability of maize for soil mineral N may be due to the slow development of maize in spring.

Table 1. Nitrogen concentration (% of DM) in cob and stem of maize as influenced by intercropping and N fertilization.

Crop	N fertilizer kg N/ha	1980		1981	
		Stem	Cob	Stem	Cob
Pure stand	0	0.99	1.28	0.86	1.26
Intercrop	0	1.40	1.58	0.97	1.38
Pure stand	50*	1.15	1.29	0.78	1.24
Intercrop	50*	1.49	1.51	0.86	1.34
Pure stand	50**	1.09	1.27	0.83	1.30
Intercrop	50**	1.43	1.49	0.94	1.42
LSD 5%		0.27	0.15	0.10	0.11

* N fertilizer broadcast; ** N fertilizer side-dressed to maize rows.

Table 2. Total N yield (kg N/ha) in faba bean and maize grown in pure stands and intercrops.

Crop	N fertilizer kg N/ha	1980			1981		
		Faba bean	Maize	Intercrop total	Faba bean	Maize	Intercrop total
Pure stands	0	331	117		237	100	
Intercrop	0	228	40	268	155	30	205
Pure stands	50*	287	157		269	123	
Intercrop	50*	245	39	284	139	65	204
Pure stands	50**		150			128	
Intercrop	50**	231	48	279	157	69	226
LSD 5%		79	19		39	13	

* Broadcast; ** Sidedressed.

Intercrops contained 50% of the number of faba bean plants per unit area in pure stand. From Table 2 it can be seen that the individual faba bean plants in the intercrops assimilated more nitrogen than plants in pure stands. This may be due to higher amounts of N_2 fixed symbiotically.

The advantage gained from intercropping compared to growing pure stands is often evaluated by calculating the LER (Willey 1985). If LER is higher than unity there is an advantage (increased biological efficiency) from intercropping compared to growing pure stands. LER values calculated from the above-ground dry matter production were not significantly higher than unity in 1980, but intercrops had LER values that were slightly higher than unity in 1981 (Table 3). The results indicate that only a minor advantage may be obtained from intercropping faba bean with maize.

Table 3. Land equivalent ratios (LER) calculated from yields of above-ground biomass dry matter.

N fertilizer (kg N/ha)	1980			1981		
	L_b	L_m	LER	L_b	L_m	LER
0	0.74	0.26	1.00	0.63	0.45	1.08
50*	0.83	0.21	1.04	0.53	0.48	1.01
50**	0.73	0.26	0.99	0.65	0.48	1.13

* Broadcast; **Sidedressed; L_b = Ybm/Ybb; Lm = Ymb/Ymm.

References

Allen, J.R. and Obura, R.K. 1983. Yield of corn, cowpea, and soybean under different intercropping systems. Agronomy Journal 75:1005-1009.

Andersen, A.J., Haahr, V., Jensen, E.S. and Sandfaer, J.S. 1983. Effect of N-fertilizer on yield, protein content, and symbiotic N-fixation of *Pisum sativum* L. grown in pure stand and mixtures with barley. Pages 205-217 *in* Perspectives for Peas and Lupins as Protein Crops (Thompson, R. and Casey, R. eds.). Martinus Nijhoff, The Hague, The Netherlands.

Beets, W.C. 1977. Multiple cropping of maize and soya beans under a high level of crop management. Netherlands Journal of Agricultural Science 25: 95-102.

Daniel, P. 1983. Die Erhohung des Proteingehaltes in Maissilagen uber die Erstellung von Mais-Mischsilagen mit Futterleguminosen. Landwirtschaftliche Forschung 36:255-259.

Eaglesham, A.R.J., Ayanaba, A., Ranga Rao, V. and Eskew, D.L. 1981. Improving the nitrogen nutrition of maize by intercropping with cowpea. Soil Biology and Biochemistry 13:169-171.

Enyi, B.A.C. 1973. Effects of intercropping maize or sorghum with cowpeas, pigeon peas, or beans. Experimental Agriculture 9:83-90.

Jensen, E.S. 1986. Intercropping field bean with spring wheat. Vortrage fur Pflanzenzuchtung. (In press).

Willey, R.W. 1979. Intercropping - its importance and research needs. Part 1. Competition and yield advantages. Field Crop Abstracts 32:1-10.

Willey, R.W. 1985. Evaluation and presentation of intercropping advantages. Experimental Agriculture 21:119-133.

de Wit, C.T. 1960. On competition. Verslagen van Landbouwkundige Onderzoekingen 66:1-81.

Pests and Diseases

Host Preference and Biological Aspects of the Looper Worm, Gymnoscelis pumilata Hub. (Lepidoptera: Geometridae)

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Abstract

Laboratory rearing of the looper worm, *Gymnoscelis pumilata*, for two successive generations on five different crops revealed that faba bean, clover, and maize are suitable hosts. Sweet potato and tomato were unsuitable hosts since all larvae reared on these crops failed to develop and died within a few days. The duration of the different stages of the life cycle varied with host plant. On clover, faba bean, and maize the larval stage averaged 21.9, 18.9, and 18.2 days, respectively, and the pupal stage averaged 13.1, 15.1, and 19.0 days, respectively. The average life cycle of females was 53.1, 50.1, and 50.9 days on maize, clover, and faba bean, respectively, while the average male life cycle was 53.1, 49.7, and 47.6 days, respectively. Longevity of females averaged 10.1 days on clover, 12.0 days on maize, and 12.3 days on faba bean and that of males averaged 6.8, 8.0, and 9.1 days, respectively. Egg-laying capacity was 91.4 eggs/female on maize, 59.8 eggs/female on faba bean, and 33.6 eggs/female on clover.

Introduction

Gymnoscelis pumilata Hub. is one of 68 species of looper worms found in Egypt (El-Monziery 1943; Wiltshire 1949). Saad (1965) reported that the larvae of this species cause serious damage to maize yields by feeding on the silk and kernels at the tip of the ears. The larvae also damage clover, tomato, sweet potato, and some ornamental plants. Recently, Kirollos and Moustafa (1986) recognized looper worm as a serious pest of faba bean, feeding on leaves, flowers, and plant tips and causing considerable vegetative damage and flower drop which reduces bean yield.

The present investigation aimed to elucidate the preference of *G. pumilata* for different plant hosts. A comparative study was made of its biology on faba bean, clover, maize, sweet potato, and tomato.

Materials and Methods

The looper worm, *G. pumilata* Hub., was reared on maize silk and the leaves of faba bean, clover, sweet potato, and tomato. Rearing was carried out under laboratory conditions, at an average temperature of 16.2°C and average RH of 75%. For each host, 20 newly hatched larvae were placed in each of 12 petri dishes (10 cm diameter). Fresh food was provided every 2 days.

Pupal weight was recorded and each pupa was isolated in a glass vial with a cotton stopper. At emergence, moths were sexed and each female was confined with a male in a chimney glass. Ten of these glasses were used as oviposition cages, so each was covered with a muslin cloth and placed on a petri dish. As an oviposition site, a faba bean seedling, with its roots wrapped in moist cotton to delay wilting, was placed inside each cage. This rearing technique was used for two successive generations. Daily observations and records were made on the length of egg incubation, larval and pupal stages, preoviposition, oviposition, and postoviposition stages, and generations, longevity of adults, and egg-laying capacity of females.

For each host, the number of larvae that failed to develop and the number of pupae that failed to emerge as adults were also recorded. All data were statistically analyzed.

Results and Discussion

Duration of developmental stages

The duration of the different stages of development of *G. pumilata* reared on maize silk, clover, and faba bean are shown in Table 1. Sweet potato and tomato were not suitable hosts for this insect, since all larvae kept on the leaves of these plants died within 1-2 days.

The egg incubation period was significantly longer on clover than on maize or faba bean (Table 1).

Similarly, the larval stage was significantly longer on clover (Table 1). However, the pupal stage on maize was significantly longer than that on clover or faba bean. The difference between the latter two hosts was not statistically significant (Table 1). The pupal weight was highest when insects fed on maize followed by faba bean then clover. The average weight and range on these hosts was 0.0182 (0.0079-0.0250) mg/pupa, 0.0153 (0.0039-0.0225) mg/pupa, and 0.0074 (0.0016-0.0140) mg/pupa, respectively.

Longevity of adults

Longevity of adult females was insignificantly shorter on clover than on maize or faba bean (Table 1). On the other hand, the longevity of adult males was significantly shorter on clover compared to that on faba bean. On maize, longevity was not significantly different from the other two hosts.

The longevity of males was generally shorter than that of females regardless of host.

Life cycle

The total life cycle of females on maize, clover, and faba beans was more or less the same (Table 1). For males, the total life cycle on faba bean was significantly shorter than on maize, while on clover, the value was intermediate (Table 1).

In general, the life cycle of males was shorter than that of females, especially on clover and faba bean plants.

Fecundity of females

The preoviposition, oviposition and postoviposition periods were not significantly affected by the three hosts (Table 2).

The number of eggs/female was significantly affected by the host, the number being significantly lower on clover than on maize or faba bean (Table 2).

Host preference

Maize silk and faba bean leaves were more suitable hosts for *G. pumilata* than clover (Tables 1 and 2). Larvae completed development in almost a similar period of time on both hosts, whereas on clover leaves, a considerably longer period was required. Also, the fecundity of females was negatively correlated with the feeding period of larvae where there were fewer eggs/female in the clover group with longer larval period. Therefore, host preference in the plants tested could be arranged in the order, maize silk, faba bean (with no significant difference), and clover. Sweet potato and tomato were not suitable hosts.

This study also revealed that *G. pumilata* could potentially be a serious pest of faba beans in Egypt. This has not been previously reported. Saad (1965) studied some morphological and biological aspects of three looper species in Egypt, *Scopula ocholeucaria*, *S. coenesaria luridata*, and *G. pumilata*. Later, El-Sawaf *et al.* (1968) reported that *G. pumilata* only damages maize, tomato, clover, sweet potato, and many ornamental plants, but no comparative evaluations were given.

Table 1. Effect of different host plants on the duration of the different stages of *Gymnoscelis pumilata* (Hub.) reared under laboratory conditions (16.2°C and 75% RH).

Host plants	Duration in days							
	Egg stage	Larval stage	Pupal stage		Adult longevity		Total life-cycle	
			♀	♂	♀	♂	♀	♂
Maize silk	4.73 ± 0.18 (4-6)*	18.23 ± 0.70 (13-23)	19.00 ± 1.30 (12-31)	21.27 ± 1.02 (14-28)	12.00 ± 1.01 (7-19)	8.00 ± 0.22 (7-9)	53.13 ± 1.86 (39-64)	53.07 ± 1.97 (39-63)
Clover	5.93 ± 0.19 (5-7)	21.87 ± 0.88 (15-35)	13.07 ± 0.43 (11-18)	14.33 ± 0.81 (12-22)	10.11 ± 0.60 (7-19)	6.80 ± 0.43 (4-8)	50.13 ± 1.69 (43-64)	49.73 ± 1.62 (41-65)
Faba bean	4.93 ± 0.25 (4-7)	18.90 ± 0.58 (12-23)	15.13 ± 0.74 (7-18)	14.27 ± 0.73 (7-17)	12.33 ± 1.01 (7-19)	9.13 ± 0.54 (7-12)	50.93 ± 1.61 (39-61)	47.60 ± 1.33 (39-59)
"F"	10.08	10.07	11.620	24.506	2.430	6.716	1.725	3.469
P	0.01	0.01	0.01	0.01		0.01		0.05
LSD 0.05	0.598	1.724	2.560	2.235		1.305		4.284
LSD 0.01	0.795	2.293	3.451	3.172		1.759		5.776

* Figures in parentheses show range.

Table 2. Effect of host plants on the length of oviposition periods and the egg-laying capacity of mated female moths under laboratory conditions (19.8°C and 70% RH).

Host plants	Period in days			Number of eggs/ female
	Preoviposition	Oviposition	Postoviposition	
Maize silk	4.20 ± 0.37 (3-5)*	7.00 ± 2.02 (2-13)	1.20 ± 0.20 (1-2)	91.40 ± 17.04 (35-142)
Clover	3.40 ± 0.40 (2-4)	3.20 ± 0.66 (1-5)	3.40 ± 1.12 (1-7)	33.60 ± 7.24 (14-47)
Faba bean	5.00 ± 0.63 (4-7)	5.40 ± 1.44 (1-10)	2.00 ± 0.32 (1-3)	59.80 ± 7.12 (44-72)
"F"	2.21	2.435	2.71	5.096
P				0.05
LSD 0.05				41.832
LSD 0.01				60.812

* Figures in parentheses show range.

References

El-Monziery, A.I. 1943. Egypt Lepidoptera fauna. Technical Bulletin, Ministry of Agriculture, Cairo, Egypt.

El-Sawaf, S.K., Hammad, S.M., Donia, A.R. and Saad, A.H. 1968. Biological studies on *Gymnoscelis pumilata* Hub. Lepidoptera, Geometridae. Bulletin de la Societe Entomologique d'Egypte 58: 41-44.

Kirollos, J.Y. and Moustafa, F.F. 1986. Field observations and laboratory rearing of *Gymnoscelis pumilata* (Hub.), Lepidoptera, Geometridae, as a new potential pest of faba bean, *Vicia faba* (L.) in Egypt. FABIS Newsletter 16: 31-37

Saad, A.H. 1965. Studies on some geometrid insects. M.Sc. thesis. Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

Wiltshire, E.P. 1949. The Lepidoptera of the Kingdom of Egypt (Part 1). Bulletin de la Societe. Fouad Ier Entom. 32: 203-298.

Field Observations and Laboratory Rearing of Gymnoscelis pumilata Hubner (Lepidoptera: Geometridae) as a New Potential Pest on Faba Bean (Vicia faba) in Egypt

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Abstract

A severe infestation of the looper worm, *Gymnoscelis pumilata* was observed on faba bean plants in the Fayoum governorate of Egypt. Field investigations revealed four overlapping generations between November and April. Infestation began soon after emergence and continued till harvest, with the highest intensity during January. The growing points of young plants and tender leaves and pods were attacked, causing characteristic symptoms. A high percentage of shed flowers were infested. Rearing the looper worm on faba bean seedlings under laboratory conditions showed that eggs hatch within 4 - 7 days of deposition. The larval stage (5 instars) averaged 16.5 - 17.8 days and the pupal stage 10.2 - 12.0 days, depending on temperature and relative humidity (RH). Adult females and males lived for 4 - 22 and 3 - 17 days, respectively. Longevity was also affected by temperature and RH. The life cycle was 33 - 64 days in females, and 31 - 55 days in males. An average female deposited 66.2 - 71.6 eggs in 2.8 - 5.8 days. The preoviposition and postoviposition periods averaged 2-5 and 1.6 - 2.2 days, respectively. This study proved that faba bean is a suitable host for this looper worm which is potentially a serious pest.

Introduction

Most bean pests are polyphagous and attack several cultivated legumes and other crops. However, according to Singh *et al.* (1978), El-Sawaf *et al.* (1968), and El-Kifl *et al.* (1974), the looper worm *Gymnoscelis pumilata* Hub. has not been recorded as a pest of faba bean plants. During the 1985/86 season, a serious infestation was observed in faba bean fields in Fayoum governorate.

This study involved field and laboratory investigations to evaluate the symptoms of infestation, infestation percentages of plants and flowers, population fluctuations throughout the season, the number of generations/season, the relationship between infestation and flower drop, and some biological aspects under laboratory conditions (including the duration of different developmental stages, adult longevity, and female fecundity).

Materials and Methods

Field studies

Faba bean, variety Giza 2, was planted in Fayoum governorate on three different dates (15 October, 1 November, and 15 November) during 1985/86. For each date, an area of 1/3 feddan was divided into four equal plots. Weekly samples of 10 plants/plot (40 plants/date) were taken at random and the numbers of eggs and larvae recorded to obtain population dynamics throughout the season.

Infestation levels were determined weekly by examining 100 intact plants (25 plants/plot). To determine the relationship between flower drop and infestation, weekly collections were made of 200 of the fallen flowers, which were then examined for infestation. Data were statistically analyzed.

Laboratory studies

G. pumilata was reared on faba bean leaves in the laboratory in petri dishes of 10 cm diameter and at a temperature and RH of 13.61 - 16.80°C and 64.11 - 71.20%, respectively. Twenty rearing dishes were used, each containing 10 individuals. Eggs were examined daily and fresh leaves were provided every 2 days. For observations on egg incubation, larval and pupal stages, adult longevity, and number of eggs per female, pupae were sexed, weighed, and placed in individual glass vials, according to the method described in Moustafa and Kirollos (1986). Data were statistically analyzed.

Results and Discussion

Field investigations

Population dynamics (eggs and larvae)

Seasonal distribution of *G. pumilata* on faba beans in the field was estimated from the number of eggs and larvae on plants during November - April. Eggs and larvae were present on plants from early November to late April but at different intensities (Table 1 and Fig. 1). Infestation levels throughout the season were 12.5 - 63.8% for plants and 7.0 - 28.5% for flowers, indicating the possibility of serious damage to the crop. The highest egg density occurred in January (5.1 eggs/10 plants), especially during the third week of this month. The highest larval density also occurred during this period, reaching 11.5 larvae/10 plants. The lowest egg and larval densities occurred during April with an average of only 0.67/10 plants in each case.

Severity of infestation

Estimated as percentages of infested plants and flowers, the severity of *G. pumilata* infestation in faba bean (Table 1) was high, ranging between 28.8 (average in April) and 56.3% (average in February). During the main period of vegetative growth (early

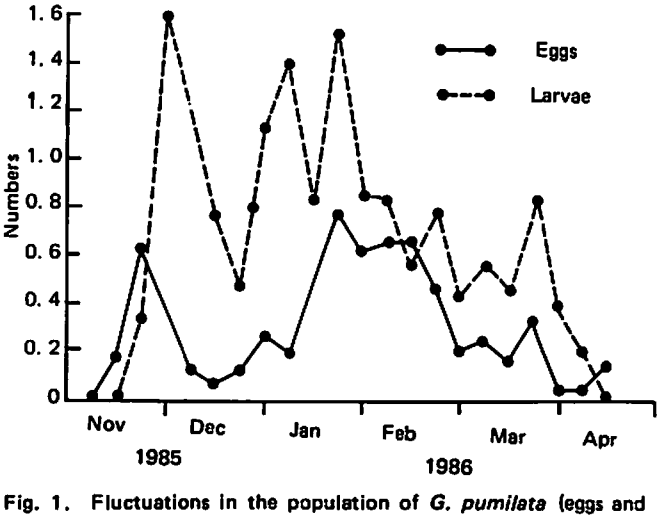

Fig. 1. Fluctuations in the population of *G. pumilata* (eggs and larvae) on faba bean at Fayoum in the 1985/86 season.

Table 1. Seasonal distribution of *G. pumilata* eggs and larvae on faba bean plants and % infested plants and flowers at Fayoum during 1985/86.

Sampling	date	Mean number/10 plants		Infestation (%)	
		Eggs	Larvae	Plant	Flower
November	7	0.0	0.0	0.0	
	15	1.8	0.0	0.0	
	22	6.3	3.3	12.5	
	30	3.5	16.0	47.5	
December	7	1.3	12.5	56.3	
	15	0.8	7.7	58.8	
	22	1.2	4.7	42.5	18.0
	30	2.6	11.3	57.5	13.0
January	7	1.9	14.0	55.0	11.5
	15	4.6	8.3	63.8	28.5
	22	7.8	15.3	47.5	21.0
	30	6.1	8.4	53.8	22.5
February	7	6.6	8.3	62.5	22.0
	15	6.6	5.5	56.5	19.5
	22	4.6	7.8	53.8	12.0
	28	2.0	4.3	52.5	7.0
March	7	2.5	5.6	41.3	24.0
	15	1.6	4.5	43.8	16.0
	22	3.3	8.3	46.3	19.0
	30	0.5	3.8	45.0	
April	7	0.5	2.0	37.5	
	15	1.5	0.0	18.9	
	22	0.0	0.0	30.0	

December to late February), symptoms were evident on more than 50% of plants, which could cause serious damage to bean yield (Fig. 2). Furthermore, 15.5 - 19.7% of the shed flowers showed symptoms of infestation (Fig. 3). Flower drop in faba beans is high, especially in Fayoum, and the high level of looper infestation in these flowers may be one reason for this.

Infestation symptoms and periods of occurrence

As shown in Fig. 2, *G. pumilata* larvae preferred the growing points of faba bean plants, especially during the early stages of growth. They also fed on the tender leaves causing irregular holes in the leaf blades. At flowering, the flowers were also attacked by larvae, which were observed feeding at flower bases, causing characteristic small, round holes. Green tender pods were also attacked,but other pods were not infested. Eggs and larvae could easily be seen on infested plants, for a long period throughout the season. Symptoms appeared 2-3 weeks after planting and continued until harvest. Generally, the preferred site for insect activities was the top of plants.

The periods of occurrence and status of eggs and larvae are shown in Table 2. There were four egg broods in a season. The first brood was medium and lasted for 4 weeks, starting in the second week of November. The second was weak and lasted for 6 weeks starting in the first week of December. The third, which was strong, lasted for 6 weeks, starting in the first week of January. The fourth brood was weak, similar to the second brood, and started in the first week of February.

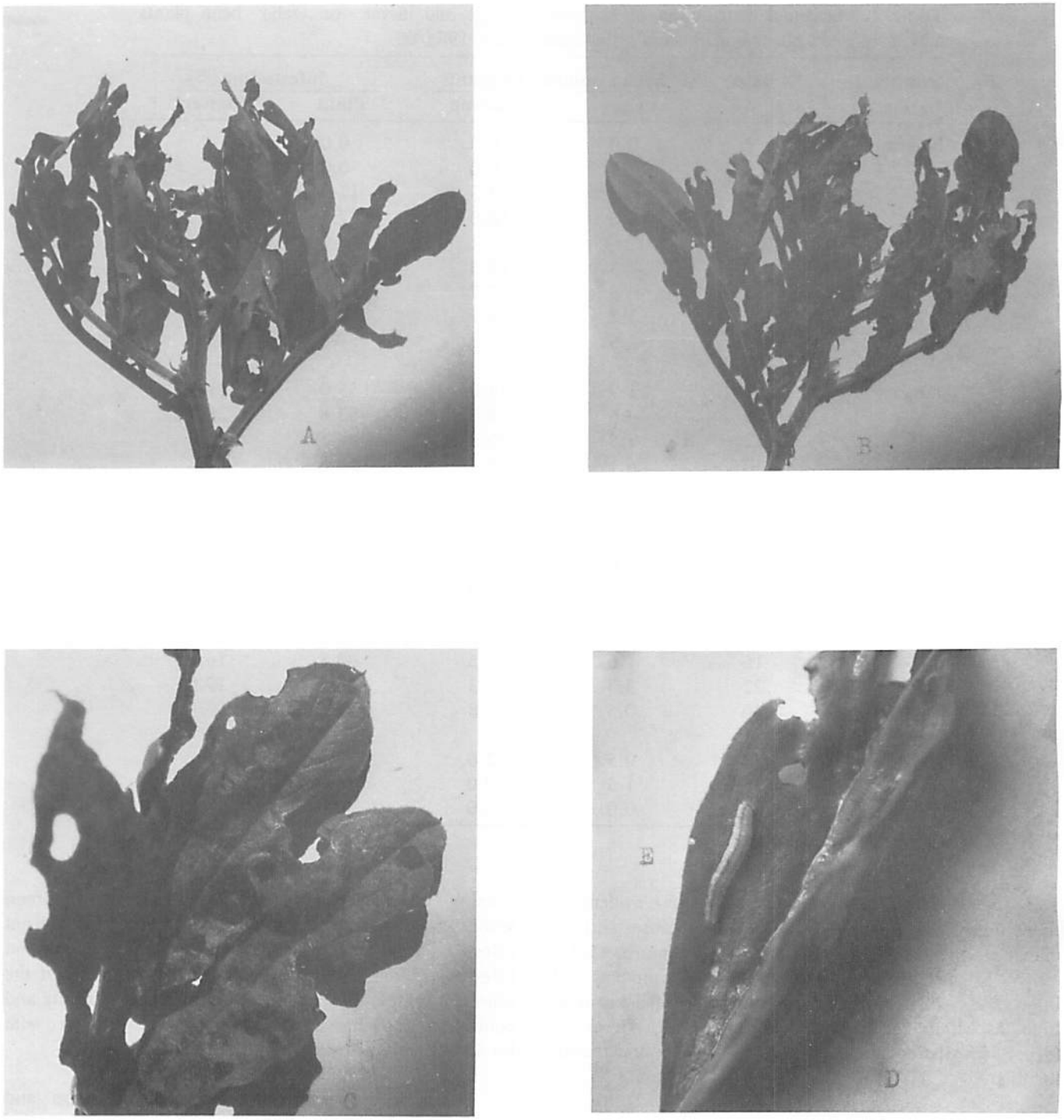

Fig. 2. Symptoms of infestation in faba bean caused by the looper worm *G. pumilata* (A, B plant tops; C, D leaflets; E 5th instar larvae).

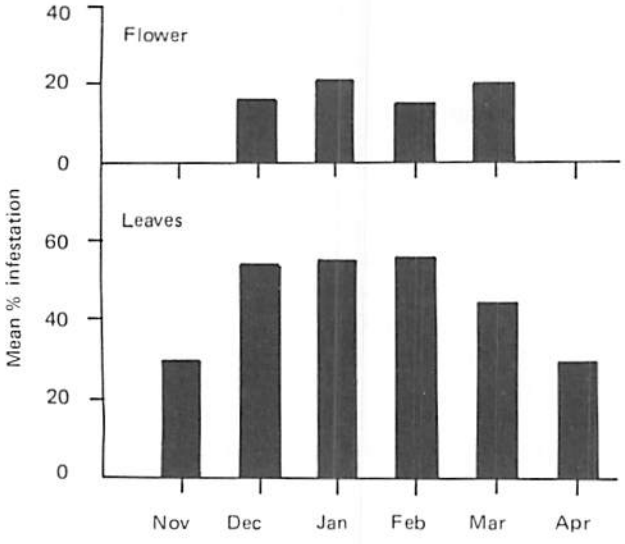

Fig. 3 Infestation levels to faba bean leaves and flowers by *G. pumilata* at Fayoum during 1985/86 season.

The occurrence and status of four broods of larvae throughout the season can also be observed from data in Table 2. The first, second, and third broods were strong while the last brood was medium. The first two broods each lasted 6 weeks from the second week of December to the fourth week of January. The third brood lasted for 7 weeks, starting in the first week of January, and the fourth brood lasted for 4 weeks, starting in the second week of February.

Number and duration of generations

There were four generations of *G. pumilata* throughout the season. The first generation (8 November to 22 December) was the shortest (7 weeks), and the fourth generation (1 February to 15 April) was longest (9 weeks). The second and third generations (1 December to 22 January and 1 January to 22 February, respectively) were both 8 weeks long. (Table 3).

The data indicate how the generations overlap during the 3 week period between each generation.

Laboratory investigations

Biodata of G. pumilata

The durations of the different developmental stages of *G. pumilata* were obtained by growing the worm on faba bean seedlings for three generations, under laboratory conditions. The data obtained are shown in Table 4. The mean temperatures were 16.8, 14.7, and 13.6°C for the first, second, and third generations. The respective RH values were 64.1, 71.2, and 69.1%.

The egg stage. The egg is oval and newly laid eggs are pale yellow, darkening gradually to dark yellow shortly before hatching. Eggs hatched within 4-7 days of deposition and the average incubation period was 5.87, 5.17, and 5.43 days for the three generations tested.

The larval stages. There are five larval instars from egg hatch to pupation and larval development was generally completed in 11-25 days. The larval stage was longer in the third generation, with an average of 17.87 days, compared to the larval stages in the first and second generations which averaged 16.53 and 16.63 days, respectively. This difference may be due to the lower temperature (13.6°C) that prevailed during the third generation (Table 4).

Table 3. Period of occurrence and durations of generations of *G. pumilata* in faba bean crop at Fayoum during the 1985/86 season.

Generation	Periods of occurrence		Generation duration (weeks)
	From	To	
First	Mid Nov	End Dec	7
Second	Early Dec	End Jan	8
Third	Early Jan	End Feb	8
Fourth	Early Feb	Mid Apr	9

Table 2. Periods of occurrence, and status of broods (eggs and larvae) of *G. pumilata* in faba bean crop at Fayoum during the 1985/86 season.

Brood	Eggs Period of occurrence		Status	Larvae Period of occurrence		Status
	From	To		From	To	
First	Mid Nov	Mid Dec	Medium	Mid Nov	End Dec	Strong
Second	Early Dec	Third week Jan	Weak	Mid Dec	End Jan	Strong
Third	Early Jan	Third week Feb	Strong	Early Jan	End Feb	Strong
Fourth	Early Feb	Third week Apr	Weak	Mid Feb	Mid Apr	Medium

Table 4. Biodata for *G. pumilata* reared on faba bean leaves under laboratory conditions.

Generations	Period ranges and means ± S.E. (in days)							
	Egg stage	Larval stage	Pupal stage ♀	Pupal stage ♂	Adult stage ♀	Adult stage ♂	Total life cycle ♀	Total life cycle ♂
First	5.87 ± 0.10 (5-7)*	16.53 ± 0.44 (12-22)	10.20 ± 0.46 (8-15)	10.00 ± 0.35 (9-13)	11.80 ± 1.13 (8-20)	6.80 ± 0.62 (4-10)	44.07 ± 1.35 (37-53)	39.67 ± 1.07 (35-47)
Second	5.17 ± 0.14 (4-7)	16.63 ± 0.59 (11-24)	11.00 ± 0.82 (7-20)	11.47 ± 0.79 (7-20)	7.53 ± 0.79 (4-13)	4.40 ± 0.36 (3-7)	40.73 ± 1.96 (33-64)	37.27 ± 1.53 (31-55)
Third	5.43 ±0.20 (4-7)	17.87 ±0.67 (12-25)	12.67 ±0.71 (9-16)	12.07 ±0.55 (8-15)	14.67 ±0.97 (11-22)	9.73 ±0.95 (4-17)	51.27 ±1.73 (37-64)	44.47 ±1.22 (35-52)

* Figures in parentheses show range.

The pupal stage. The pupa is obtect, usually found inside a light cocoon of white silk. The female pupal stages were 7-20 days, with an average of 10.20, 11.00, and 12.00 days for the three generations tested. The pupal stage in males was the same as in females, and averaged 10.00, 11.47, and 12.07 days, respectively for the three generations. As in the larval stage, the pupal stage in the third generation was longer than other generations, which confirmed that lower temperatures delayed development. The average pupal weight for the three generations was 0.0170 mg (0.0079-0.0258 mg), 0.0102 mg (0.0045-0.0158 mg), and 0.0163 mg (0.0088-0.0240 mg), respectively.

The adult stage. Adult females lived for 4-22 days with an average longevity of 11.8, 7.53, and 14.67 days for the three generations tested. Corresponding averages for adult males were 6.80, 4.40, and 9.73 days (3-17 days). Females lived longer than males and adults of the third generation lived longer than those in the first and second generations when the temperature was low.

The life cycle. The durations of the life cycle are shown in Table 4. The female life cycle was 33-64 days, with an average of 44.07, 40.73, and 51.27 days in the first, second, and third generations, respectively. Males generally had shorter life cycles (31-55 days), averaging 39.67, 37.00 and 44.47 days, respectively.

Fecundity of females. The lengths of the preoviposition, oviposition, and postoviposition periods are shown in Table 5 for the three generations. The mean temperatures were 17.3, 16.3, and 15.4°C for the first, second and third generations, respectively. The respective RH values were 66.2, 70.1, and 70.2%. Mated females started egg laying after 2-5 days in the first and second generations. However, the preoviposition period was prolonged at low temperatures, reaching a maximum of 17 days during the third generation.

The oviposition period was 1-12 days with an average of 5.8, 2.8, and 4.2 days for the three

Table 5. Fecundity of *G. pumilata* females reared on faba bean leaves under laboratoratory conditions.

Generation	Period in days			Egg laying capacity
	Preoviposition	Oviposition	Postoviposition	
First	4.00 ± 0.55 (2-5)*	5.80 ± 1.62 (3-12)	2.20 ± 0.58 (1-4)	71.60 ± 13.91 (34-102)
Second	3.00 ± 0.32 (2-4)	2.80 ± 1.20 (1-7)	1.60 ± 0.40 (1-3)	63.60 ± 9.45 (35-93)
Third	9.00 ± 2.39 (5-17)	4.20 ± 0.66 (2-6)	1.60 ± 0.40 (1-3)	41.40 ± 12.77 (15-82)

* Figures in parentheses show range.

generations, respectively. The postoviposition period was 1-4 days with averages of 2.2, 1.6, and 1.6 days.

As shown in Table 5, the egg laying capacity was 15-102 eggs/female. However, first generation females at 17.3°C and 66.18% RH were more fecund, laying an average of 71.60 eggs/female. Second generation females at 16.32°C and 70.15% RH laid fewer eggs, with an average of 63.60/female. The smallest number of eggs was laid by females in the third generation, with an average of 41.40 eggs/female at an average temperature of 15.38°C and average RH of 70.20%.

References

El-Kifl, A.H., Wahab, A.E.A., Assem, M.A. and Metwally, A.A. 1974. List of insects, mites and pests associated with leguminous crops in Egypt. Bulletin de la Societe Entomologique d'Egypte 58: 297-302.

El-Sawaf, S.K., Hammad, S.M., Donia, A.R. and Saad, A.H. 1968. Biological studies on *Gymnoscelis pumilata* Hub. Lepidoptera, Geometridae. Bulletin de la Societe Entomologique d'Egypte 52: 41-44.

Moustafa, F.F. and Kirollos, J.Y. 1986. Host preference and biological aspects of the looper worm, *Gymnoscelis pumilata* Hub. (Lepidoptera: Geometridae). FABIS Newsletter 16. 29-31

Singh, S.R., Van Emden, H.F. and Ajibola Taylor, T. 1978. Pests of grain legumes: Ecology and control. Academic Press, London, England.

Resistance in Vicia faba to Stem Nematodes (Ditylenchus dipsaci)

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Abstract

Attempts were made to identify useful sources of resistance in *Vicia faba* to *Ditylenchus dipsaci* by evaluating some ICARDA selections in infested fields in Tunisia and Syria. Eleven of the 12 selections resistant to stem nematode previously identified in Syria were also resistant in Tunisia. These were selections from BPL 1, 11, 12, 21, 26, 27, 63, 88, 183, and 40. Selection 82-Lat-47-2 (BPL 40) had a disease rating of 1 whereas the local susceptible check had a rating of 7-9. Incorporation of genes for resistance from these sources into well adapted local cultivars should help to increase and stabilize faba bean yields.

Introduction

The stem nematode, *Ditylenchus dipsaci* (Kuhn) Filipjev, is one of the most important seed- and soil-borne pathogens of faba bean (*Vicia faba* L.) in many parts of North Africa, Europe, and the Middle East (Hanounik and Sikora 1980; Hooper 1971; Hebblethwaite 1983; Caubel 1971). Studies on disease-yield relationships indicated that *D. dipsaci* could reduce faba bean yield by 60%, particularly when large populations of the nematode are present in the soil (Hanounik 1983). Although the use of nematicides (Hanounik 1983) and clean seeds (Hooper 1971) may provide partial crop protection, effective control can be achieved only when host resistance is used as a major component. Previous attempts to identify useful sources of resistance to *D. dispaci* resulted in the detection of only a few lines which did not seem effective enough to develop acceptable disease resistant cultivars (Hooper 1976; 1977).

Therefore, this study was initiated by the International Center for Agricultural Research in the Dry Areas (ICARDA) and the Tunisian National Food Legume Program to identify useful sources for resistance to *D. dipsaci*.

Materials and Methods

Germplasm screening in Syria

Field evaluations of ICARDA's faba bean germplasm lines were made in 1981 and 1982 at Lattakia, ICARDA's sub-site in northern Syria. Large quantities of *D. dipsaci*-infected stems of the susceptible Syrian local cv ILB 1815 were collected from infested fields, cut into 2 cm segments and mixed thoroughly with soil in a ratio of 1:1 (v:v). The soil was watered daily. After 2 weeks the infested soil was diluted with a nematode-free soil until a population density of about 300 larvae/1000 cc soil was obtained. Seeds of 200 faba bean germplasm lines were sown in rows 1 m long and 50 cm apart, with the Syrian local susceptible cultivar ILB 1815 repeated after every five test entries. All seeds were covered to a depth of 15 cm

with infested soil, then irrigated immediately. Disease readings were recorded at about 80% podding, when stem symptoms were well developed on ILB 1815.

In order to identify useful sources for resistance, promising selections detected in 1981 were retested at the same site in 1982 using the same procedures.

In 1981 and 1982 soil samples were collected immediately after planting from five random plots and the initial population density of *D. dipsaci* in the soil was determined (Seinhorst 1962).

Evaluation of *D. dipsaci*-resistant faba bean selections in Tunisia

Based on the local screening in Syria, 12 *D. dipsaci* - resistant faba bean lines were provided for testing in Tunisia in 1984. These lines were planted in a naturally infested field at Krib with the Tunisian faba bean local large seeded cultivar repeated after every two test entries. Disease readings were made, using ICARDA's 1-9 scoring scale (see Table 1 for details), towards the end of the season when stem nematode infections reached an advanced stage on plants of the local check cultivar. The site at Krib was selected for this test because of the very high incidence of stem nematode infections observed on a commercial faba bean cultivar grown at the same site in 1983.

Table 1. Host status of different faba bean germplasm lines in relation to the stem nematode *Ditylenchus dipsaci* in Syria.

Host status[1]	Number and percentage of germplasm lines			
	1980/81		1981/82	
	Number	%	Number	%
R	53	26.5	12	22.6
S	147	73.5	41	77.4
Total	200		53	

[1] Resistant (R) is 1 or 3 and susceptible (S) is 5, 7, or 9 on ICARDA's 1-9 scoring scale, where 1=no infection or very small stem swellings, 3= few stem infections on less than 20% of the plants, 5=stem and leaf swellings on 21-50% of the plants, 7=stunting, elongated necrotic stem infections and moderate defoliation on 51-75% of the plants, and 9= severe stunting, giant necrotic stem swellings and severe defoliation on more than 75% of the plants.

In order to identify races of *D. dipsaci*, fourth stage larvae extracted (Seinhorst 1962) from infected plants in the two tests in both Syria and Tunisia were examined in the laboratory (Goodey 1941).

Results and Discussion

In Syria, stem nematode infections varied considerably among different faba bean lines. Of the 200 lines tested in 1981, 53 were rated 1 or 3, with the remaining 147 lines rated 5, 7, or 9 (Table 1). Plants of the Syrian local cv ILB 1815 were rated 7. Of the 53 promising lines retested at the same site in 1982, only 12 were rated 1 or 3, with the remaining 41 lines rated 7 or 9. All plants of the local cv ILB 1815 were rated 9. The increase in disease scores on plants of ILB 1815 from 7 in 1981 to 9 in 1982, was associated with a considerable decrease in the number of resistant lines (from 53 in 1981 to 12 in 1982). This was due to an appreciable increase in the population density of *D. dipsaci* from about 270 larvae in 1981 to 588 larvae/1000 cc soil in 1982 (Table 2). The buildup in the population of the nematode resulted from the addition of large quantities of infected stems to the soil and from the cultivation of faba beans for two consecutive seasons at the same site.

Results from the evaluation in Tunisia indicated that 11 of the 12 lines provided by ICARDA were also resistant there, whereas the local cultivar was susceptible (Table 3).

Laboratory examinations of the fourth stage larvae extracted from infected plants revealed the presence of the giant race of *D. dipsaci* in both Syria and Tunisia.

This is the first report on the resistance of certain faba bean lines to *D. dipsaci* in two different geographical regions. The incorporation of genes for resistance from these sources into well adapted local cultivars should help increase and stabilize faba bean production, particularly in North Africa and West Asia where stem nematode has long been known to be a serious problem. Additional work is needed to study the stability of resistance in these lines to populations of *D. dipsaci* in other geographical regions.

References

Caubel, G. 1971. Le probleme du nematode des tiges et des bulbes en France. Pages 193-256 *in* Les Nematodes des Cultures. Journees francaises

Table 2. The initial population density of *Ditylenchus dipsaci* in two consecutive seasons at Lattakia, Syria.

Season	Nematode density (larvae/1000 cc soil)						
	Replication						
	I	II	III	IV	V	Average	SD
1980/81	270	230	280	320	250	270	30.3
1981/82	640	570	530	620	580	588	162.7

Table 3. Faba bean (*Vicia faba*) reactions to *Ditylenchus dipsaci* in Syria and Tunisia.

Line no.	Pedigree	Accession	Origin	Disease reaction[1]		
				Syria		Tunisia
				1981	1982	1984
1	Sel.82.Lat-1	BPL 1	Jordan	R	R	R
2	Sel.82.Lat-13	BPL 11	Jordan	R	R	Unadapted
3	Sel.82.Lat-14	BPL 12	Jordan	R	R	R
4	Sel.82.Lat-23	BPL 21	Syria	R	R	R
5	Sel.82.Lat-29	BPL 26	Syria	R	R	R
6	Sel.82.Lat-31-1	BPL 27	Syria	R	R	R
7	Sel.82.Lat-31-2	BPL 27	Syria	R	R	R
8	Sel.82.Lat-76	BPL 63	Iraq	R	R	R
9	Sel.82.Lat-106-1	BPL 88	Iraq	R	R	R
10	Sel.82.Lat-106-2	BPL 88	Iraq	R	R	R
11	Sel.82.Lat-217	BPL 183	Afghanistan	R	R	R
12	Sel.82.Lat-47-2	BPL 40	Syria	R	R	R
13	Syrian local	ILB 1815	Syria	S	S	NT*
14	Tunisian local		Tunisia	NT	NT	S

[1] Disease reactions were recorded as shown under Table 1.

* NT= Not tested.

d'etudes et d'information, Paris, 3-5 Novembre, 1971. Association de Coordination Technique Agricole (ACTA), Paris, France.

Goodey, T. 1941. Observations on a giant race of the stem eelworm *Anguillulina dipsaci*, attacking broad beans, *Vicia faba* L. Journal of Helminthology 19: 114-122.

Hanounik, S.B. 1983. Effects of aldicarb on *Ditylenchus dipsaci* in *Vicia faba*. Page 1194 *in* Proceedings of the 10th International Congress of Plant Protection, 20-25 Nov 1983. The Lavenham Press Limited, Lavenham, Suffolk.

Hanounik, S.B. and Sikora, R.A. 1980. Report of stem nematode (*Ditylenchus dipsaci*) on faba bean in Syria. FABIS Newsletter 2: 49.

Hebblethwaite, P.D. (ed.). 1983. The Faba Bean (*Vicia faba* L.). Butterworths, London. 573 pp.

Hooper, D.J. 1971. Stem eelworm (*Ditylenchus dipsaci*), a seed and soil borne pathogen of field beans (*Vicia faba*). Plant Pathology 20: 25-27.

Hooper, D.J. 1976. Stem eelworm (*Ditylenchus dipsaci*) on field beans (*Vicia faba*). Pages 202-203 *in* Rothamsted Experimental Station Report for 1975, Part 1. Rothamsted Experimental Station, Harpenden, Herts., England.

Hooper, D.J. 1977. Stem nematode. Page 205 *in* Rothamsted Experimental Station Report for 1976, Part 1. Rothamsted Experimental Station, Harpenden, Herts., England.

Seinhorst, J.W. 1962. Modification of the elutriation method for extracting nematodes from soil. Nematologica 8: 117-128.

Seed Transmission of Broad Bean Stain Virus in the Wild Legume Vicia palaestina Boiss

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Abstract

Seed-transmissibility of broad bean stain virus (BBSV) was investigated in a number of wild legume species. Germinating axes of seeds collected from BBSV-infected plants were tested by the enzyme-linked immunosorbent assay (ELISA). The virus was found to be seed-transmitted in *Vicia palaestina*.

Introduction

In a recent study Makkouk *et al.* (1987) indicated that a number of wild legumes naturally occurring in Syria are susceptible to BBSV infection. The importance of these species as potential reservoirs and sources of virus inoculum in the field is, however, increased if the virus is also seed-transmissible. The purpose of this study was to investigate whether or not the virus is transmitted in the seeds of these species.

Materials and Methods

Seeds from forty-four wild leguminous spp. naturally occurring in Syria were collected by the Genetic Resources Program of ICARDA. Of these species, 11 were found to be susceptible to BBSV infection in a previous study (Makkouk *et al.* 1987) and they were included in this work (Table 1).

Using three pots per species, 5-10 seeds were sown per pot and kept in the glasshouse. Three to four weeks after sowing, plants were mechanically inoculated with a BBSV isolate from Syria (SV 173-85). For each species, one pot was left uninoculated and served as the healthy control. After maturity, seeds from infected and healthy plants were collected and replanted in sterilized sand. The germinated seedlings (7-10 days after sowing) were then tested for the presence of BBSV by ELISA. The BBSV anti-serum used in the test was produced earlier in our laboratory. Seedlings were tested in groups, depending on the number of seeds available for each species.

Results and Discussion

Table 1 shows that among the 11 species tested, BBSV was found to be seed-borne only in *V. palaestina* (Fig. 1). It cannot be concluded, however, that BBSV is not seed-borne in all the other species tested because the number of seeds tested in some of them was very low. Seed production of BBSV-inoculated plants of some of the species such as *M. constricta*, *T. nigriscens*, *T. resupinatum*, and *T. subterraneum* was very low under glasshouse conditions.

Table 1. Detection of broad bean stain virus by ELISA[a] in germinating embryo axes of seeds collected from BBSV-infected wild leguminous species.

Plant species	Total number of seeds tested	Number of groups	Number of infected groups
Medicago arabica (L.) Huds.	112	11	0
M. constricta Dur.	8	1	0
M. polymorpha var. brevispina L.	28	3	0
Trifolium lappaceum L.	252	25	0
T. nigriscens Viv.	5	1	0
T. resupinatum L.	4	1	0
T. subterraneum L.	3	1	0
T. spumosum L.	150	15	0
T. tomentosum L.	21	3	0
Trigonella arabica Del.	50	5	0
Vicia palaestina Boiss.	29	3	2

[a] Values higher than those of the healthy mean plus five standard deviations were considered positive.

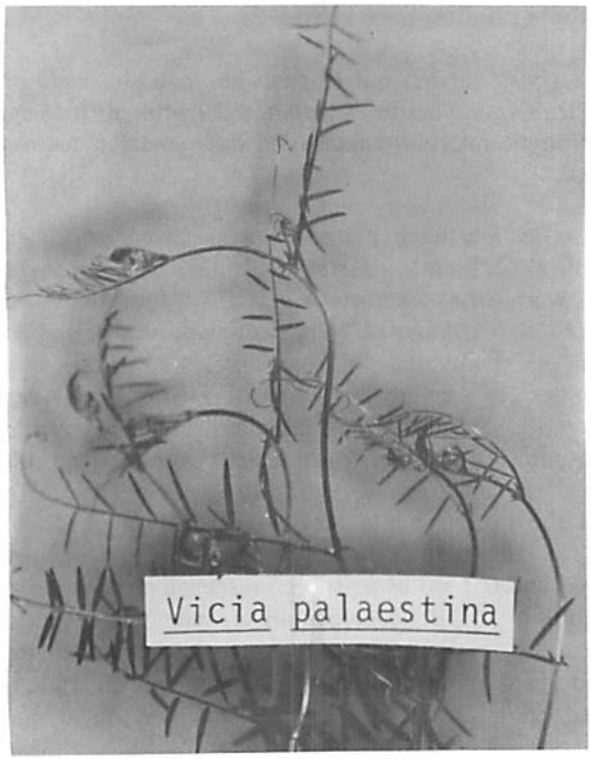

Fig. 1. *Vicia palaestina.*

All the wild legumes listed in Table 1 can play the role of BBSV reservoir in nature. Infection can spread from these species to susceptible crops such as faba beans, lentils, peas, french bean, etc. through weevil vectors (Cockbain *et al.* 1975). However, since most of these species are annual winter legumes they cannot increase the chances of BBSV survival over the dry hot summers unless the virus is seed-borne. This characteristic permits the virus to perenate. Since BBSV was found to be seed-borne in *V. palaestina*, this wild legume can, therefore, play an important role in the ecology of the virus. *V. palaestina*, known locally as "Kirsannah-barri", is a morphologically variable wild leguminous species naturally present in the East Mediterranean region including Turkey, Syria, Lebanon, Jordan, and Cyprus (Davis 1970; Post 1932). This is the first report of seed-transmissibility of BBSV in *V. palaestina.*

Acknowledgments

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References

Cockbain, A. J., Cook, S. M. and Bowen, R. 1975. Transmission of broad bean stain virus and Echtes Ackerbohnemosaik-virus to field beans (*Vicia faba*) by weevils. Annals of Applied Biology 81: 331-339.

Davis, P. H. 1970. Flora of Turkey and the East Aegean Islands. Edinburgh University Press, Edinburgh, UK. 628 pp.

Makkouk, K. M., Bos, L., Azzam, O. I., Katul, L. and Rizkallah, A. 1987. Broad bean stain virus: identification, detectability with ELISA in faba bean leaves and seeds, occurrence in West Asia and North Africa and possible wild hosts. Netherlands Journal of Plant Pathology. (In press).

Post, G. E. 1932. Flora of Syria, Palestine and Sinai. Volume 1. American Press, Beirut, Lebanon. 658 pp.

Inhibition of Botrytis fabae in the Phyllosphere of Vicia faba Leaves

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Abstract

***In-vitro* studies on *Botrytis fabae* - *Vicia faba* interactions indicated the presence of a strong inhibitory phyllosphere effect on the pathogen before penetration into leaf tissue. Washings from leaflets of the resistant faba bean lines BPL 1179 and 710 significantly suppressed spore germination and germ-tube elongation of *B. fabae*, compared to those from leaflets of the susceptible line R-40. Additional work is needed to differentiate between the effects of epiphytic microorganisms and those of leaflet diffusates on *B. fabae*. These investigations should help in the identification of new mechanisms of resistance to the pathogen.**

Introduction

Studies on host-pathogen interactions have indicated that the invasion of faba bean cells by *Botrytis fabae*

or *B. cinerea* activates the production of high levels of phytoalexins (Purkayastha and Deverall 1964; Deverall and Vessey 1969; Letcher *et al.* 1970; Mansfield and Deverall 1974a; 1974b). However, reports on the passive mechanisms of resistance that occur in the phyllosphere, before the invasion of leaf tissue, are fragmentary (Rossall and Mansfield 1980).

Previous studies with several species of *Botrytis* in the absence of chocolate spot-resistant faba bean lines (Mansfield and Hutson 1980) showed that, although spores of *B. cinerea* germinate poorly on faba bean leaves, the addition of pollen grains or orange juice to the spores on the leaf surface improved spore germination and germtube elongation, and induced the development of the aggressive phase of chocolate spot, which is normally caused by *B. fabae* (Myra and Preece 1968). However, recent studies indicated that the poor spore germination and germtube development of *B. cinerea* and *B. elleptica* on susceptible faba bean leaves were due to the strong inhibitory effects of epiphytic bacteria and leaf diffusates, which were inefficient enough to suppress germination of *B. fabae* (Rossall and Mansfield 1980). This study showed strong inhibitory effects in the phyllosphere of chocolate spot-susceptible lines on the weak pathogens *B. cinerea* and *B. elleptica.* However, it provided no information on the possible phyllospheric inhibitory effects of chocolate spot-resistant materials against the virulent pathogen *B. fabae.* Therefore, the present investigations were initiated to examine the phyllosphere effects of resistant and susceptible faba bean lines on germination of *B. fabae* before invasion of leaf tissue.

This work is important because resistant materials were not available in the past to create a differential host reaction with *B. fabae.*

Materials and Methods

These *in-vitro* studies were conducted in the laboratory at ICARDA's subsite in Lattakia, Syria.

Healthy and physiologically uniform leaves, at the sixth node position, were detached from the chocolate spot-resistant faba bean lines BPL 1179 and 710, and also from susceptible line R-40. The plants had been grown in the field. Leaves from each line were divided into two sets, each set being used for a different test.

The whole phyllosphere effects

This test was carried out to study the combined effects of extraneous leaflet substances, leaflet diffusates, and epiphytic microorganisms and their metabolites on *B. fabae.*

Two leaflets were placed in a sterilized petri dish containing 2.5 ml of sterile distilled water. These leaflets were then incubated at 20°C for 48 h to enhance the leakage of fresh leaflet diffusates and to help in the production of any possible antagonistic metabolites by epiphytic microorganisms. After incubation, extraneous substances and epiphytic microorganisms and their metabolites were washed off the leaflets carefully by brushing a very gentle brush against the leaflets while they were still immersed in water in the petri dishes. The leaflets were then removed and 0.1 ml of a spore suspension containing 0.5 million of *B. fabae* per ml of water was added to the leaflet washings. All petri dishes were incubated again at 20°C for 48 h, then spore germination and germtube length were measured under the microscope.

The effect of leaflet diffusates on *B. fabae*

This test was conducted to study the effect of leaflet diffusates alone on *B. fabae.*

Faba bean leaflets were surface disinfected for 2 min in 10% Clorox solution (0.5% sodium hypochlorite), then washed thoroughly but very carefully in sterile distilled water to remove any residual Clorox, extraneous leaflet substances, or any metabolites which may have been produced on the leaf surfaces by epiphytic microorganisms during the season. These leaflets were then placed in petri dishes and incubated at 20°C for 48 h to enhance the leakage of leaflet diffusates. After incubation the leaflets were removed and spores of *B. fabae* were added to the 2.5 ml of water containing the leaf diffusates. After incubation, the spores were examined for sporulation and germtube elongation as previously described.

A complete randomized block design with four replicates was employed for each test.

Results and Discussion

In the first test, washings from leaflets of the chocolate spot-resistant lines BPL 1179 and 710 significantly suppressed (P=0.05) spore germination

(Fig. 1) and germtube elongation (Fig. 2) of *B. fabae*. This was apparently due to the strong inhibitory effects of extraneous substances, leaf diffusates, and/or the antagonistic action of epiphytic microorganisms in the phyllosphere of these lines. Susceptible line R-40 did not seem to have such a marked effect on spore germination and germtube elongation (Figs. 1 and 2).

In the second test, washings from the Clorox-treated leaflets gave similar but less dramatic effects on spore germination and germtube elongation (Figs. 1 and 2). This indicates that the erosion of extraneous substances and/or the antagonistic action of epiphytic microorganisms decreased the phyllosphere effects against *B. fabae*, and that the combined effects of these phyllospheric components with leaflet diffusates are apparently greater than the effect of leaflet diffusates alone.

These preliminary findings indicated, in general, the presence of a stronger inhibitory effect in the phyllosphere of the chocolate spot-resistant lines BPL 1179 and 710 compared to that of the susceptible line R-40.

Although leaf diffusates from Clorox-treated leaflets significantly suppressed *B. fabae* (P=0.05) before the invasion of leaf tissues, procedures adopted in these tests were insufficient to differentiate completely between the inhibitory action of different components in the phyllosphere of faba bean leaflets.

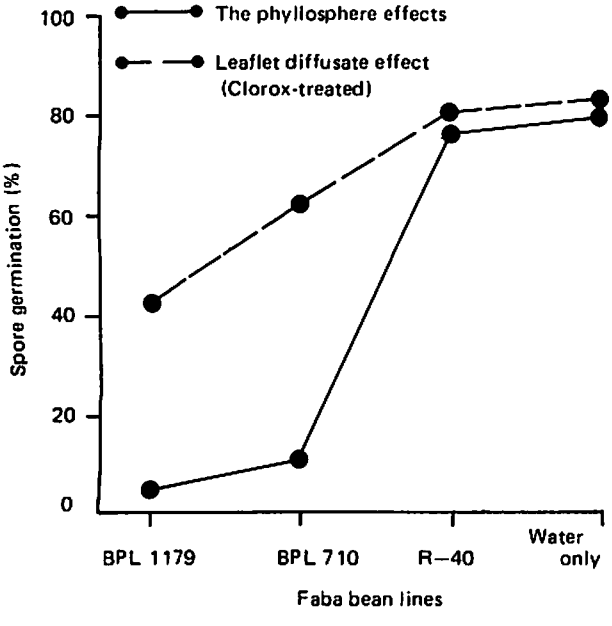

Fig. 1. Effects of different phyllosphere components of leaflets of the chocolate spot-resistant (BPL 1179 and BPL 710) and susceptible (R–40) faba bean lines on spore germination of *Botrytis fabae*.

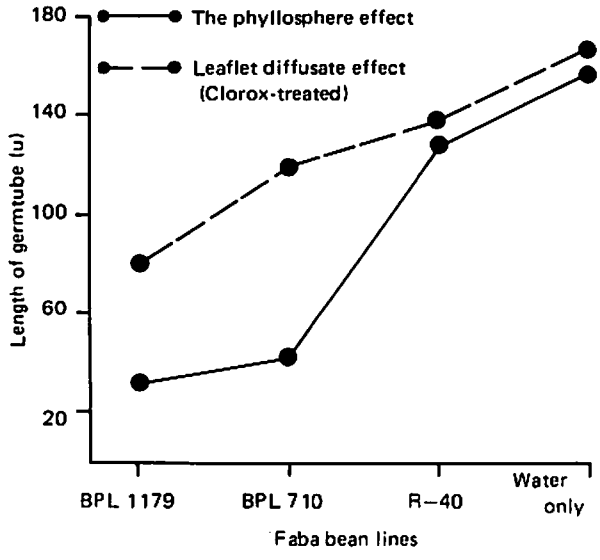

Fig. 2. Effects of different phyllosphere components of leaflets of the chocolate spot-resistant (BPL 1179 and BPL 710 and susceptible (R–40) faba bean lines on germtube elongation of *Botrytis fabae*.

Therefore, these preliminary studies should be continued in gnotobiotic isolator chambers (growing plants aseptically under organism-free conditions) to separate the effects of epiphytic microorganisms and their biologically active metabolites from the effects of leaf diffusates and host substances in the phyllosphere that affect the spores of *B. fabae* before penetration into leaflet tissue. These investigations will be continued in the future to study new passive mechanisms of resistance and identify some phyllospheric antagonists that could play an important role in the biological control of *B. fabae*. These investigations will also be used to develop a new *in-vitro* screening technique to identify new sources of resistance to chocolate spot. This is the first report on the presence of strong inhibitory effects against *B. fabae* in the phyllosphere of leaflets of the chocolate spot-resistant lines BPL 1179 and 710.

References

Deverall, B. J. and Vessey, J. C. 1969. Role of a phytoalexin in controlling lesion development in leaves of *Vicia faba* after inoculation by *Botrytis* sp. Annals of Applied Biology 63: 449-458.

Letcher, R. M., Widdowson, D. A., Deverall, B. J. and Mansfield, J.W. 1970. Identification and activity of Wyeron acid as a phytoalexin in broad bean (*Vicia faba*) after infection by *Botrytis*. Phytochemistry 9: 249-252.

Mansfield, J.W. and Deverall, B.J. 1974a. Changes in wyerone acid concentration in leaves of *Vicia faba* after infection by *Botrytis cinerea* or *B. fabae*. Annals of Applied Biology 77: 227-235.

Mansfield, J.W. and Deverall, B.J. 1974b. The rate of fungal development and lesion formation in leaves of *Vicia faba* during infection by *Botrytis fabae*. Annals of Applied Biology 79: 77-89.

Mansfield, J.W. and Hutson, R.A. 1980. Microscopical studies on fungal development and host responses in broad bean and tulip leaves inoculated with five species of *Botrytis*. Physiological Plant Pathology 17: 131-144.

Myra, C.C. and Preece, T.F. 1968. The effect of pollen grains on infections caused by *Botrytis cinerea* Fr. Annals of Applied Biology 62: 11-22.

Purkayastha, R.P. and Deverall, B.J. 1964. A phytoalexin type of reaction in the *Botrytis* infection of leaves of bean (*Vicia faba* L.). Nature 201: 938-939.

Rossall, S. and Mansfield, J.W. 1980. Investigation of the cause of poor germination of *Botrytis* spp. on broad bean leaves (*Vicia faba* L.). Physiological Plant Pathology 16: 369-382.

Sporulation of Botrytis fabae as Affected by Dextrose and Faba Bean Leaf Extract

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Abstract

Sporulation of *Botrytis fabae* is affected by several factors which include the nutritional requirements. In this study, spore production at different concentrations of faba bean leaf extract and dextrose was investigated. In the first experiment three isolates of *B. fabae* (Homs-3, Egy-34, and Lat-710 were grown on faba bean dextrose agar (FDA) containing five different concentrations of dextrose (0, 5, 10, 15, and 20 g/l). In the second experiment isolate Lat-710 was grown on FDA containing three concentrations of dextrose (0, 10, and 20 g/1), and four concentrations of leaf extract (0, 100, 200, and 300 g/1). Spores were counted after 12 days of light treatment. Isolates Homs-3 and Egy-34 produced only very few spores/cm^2 (up to 50). Lat-710 produced a very high number of spores (0.18 million spores/cm^2) at 0 g/l which was increased ten-fold at 5 g/l. There were no further increases in spore numbers at higher concentrations. Sporulation in Lat-710 was influenced independently by leaf extract and dextrose, leaf extract having a significantly greater effect than dextrose.

Introduction

Chocolate spot, caused by *Botrytis fabae* is one of the most important diseases of *Vicia faba worldwide* (Hanounik and Hawtin 1982). The pathogen does not sporulate easily so information concerning factors that induce sporulation is essential for effective screening and detection of new sources for resistance.

B. fabae grew very fast in faba bean dextrose agar (FDA) and faba bean leaf extract dextrose agar (FLDA) in Holetta Research Centre Pathology Laboratory but did not produce spores (IAR 1986). However, a large number of spores were produced using special techniques at ICARDA's sub-site in Lattakia (Hanounik and Maliha 1984).

The experiment reported here was conducted at ICARDA's subsite in Lattakia, Syria, 1986 to determine the number of spores produced on FDA containing different concentrations of dextrose, and leaf extract and dextrose.

Materials and Methods

Two experiments were conducted to determine: (a) the sporulation of three *B. fabae* isolates (Homs-3, Egy-34, and Lat-710) on faba bean dextrose agar (FDA) containing five concentrations of dextrose (0, 5, 10, 15, and 20 g/1) in a completely randomized experiment with four replications, and (b) the spore production of Lat-710 as affected by combinations of four concentrations of leaf extract (0, 100, 200, and 300 g/l) and three concentrations of dextrose (0, 10, and 20 g/l) in a factorial experiment with three replications.

In both experiments, a disc of culture from a previous isolation was placed at the center of the medium in a petri dish and incubated at 20°C for 24 h. The culture was subjected to 12 h alternating light treatment at 20± 2°C.

After 12 days, cultures were washed with 10 ml of water. Two samples from each replication were taken and 50 µl from each sample placed on a petri dish and covered for microscopic examination. The number of spores/cm^2 was statistically analyzed and general observations on growth and sclerotial formation were made.

Results and Discussion

Isolates Homs-3 and Egy-34 yielded fewer than 50 spores/cm^2 while Lat-710 yielded 0.18 million spores/cm^2 at 0 g dextrose/l and 1.22 million at 5 g/l. Further increases in sporulation were not observed at higher dextrose concentrations (Table 1). These

Table 1. Sporulation of *Botrytis fabae* on faba bean dextrose agar containing different concentrations of dextrose.

Dextrose (g/l)	Number of spores/cm^2		
	Homs-3	Egy-34	Lat-710
0	12.6	20.5	0.18
5	13.1	21.2	1.22
10	13.1	48.7	1.15
15	13.9	44.0	1.05
20	34.6	42.4	1.11

results indicate that isolates Homs-3 and Egy-34 did not produce many spores regardless of the dextrose concentration, while isolate Lat-710 sporulated abundantly on FDA.

In the second experiment sporulation occurred in media containing combinations of different concentrations of leaf extract and dextrose (Table 2). Highly significant differences in sporulation were observed for leaf extract and dextrose concentrations but the interaction was not significant. The increase in leaf extract concentration influenced the sporulation of Lat-710 irrespective of dextrose level and *vice versa*. However, at 0 g/l of leaf extract sporulation did not occur. Sporulation was increased more with leaf extract than with dextrose. Moreover, sclerotial formation was faster and greater as the

Table 2. Sporulation of *Botrytis fabae* isolate Lat-710 as affected by different concentrations of dextrose and leaf extract.

Leaf extract (g/l)	Dextrose (g/l)			
	0	10	20	Mean
0	0	0	0	0
100	259	366	774	466
200	691	927	1173	930
300	991	1729	1768	1496
Mean	485	756	929	

SE= ± 6.48 (Leaf extract), ± 2.06 (dextrose), ± 0.61 (interaction).

dextrose concentration was increased from 10 to 20 g/l but no sclerotia were formed when dextrose was not added.

In general the isolates of *B. fabae*, Homs-3 and Egy-34, required special treatment to ensure sporulation besides the treatment considered in this test. With Lat-710 the maximum number of spores was 1.2 million/cm^2.

Acknowledgement

I am grateful to Dr. S. Hanounik, ICARDA's faba bean pathologist at Lattakia for his guidance. I also thank Dr. Ahmed Mohammed Hasanain, Plant Pathologist, Plant Pathology Institute, Giza, Egypt, for his suggestions and encouragement. Thanks are also due to Mrs. S. Sheikho for typing the manuscript and her assistance in the library. Finally, I gratefully acknowledge the training fellowship offered by ICARDA which enabled me to conduct this work at Lattakia.

References

Hanounik, S.B. and Hawtin, G.C. 1982. Screening for resistance to chocolate spot caused by *Botrytis fabae*. Pages 243-250 *in* Faba Bean Improvement: Proceedings of the Faba Bean Conference (Hawtin, G. and Webb, C., eds). ICARDA/IFAD Nile Valley Project, 7-11 Mar 1981, Cairo, Egypt. Martinus Nijhoff Publishers, The Hague, The Netherlands.

Hanounik, S.B. and Maliha, N. 1984. Pathogenic and cultural variability in *Botrytis fabae*. FABIS Newsletter 10: 21-24.

IAR (Institute of Agricultural Research). 1986. Crop protection progress report for 1985/86, Addis Ababa, Ethiopia. (In press.)

Comparison of Some Methods for Evaluation of Reaction of Different Winter Faba Bean Genotypes to Botrytis fabae

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Abstract

Reaction of nine genotypes of faba bean (*Vicia faba*) and one of narbon vetch (*Vicia narbonensis*) to *Botrytis fabae* was studied using the detached leaf technique and under artificial infection in pots and in the field. Although the genotypic differences could be identified with each method, there was little consistency in the ranking perhaps because each method tends to express a particular phenomenon related to the crop's defence mechanism against the disease.

Introduction

In France, the winter faba bean (*Vicia faba* L.) is subjected to attacks of several pathogens which can cause considerable losses in yield. *Ascochyta fabae* is the first to infect faba bean plants during winter, followed by *Botrytis fabae* in spring, and *Uromyces fabae* and *Peronospora* sp. in June. *B. fabae* is considered to be the most common and serious of these pathogens. Chemical control and modified cultural practices provide only partial control. Therefore breeding for disease resistance is of major importance in controlling this disease.

This work aimed to study the performance of seven lines and two varieties of *V. faba* and one related species (*Vicia narbonensis*) to *B. fabae* using three methods of artificial inoculation; detached leaves maintained at survival level (Mohamed *et al.* 1980; Khalil and Harrison 1981; Abou-Zeid 1985), whole plants grown in pots (Gondran 1978; Elliot and Whittington 1979), and field inoculation (Hanounik 1983).

Materials and Methods

The plants

Based on Gondran's (1978) findings the following lines and varieties were selected for this study. Seven lines (two English LCF and S45, five French 245.17, 48B, 3.33, 29E, and 29H), two synthetic varieties (Bourdon and Soravi), and one related species *V. narbonensis* which is slightly susceptible to *B. fabae*.

The experiments were conducted at Le Rheu Station. In the field, plants were grown in 5.4 m^2 plots with a population density of 25 plants/m^2 using Fisher blocks in triplicate. Sowing was on 27 October 1983 and 27 November 1984 for the cropping seasons 1983/84 and 1984/85, respectively. In pots, three seeds were sown per pot (14 cm in diameter), each of which contained equal proportions of arable soil, brown peat, and sand. After 5 weeks of vernalization at 4°C (8 h of photoperiod) the plants were kept in a greenhouse until inoculation.

Inoculum increase

The fungus was grown on two different media. Faba bean leaf extract medium, as described by Leach and More (1966), was used to prepare the spore suspension for inoculation of detached leaves and whole plants in pots. On this medium the fungus produced a large number of spores, which tend to lose their infectivity with time (Last 1960). After 10 days' incubation at 20°C under black light (435 nm), the spores were collected in 5 ml sterile water by gently passing an elbowed Pasteur pipette over the surface of the colonies, then filtered through sterile gauze. Barley grain medium was used to produce inoculum for field inoculation. The fungus was propagated on barley grains which were placed in Erlenmeyer flasks, moistened, and autoclaved twice at 120°C for 1 h, at 24 h intervals. The inoculum was added to the grains and the flasks were incubated at 20°C. After 1 month the grains were covered with large numbers of *B. fabae* sclerotia.

To preserve the aggressiveness of *B. fabae*, the fungus was reisolated from infected plants each year, kept in a malt extract agar medium, then plated on the above media to stimulate sporulation.

Methods of inoculation and data collection

Detached leaves maintained at survival level

Detached leaves were placed on slides in petri dishes, 14 cm in diameter, containing filter paper saturated with 10 ml of sterile water. The petioles of each leaflet were cut longitudinally to avoid possible interactions among leaflets of the same leaf. Each end was covered with moistened cotton to preserve leaf turgidity. A drop (20 µl) of spore suspension

containing 0.005 million spores/µl was applied to the center of each leaf. Inoculated leaves were then incubated at 20°C. Data were recorded on the number of spots/leaflet (recorded every 12 h after the appearance of disease symptoms), disease development (recorded daily after the first lesions started to coalesce using the scale established by Abou-Zeid in 1985), and sporulation (evaluated by collecting the spores of each leaflet in a fixed volume of sterile water).

Whole plants in pots

The plants were inoculated twice, at the 5-7 leaf stage and at flowering (28 February 1984 and 19 March 1985). Each plant was inoculated by spraying a spore suspension containing 0.05 million spores/ml. After inoculation the plants were kept in a phytotronic enclosure at 96% relative humidity, at a temperature of 20 and 15°C during the day and night, respectively, and with 16 h of photoperiod.

Whole plants in the field

To simulate natural infection, barley grains infected with *B. fabae* were distributed among the plants at the rate of 5 grains/plant.

In both seasons, plants were inoculated 4 months after sowing (26 March 1984 and 25 April 1985). To enhance the disease development inoculated plots were sprinklered as soon as the daytime average temperature reached 18 °C.

For both whole plants in pots and in the field the data were recorded according to Gondran's (1977) disease scoring scale.

Results

Detached leaves

Chocolate spot symptoms were evident on faba bean lines 7-8 h after inoculation and after 9 h on narbon vetch (*V. narbonensis*). The disease symptoms started as a few small spots which significantly increased in number with time (Fig. 1) The average number of spots/leaflet varied significantly among the different lines (Table 1): 15 h after inoculation it was 6.1 and 19.4 on faba bean lines S45 and 29 H, respectively, and 2.3 on narbon vetch. The average time needed for new spots to appear ranged from 0.5 h on narbon vetch to 4.1 h on faba bean lines 29 H and 3.33.

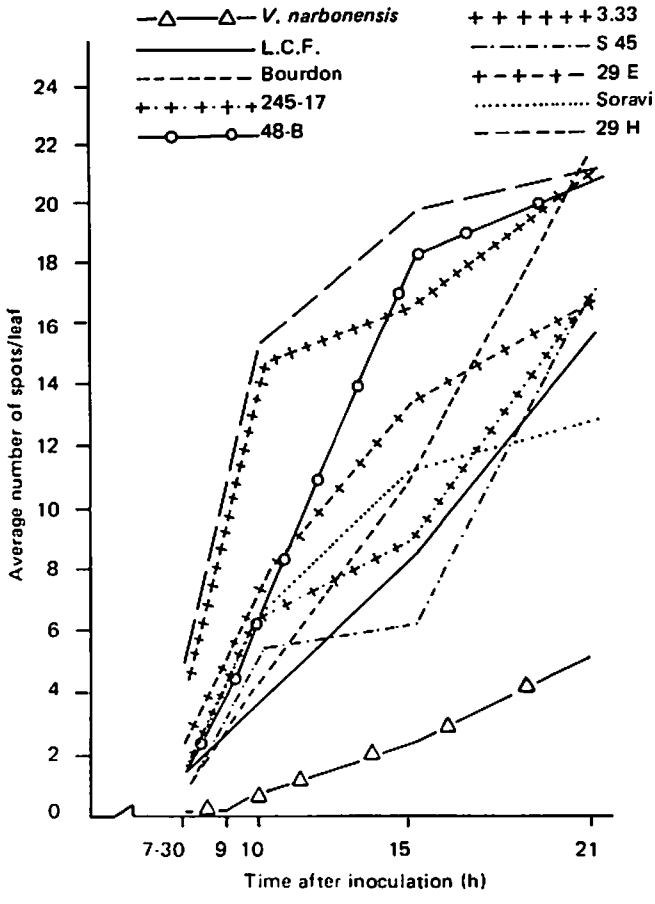


Fig. 1. Average number of spots appearing on detached leaves of nine genotypes of *V. faba* and one of *V. narbonensis* (v.n.) after inoculation with *B. fabae*.

Spot coalescence started 24-36 h after inoculation and the size of the spots significantly increased with time. Six days after inoculation the average disease scores were 4.4-7.9 for faba bean lines 29 H and 48B, respectively, and 5.2 for narbon vetch (Table 1).

Sporulation was estimated 11 days after inoculation. Considerable differences in sporulation were detected among the 10 lines tested, with the average number of spores produced by each line ranging from 0.02 to 1.0 million spores/leaflet on faba bean lines 29 E and Bourdon, respectively. Sporulation on vetch was intermediate with 0.6 million spores/leaflet (Table 1).

Whole plants in pots

Table 2 shows the average disease scores of plants inoculated at the 6-8 leaf stage and at flowering. At both stages there were significant differences in disease score, but the differences among lines

Table 1. Average reaction of detached leaves of nine genotypes of *V. faba* and one of *V. narbonensis* (*V.n.*) to *B. fabae*.

Appearance of symptoms				Disease development		Sporulation	
No. of spots 15 h after inoculation		Speed of new spot formation (spot/h)		Disease score 6 days after inoculation		No. of spores/leaflet 11 days after inoculation (million)	
V.n	2.3	*V.n.*	0.5	29H	4.4	29E	0.02
S45	6.1	LCF	1.1	Soravi	4.9	S45	0.04
LCF	8.7	Bourdon	1.6	29E	5.0	29H	0.09
245.17	9.1	29E	1.8	S45	5.1	245.17	0.10
Bourdon	11.0	S45	1.9	*V.n.*	5.2	3.33	0.30
Soravi	11.1	245.17	1.9	LCF	6.4	Soravi	0.30
29E	13.3	48B	2.2	Bourdon	6.6	*V.n.*	0.60
3.33	16.6	Soravi	2.5	245.17	6.8	LCF	0.70
48B	18.4	29H	4.1	3.33	6.8	48B	0.80
29H	19.4	3.33	4.1	48B	7.9	Bourdon	1.00
F calculated	6.62		9.08		5.55		2.35
F at P=0.05	2.45		2.45		2.45		3.07
LSD	6.28		1.12		1.4		NS

Table 2. Average disease scores of nine genotypes of *V. faba* and one of *V. narbonensis* (V.n.) grown in pots in response to *B. fabae* inoculum applied at two different stages of growth.

Young plant stage		Flowering stage			
		Inoculation 28/02/84		Inoculation 19/03/85	
LCF	3.3	V.n	2.4	Soravi	2.3
S45	3.4	29H	5.7	V.n.	3.0
Bourdon	3.5	Soravi	5.8	245.17	4.3
48B	3.8	29E	7.0	S45	4.4
3.33	4.5	LCF	7.3	29E	4.6
245.17	4.6	S45	8.1	29H	5.0
Soravi	4.9	Bourdon	8.2	Bourdon	5.8
29H	5.0	245.17	8.4	LCF	6.1
29E	5.6	48B	8.5	3.33	6.1
		3.33	8.5	48B	6.8
F calculated	92.7		14.4		18.3
F at 0.05	2.3		2.2		2.1
LSD.	0.5		0.6		0.9

inoculated at the flowering stage were more evident. Plants inoculated early in the season reacted differently to the disease compared to those inoculated later in the season. Moreover, in 1984 plants inoculated at flowering showed a different reaction to the disease compared to those grown during 1985.

Whole plants in the field

Table 3 shows the floral damage and disease reaction of the inoculated plants during 1983/84 and 1984/85. It is evident that the disease pressure was much higher in 1984/85. In 1984, the disease score ranged from 1.2

Table 3. Average disease scores and the relative values for undamaged floral parts of nine genotypes of *V. faba* and one of *V. narbonensis* (V.n.) to *B.fabae* under field conditions.

1983/84			1984/85		
Disease score		Relative values for undamaged floral parts	Disease score		Relative values for undamaged floral parts*
V.n.	1.2	132	*V.n.*	6.2	Bourdon 86
Bourdon	1.4	113	29E	6.8	*V.n.* 83
Soravi	1.5	100	Bourdon	7.1	3.33 77
S45	1.6	92	S45	7.1	S45 74
48B	1.7	91	LCF	7.2	Soravi 71
245.17	1.8	89	48B	7.2	29E 68
LCF	1.8	88	Soravi	7.4	LCF 62
29E	1.9	83	29H	7.6	245.17 61
29H	2.0	83	3.33	7.8	29H 52
3.33	2.1	77	245.17	7.8	48B 50
F calculated	9.9	20.1		4.4	2.7
F at P= 0.05	2.5	2.5		2.5	2.5
LSD	0.3	10.0		0.7	17.0

* Numbers over 100 indicate that the disease did not reach the first floral stage.

for narbon vetch to 2.1 for line 3.33, while in 1985 it ranged from 6.2 for vetch to 7.8 for line 245.17. Differences among the 10 lines tested were significant in both years.

Discussion and Conclusion

These results show that although the methods for the evaluation of performance of faba bean in relation to *B. fabae* are relatively simple, the relations between these different methods are not always obvious, because each one shows a particular phenomenon.

On detached leaves infected by *B.fabae* two important aspects are observed: the rate of appearance of the symptoms and the rate of development of the disease. The first one varies considerably from one genotype to another, while the second is less discriminating. So, a line with good performance in the first phase of fungal attack could be totally affected by the disease once the infection has set in. The most spectacular example is provided by the narbon vetch which considerably delayed the initial establishment of infection but was unable to limit its spread later in the rest of the tissue. This situation shows without doubt the importance of two different mechanisms in the host resistance to the disease.

The performance studied after inoculation in pot culture in the greenhouse integrates at a certain moment of the plant life, the plant's intrinsic reaction to infection in a more drastic manner than may naturally occur in the field. The field technique, on the other hand, simulates a natural attack, progressive but slower than the previous method, and shows an overall performance of the plant including the interaction of the fungus with different plant organs in relation to different phases of the disease epidemiology. This overall performance in the field, which is the consequence of intrinsic or "phenotypic" reaction of plants, constitutes the reference performance.

Although the relationship between the different methods used in this study is not always evident, the delayed appearance of symptoms in narbon vetch probably explains the superior performance of this species as already noted by Gondran (1977). The faba bean genotypes varied in their response to *B. fabae* in each test used but this can be understood in view of the fact that the characters being used for evaluation differed from one test to another. However, these studies showed consistent good performance of narbon vetch, Bourdon variety, and line S 45 and consistent susceptibility of lines 3.33 and 48B.

The results obtained from this experiment revealed that the nine faba bean genotypes reacted differently in the three methods used for studying their reaction to *B. fabae*, because each method permits expression of some particular mechanisms of resistance more clearly than others. For example in the detached leaf test, line 29H, which was the most susceptible line during the early stages of infection showed limited disease development and later sporulation indicating a different mechanism of resistance. We therefore suggest that crosses should be made between different faba bean plants with different mechanisms of resistance to combine such resistance in one line.

References

Abou-Zeid, N. 1985. Contribution a l'amelioration de la resistance de *Vicia faba* L. au *Botrytis fabae* Sard. These, Doctorat es sciences, Universite Rennes I, France. 105pp.

Mohamed,H., El-Sherbeeny, M.H. and Hosni, A.M. 1980. Detached leaf technique for infection of faba bean plants (*Vicia faba* L.) with *Botrytis fabae*. FABIS Newsletter 2: 44-45.

Gondran, J. 1975. Possibilite de mise au point d'une methode d'inoculation artificielle en vue de tri de plantes resistantes contre le *Botrytis fabae* Sard. de la feverole. VIII eme congres international de la protection des plantes, Moscou. 109/12 1-19.

Gondran, J. 1977. Resistance de la vesce de narbonne et de la feverole a *Botrytis fabae*. V eme journee de phytiatrie de phytopharmacie. Circum-Mediterraneennes. 15-20 Mai 1977, Rabat, Maroc.

Gondran, J. 1978. Les maladies de la feverole en vegetation. Perspectives Agricoles 13: 47-50.

Gondran, J. 1982. Selection de la feverole pour la resistance a *Botrytis fabae*. 22 eme colloque, Societe Francaise, phytopathologie, Rennes 13-14 mai 1982 in Agronomie 1983 3:94.

Hanounik, S.B. 1983. Resistance in faba bean to chocolate spot. FABIS Newsletter 5: 24-25.

Khalil, S.A. and Harrisson, J.G. 1981. Methods of evaluating faba bean materials for chocolate spot. FABIS Newsletter 3: 51-52.

Last, F.T. 1960. Longevity of conidia of *Botrytis fabae* Sardina. Transactions of the British Mycological Society 43: 673-680.

Leach, R. and Moore, K.G. 1966. Sporulation of *Botrytis fabae* on agar culture. Transactions of the British Mycological Society 49: 593-601.

MAJOR FABA BEAN PRODUCING COUNTRIES

Area, yield, and production of faba bean in the major faba bean producing countries ranked on 1984 production.

Country	Area (1000 ha)					Yield (kg/ha)					Production (1000 MT)				
	1974/76	1977/81	1982	1983	1984	1974/76	1977/81	1982	1983	1984	1974/76	1977/81	1982	1983	1984
China	2300	4100	1900	1920	1800	1058	1069	1368	1198	1250	2433	4280	2600	2300	2250
Ethiopia	288	301	381	381	343	998	1152	1579	1577	1312	287	348	601	600	450
Egypt	106	107	115	128	120	2267	2132	2255	2305	2258	241	229	260	295	271
France	21	21	37	52	67	2039	2691	2946	3077	3149	44	57	109	160	211
Italy	209	165	150	148	148	1207	1290	1191	1092	1241	253	213	178	162	183
Morocco	213	181	111	171	200	1234	621	892	834	610	263	114	99	142	122
Turkey	31	30	36	43	42	1612	1729	1831	1812	1810	51	52	65	77	76
Spain	117	86	55	50	59	1005	1001	982	820	1085	118	87	54	41	64
Tunisia	80	66	66	58	65	563	567	593	858	846	45	39	39	50	55
Mexico	49	53	39	27	30	722	1034	1299	1425	1333	35	53	51	39	40
Brazil	192	176	135	141	142	379	348	312	234	246	73	63	42	33	35
Czechoslavakia	27	46	27	18	15	1626	1787	1553	1700	2037	44	84	41	31	30
Germany FR	17	5	6	6	8	2977	3226	3422	2987	3579	51	17	21	17	27
Algeria	35	41	43	50	50	864	717	458	423	500	30	29	20	21	25
Sudan	15	16	16	16	16	1203	1279	1375	1375	1375	18	21	22	22	22
Peru	23	23	23	24	24	915	924	927	936	936	21	21	22	22	22
Portugal	45	35	32	32	32	667	572	647	563	619	30	19	21	18	20
Canada			15	15	19			784	784	789			12	12	15
Syria	6	8	8	7	8	1608	1670	1843	1864	1750	10	13	14	13	14
German DR	6	6	7	6	6	1989	2123	2438	2117	2109	11	13	16	14	14

Source: FAO Production Yearbooks

Area, yield, and production of faba bean in different geographical regions.

Region	Area (1000 ha)					Yield (kg/ha)					Production (1000 MT)				
	1974/76	1977/81	1982	1983	1984	1974/76	1977/81	1982	1983	1984	1974/76	1977/81	1982	1983	1984
Africa	744	721	839	811	802	1199	1089	1418	1403	1189	891	783	1048	1139	954
N & C America	73	80	85	75	83	676	868	957	945	923	49	69	81	71	77
South America	252	237	186	194	195	506	501	508	466	474	127	119	94	90	93
Asia	2361	4153	1954	1978	1858	1066	1079	1379	1214	1265	2517	4368	2695	2401	2350
Europe	455	397	319	318	340	1254	1421	1409	1420	1638	570	567	449	452	556
World Total	3886	5596	3299	3393	3294	1070	1076	1327	1227	1226	4156	5915	4377	4164	4039

Source: FAO Production Yearbooks.

ANNOUNCEMENTS

The Fourth Symposium on Parasitic Weeds
The International Parasitic Seed Plant Research Group (IPSPRG) will meet at the Philips University, Marburg, Germany, 2-7 August 1987.

Further information may be obtained from:
H.Chr.Weber, Fachbereich Biologie,
Lahnberge, Philips University,
3500 Marburg,
WEST GERMANY

International Conference on Quantitative Genetics
This conference will be held in Raleigh, USA, 31 May-5 June 1987.

Further information from:
Dr. B.S.Weir
Conference Secretary,
Department of Statistics, Box 8203,
North Carolina St.University, Raleigh,
NC 27695-8203, USA

International Nitrogen Symposium
Advances in Nitrogen Cycling in Agricultural Ecosystems.

This symposium will be held at the University of Queensland, Brisbane, Australia, 11-15 May 1987. There will be review papers from invited speakers and contributed papers. The review papers will be published in full.

For copies write to:
Mr.Keith Weier
Symposium Secretary,
CSIRO Cunningham Laboratory,
St.Lucia, Brisbane, Queensland,
AUSTRALIA, 4067

International Symposium on New Crops for Food and Industry
The symposium will be held at Southampton University, 22-25 September 1987. It aims to bring together scientists, industrialists, and policy makers to identify the opportunities for developing underutilized plants of commercial value.

Further information may be obtained from:
N. Haq
Symposium Secretary,
Department of Biology, Building 44,
Southampton University,
SO9 5NH, UK

Agriculture International '87 Conference
This conference, organized by the Agricultural International Journal, will be held in Zimbabwe, 8-12 September 1987. Subjects covered by the conference will include :

(i) Development and the contributors to development.
(ii) Agricultural engineering: soil and water.
(iii) Breeding and biotechnology.
(iv) Crop production and animal husbandry.
(v) Crop protection and animal health.
(vi) Economics - marketing and incentives.

There will be presentation papers, a poster session, and a discussion panel.

For more details write to:
Agraria Press Ltd.
Yew Tree House, Horne
Horley, Surrey RH69IP
UK

14th International Botanical Congress
Berlin, West Germany 24 July-1 August 1987

For information contact:
The Secretary,
14th International Botanical Congress,
Konigin-Luise Str. 6-8, D-1000,
Berlin 33, WEST GERMANY

The British Crop Protection Conference on Weeds
This conference will be held in Brighton, UK, 16-19 November 1987.

For more information contact:
BCPC Secretariat
20 Bridport Road,
Thornton Heath, Surrey CR4 7QG,
UK

International Conference on Insect Pests in Agriculture
The conference will be held 1-3 December 1987 in Paris, France.

Contact:
ANPP Secretary,
149, rue de Bercy,
75595 Paris Cedex,
FRANCE

5th International Congress of Plant Pathology
Kyoto, Japan 20-27 August 1988.

Contact:
Secretariat,
5 th International Congress of
Plant Pathology,
1-43-11, Komagome, Toshima-Ku,
JAPAN

The Role of Legumes in Conservation Tillage Systems
Athens, Georgia, Montana, USA, 27-29 April

Contact:
American Society of Agronomy,
677 S. Segoe Rd.,
Madison, WI 53711, USA

General Assembly of the International Pulse Trade and Industry Confederation
Hotel Martinez, 73, La Croisette, Cannes, France, 11-13 June

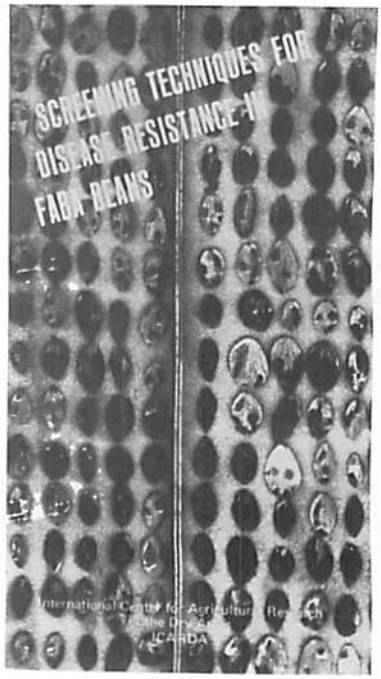
Contact:
Federation Nationale du Legume Sec,
Bureau 273-Bourse de Commerce-F- 75040
Paris Cedex 01, FRANCE

BOOK REVIEWS

Screening Techniques for Disease Resistance in Faba Beans

By S.B. Hanounik
Faba Bean Pathologist
ICARDA

This comprehensive 59 page manual is designed to help students of plant pathology and plant breeding identify resistant sources to major faba bean diseases. It covers laboratory and field screening techniques. In the laboratory section it describes media preparation; nematode extraction; fungus isolation, propagation, and purification; and seed testing. The field section includes the management of disease screening nurseries, artificial inoculation, and production of epiphytotics, with the different scales for disease measurement. This manual contains 26 colored photographs and illustrations, showing screening techniques and disease symptoms.



Copies are available from FABIS, ICARDA, Box 5466, Aleppo, Syria.

Third Conspectus of Genetic Variation Within Vicia faba (1986) FABIS September 1986

The first edition of 'Genetic Variation Within *Vicia faba*' was published in 1981 and since then it has been revised twice.

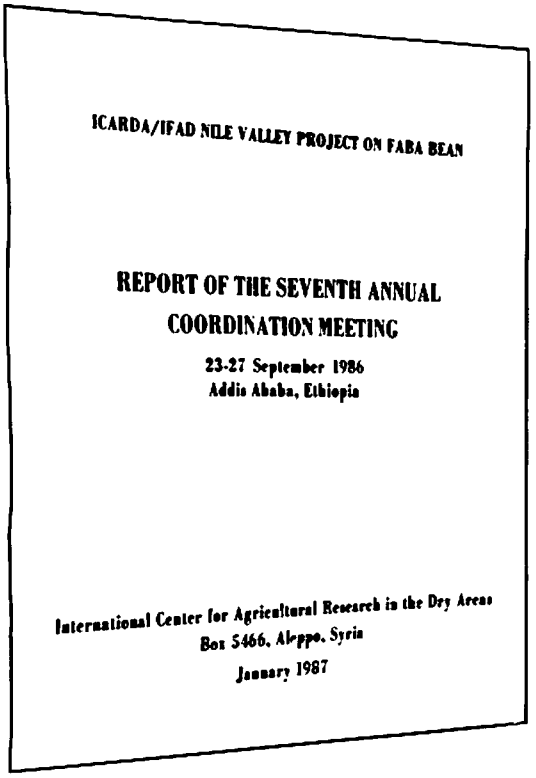
The present revision includes published variation up to the end of 1985 and variation reported at the Third International *V. faba* Review Meeting at Gatersleben in April 1985.

In Part I the *V. faba* chloroplast genome is described and in Part II is a contribution on the molecular analysis of *V. faba* cms and other cytoplasms. Part III is the revised table from previous editions and now includes isozyme variants, seed amino acid content, and an extended list of organisms with which *V. faba* interacts.

Copies are available from:
FABIS, ICARDA, Box 5466, Aleppo, SYRIA.

The International Center for Agricultural Research in the Dry Areas (ICARDA)
Introduces...

Report on the Seventh Annual Coordination Meeting
23-27 September 1986
Addis Ababa, Ethiopia



This report is the product of the Seventh Annual Coordination Meeting of the ICARDA/IFAD Nile Valley Project on Faba Beans held in Addis Ababa, Ethiopia 1986.

The report is based on papers presented by Project scientists and contains a summary of the on-farm and back-up research of the results for 1985/86, as well as details of the program of work and staff education and training during the 1986/87 season.

For copies write to:
ICARDA
P.O.Box 2416,
Cairo, EGYPT

Biology and Control of Orobanche

Edited by S.R.ter Borg
ISBN 90.6754-079-X/CIP.
Published by LH/VPO, Wageningen
THE NETHERLANDS
Price Hfl 25.00, postage included

The book is based on lectures given in a 1986 workshop on biology and control of *Orobanche* held in Wageningen, The Netherlands, 13-17 January 1986. The topics covered are dormancy, germination and haustoria formation; growth and development, population studies; and breeding and control.

In 206 pages this book presents a comprehensive review of the research done on *Orobanche* in the past few years and future needs. It also includes a few papers reviewing special topics related to *Striga*. The final chapter contains a state of the art review of the biology and control of *Orobanche* in which gaps in present knowledge are discussed and further research is suggested.

Copies are available from the editor:
S.J.ter Borg
Department of Vegetation Science,
Plant Ecology and Weed Science,
Agriculture University,
Bornsesteeg 69,
6709 PD Wageningen,
THE NETHERLANDS

Vicia faba
Cultivation, Breeding and Nitrogen Fixation

The book is based on lectures given in a 1986 workshop

Proceedings of a workshop in the CEC Programme of Coordination of Agricultural Research, 16-19 July 1986, University of Gottingen, Germany F.R.

ISSN 0723-7812
Distributed by Saatgut-Treuhandverwaltungs-GmbH, Bonn, WEST GERMANY.

As part of the EC Agricultural Research Programme, scientists engaged in faba bean research have

met regularly to discuss new results. This 21-page volume is one in a series of proceedings on plant breeding. The aim of the 1986 workshop was to determine how biological nitrogen fixation can be utilized to increase and stabilize faba bean yields. The main topics dealt with cultivation practices and breeding efforts to improve productivity and, for the first time, scientists working on biological nitrogen fixation were invited to contribute to the programme. The proceedings reflect the diversity of competence and views of the delegates, which resulted in lively dis- exchange of ideas throughout the workshop.

The Biochemistry of Host Resistance to Diseases and Insects

Published by Iowa State University, Iowa 1986
Price $ 9.00

The booklet is based on the Plant Science Lecture Series at Iowa State University.

In 152 pages there is a comprehensive review of the biological aspects of host-pathogen and host-insect interactions. The topics covered are:

1. Use of phytotoxins in selection of disease resistant mutants in tissue culture.
2. Phytoalexins and their involvement in plant disease resistance.
3. Natural chemicals in plant resistance to insects.
4. Metabolic regulation in plant-pathogen interactions from the perspective of the pathogen.
5. Physiological aspects of plant-insect interactions.
6. Genetic studies of fertility and pathogenicity in *Magnaporthe grisea* (*Pyricularia oryzae*).

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This newsletter is produced twice a year at ICARDA. Short research articles are published and comprehensive reviews are invited regularly on specific areas of lentil research. The newsletter also includes book reviews, key abstracts on lentils, and recent lentil references. For further information write LENS.

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This ICARDA service is aimed at cereals researchers in the Near East and North Africa region and Mediterranean-type environments. It publishes up-to-the-minute short scientific papers on the latest research results and news items. RACHIS seeks to contribute to improved barley, durum wheat, and triticale production in the region; to report results, achievements, and new ideas; and to discuss research problems. For further information, write RACHIS.

Field Guide to Major Insect Pests of Faba Bean in the Nile Valley (English and Arabic)
This pocket field guide for research and extension workers explains how to identify and control the main insect pests of faba bean in Egypt and Sudan. The distribution, description, and biological characteristics are given for each insect, along with the type of injury, assessment of damage, and recommended control measures. A key to injuries is included. Insects and the damage they cause on faba beans are illustrated with 41 color photos. For your copy, write FLIP.

Field Manual of Common Faba Bean Diseases in the Nile Valley (English and Arabic)
This pocket field manual is a tool for field workers to diagnose and control diseases of faba beans in Egypt and Sudan. Symptoms, development, and control of various diseases are discussed, and symptoms are illustrated with 38 color photos. Also included are rating scales for disease resistance in faba bean lines and a glossary of basic phyto-pathological terms. For your copy, write FLIP.

Field Guide to Major Insect Pests of Wheat and Barley (Arabic)
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In English and Arabic, the 24-page illustrated information brochure briefly describes research projects on lentil, faba bean, and chickpea treated either as single crops or as a group. For your copy, write FLIP.

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Announcement for Arabic FABIS

اعلان الى العلماء الباحثين العرب الكرام

يسر المركز الدولي للبحوث الزراعية في المناطق الجافة (ICARDA) ، اعلامكم بان مركز بحوث التنمية الدولية (IDRC) وافق على تقديم الدعم المادي لبرنامج فابيس ، ولمدة ثلاث سنوات ، اعتبارا من بداية عام 1987 ولغاية 1989 . ويحيطكم علما بان ادراج اللغة العربية ضمن النشرة الاخبارية للفول " فابيس " يشكل أحد أهم اهداف هذا البرنامج .

وبمزيد من السرور تعلن اسرة تحرير " فابيس " للعلماء العرب العاملين في مجال تحسين وتطوير الفول . انها ستبدأ اصدار نشرتها الاخبارية ، باللغتين العربية والانكليزية ، وذلك بدأ من العدد 17

يرجى من الاخوة العلماء الراغبين في نشر ابحاثهم باللغة العربية التفضل بارسالها الى العنوان : فابيس ، ايكاردا ـ قسم التوثيق ، ص.ب 5466 ، حلب ـ سورية .

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1) ملخص البحث يكتب باللغتين العربية والانكليزية .
2) المقدمة .
3) مواد وطرق البحث .
4) نتائج البحث .
5) المناقشة ، ويمكن دمجها مع النتائج (نتائج البحث والمناقشة) .
6) قائمة المراجع .

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With the financial support of the International Development Research Center (IDRC), ICARDA is building up its document collection on faba beans.

We would be grateful if readers who have any relevant documents would send them to:

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The aim of FABIS Newsletter is to publish quickly the results of recent research on faba beans. Articles should normally be brief, confined to a single subject, good quality, and of primary interest to research, extension, and production workers, and administrators and policy makers.

Style
Articles should have an abstract (maximum 250 words) and whenever possible the following sections:introduction, materials and methods, and results and discussion. Authors should refer to recent issues of FABIS for guidance on format. Articles will be edited to maintain uniform style but substantial editing will be referred to the author for his/her approval; occasionally, papers may be returned for revision.

Disclaimers
The views expressed and the results presented in the newsletter are those of the author(s) and not the responsibility of ICARDA. Similarly, the use of trade names does not constitute endorsement of or discrimination against any product by ICARDA.

Manuscript
Articles should be typed double-spaced on one side of the page only. The original and two other legible copies should be submitted. The contributor should include his name and initials, title, program or department, institute, postal address, and telex number if available. Figures should be drawn in India ink; send original artwork, not photocopies. Define in footnotes or legends any unusual abbreviations or symbols used in a figure or table. Good quality black and white photographs are acceptable for publication. Photographs and figures should preferably be 8.5 cm or 17.4 cm wide.

Units of measurement are to be in the metric system; e.g. t/ha, kg, μg, m, km, ml (=milliliter), m^2.

The numbers one to nine should be written as words except in combination with units of measure; all other numbers should be written as numerals; e.g., nine plants, 10 leaves, 9 g, ninth, 10th, 0700 hr.

Examples of common expressions and abbreviations
3 g; 18 mm; 300 m^2; 4 Mar 1983; 27%; 50 five-day old plants; 1.6 million; 23 ug; 5°C; 1980/81 season; 1980-82 seasons; Fig.; No.; FAO;USA. Fertilizers: 1 kg N or P_2O_5 or K_2O/ha.
Mon, Tues, Wed, Thurs, Fri, Sat, Sun; Jan, Feb, Mar, Apr, May, June, July, Aug, Sept, Oct, Nov, Dec. Versus = vs, least significant difference = LSD, standard error = SE $\pm$, coefficient(s) of variation = CV(s). Probability: Use asterisks to denote probability * = $P<0.05$; ** = $P<0.01$; *** = $P<0.001$.

Botanical: Include the authority name at the first mention of scientific names. Cultivar(s) = cv(s), variety = var(s), species = sp./spp., subspecies = subsp., subgenus = subg., forma = f., forma specialis = f. sp.

References
Journal articles: Khalil, S. A. and Harrison, J.G. 1981. Methods of evaluating faba bean materials for chocolate spot. FABIS No. 3: 51-52.

Books: Witcombe, J. R. and Erskine, W. (eds.). 1984. Genetic resources and their exploitation-chickpea, faba beans, and lentils. Advances in Agricultural Biotechnology. Martinus Nijhoff/Dr. W. Junk Publishers, The Hague, The Netherlands, 256 pp..s 1;*Articles from books*: Hawtin, G. C. and Hebblethwaite, P. D. 1983. Background and history of faba bean production. Pages 3-22 *in* The Faba Bean (*Vicia faba* L.) (Hebblethwaite, P.D., ed.). Butterworths, London, England.

Papers in Proceedings: Hawtin, G. C. 1982. The genetic improvement of faba bean. Pages 15-32 *in* Faba Bean Improvement: Proceedings of the Faba Bean Conference (Hawtin, G. and Webb, C., eds.), ICARDA/IFAD Nile Valley Project, 7-11 Mar 1981, Cairo, Egypt.

Submission of articles
Contributions should be sent to FABIS, Documentation Unit, ICARDA, P.O. Box 5466, Aleppo, Syria.

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