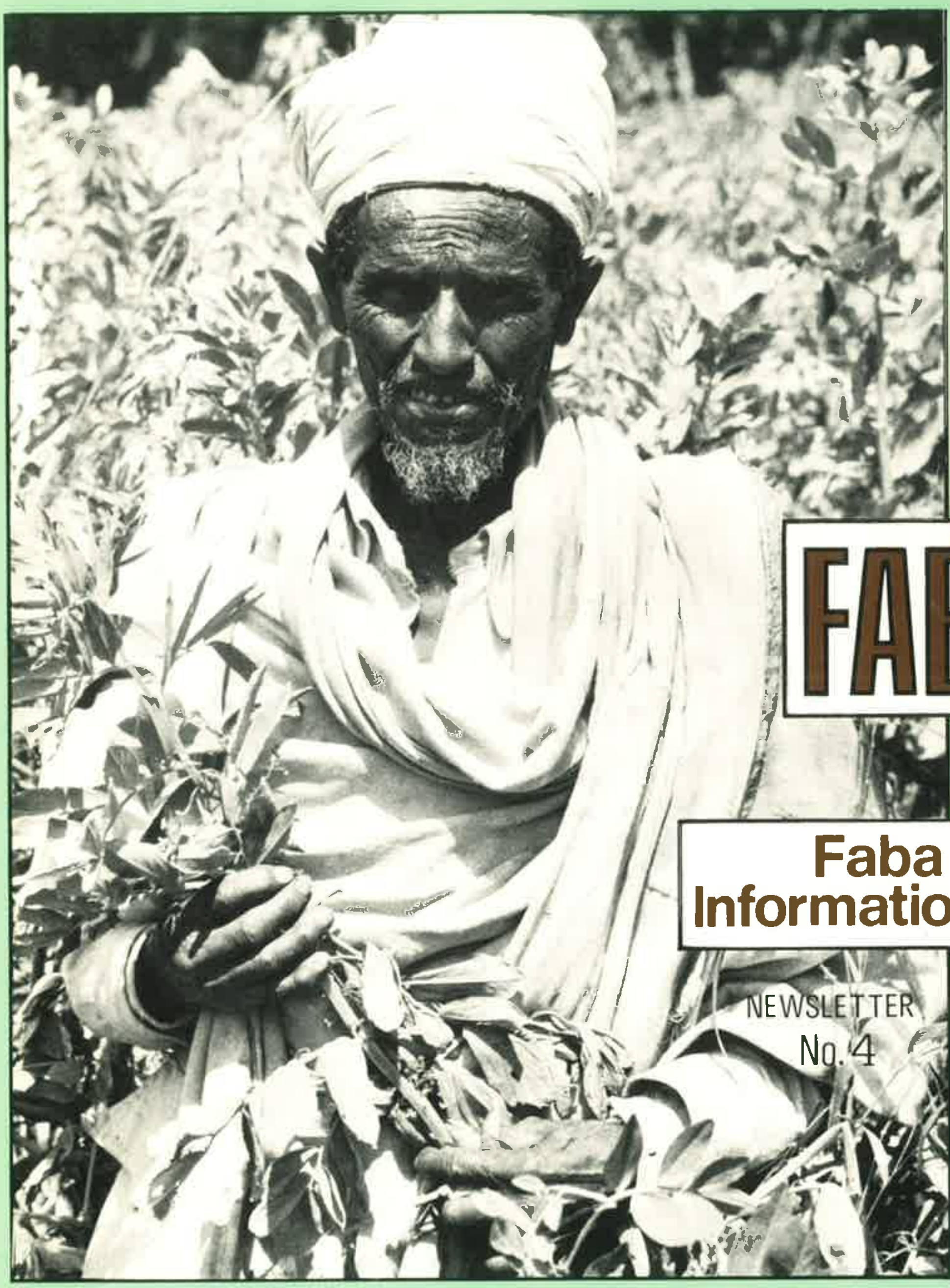

FABIS

Faba Bean Information Service

NEWSLETTER

No. 4

MAY 1982

THE INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS

ICARDA

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INTRODUCTION

TWICE A YEAR

Beginning in 1982 we intend to bring out the FABIS Newsletter twice a year, in April and in October. We would like to have your reaction to this increase in frequency of the Newsletter. And we would also like to know whether or not you think it would be to a further advantage to bring out the Newsletter three or even four times a year, if this was to prove possible from our point of view. We look forward to hearing your reactions.

Subscriptions

We are sorry to announce that after discussions with our financial officers, we have been told that we are unable to cash the cheques that have been sent to us for the 1981 FABIS subscription. This is due to the high cost of clearing cheques (U.S. $ 7 - 10/cheque). We have had to discard all cheques sent for the 1981 FABIS subscriptions. Again, please accept our apologies for any inconvenience. In the future, we would appreciate if you can send **International Money Orders** (U.S. dollars). We will discuss this further under **Payment**. We would like to thank our readership for their patience and understanding of the problems we are facing.

Rising mailing costs have forced us to increase the annual charge for the FABIS service to $ 10.00 (US) for 1982. As before, this charge only applies to those countries normally recognised as 'developed' and listed in FABIS Newsletter No. 3. Residents of all other countries will receive the service free of charge.

Payment

Please send **only International Money Orders** for the value of U.S. $ 10.00 to cover the 1982 subscription charge.

All International Money Orders **must** be made payable to **ICARDA**.

FABIS Newsletter No. 5 (scheduled for October 1982)

Please send any communications which you would like to appear in FABIS Newsletter No. 5 to us as soon as possible, and in any case before June 31st, which is the closing date. Any articles received after that date will be left to the next issue.

The General Articles in Newsletter No. 5 will focus on the **Pests and Diseases of Faba Beans**. If you, or anyone you know would like to write a General Article (around 1500 words) on this subject, please feel free to do so. We would particularly like to receive articles describing the most damaging Pests and Diseases in your country, and the measures that are being taken to combat these problems, both through practical measures and through research. Thank you.

As before, you are invited to send Short Communications on any aspect of faba bean research and development. Short communications can be as short as you like, but should not exceed 600 words in length. They can include one Table and/or one Diagram.

We would also like to receive any other items you would wish to be included in the Newsletter, such as **Letters to the Editors, In-Press Abstracts, Announcements, Advertisements, Photographs, Diagrams, Recipes, News Items, Details of forthcoming Conferences and Meetings, etc...**

Thank you for your help.

The Faba Bean Information Service

At ICARDA, we are building up a collection of all the articles and reprints we can find on faba beans. We are also receiving some Selective Dissemination of Information (SDI) services on a regular basis. If you have any information queries on faba beans, please don't hesitate to ask us for help. We may not be able to answer all your questions yet, but we will try.

We would be very grateful if authors could send us a copy of any article they published on faba bean research, so that we can include this in our collection of information on faba beans. Thanks.

Back Issues

Please note :

If you wish to receive back issues of the FABIS Newsletter please contact us.

The following are currently available :

- **FABIS Newsletter No. 1**
- **FABIS Newsletter No. 2.**
- **FABIS Newsletter No. 3**
- **Genetic Variation in *Vicia faba***
- **Directory of World Faba Bean Research**

For further information or requests,
please write to :

FABIS,
Training and Communications Program,
ICARDA, P.O. Box 5466, Aleppo, SYRIA

FABIS Co-ordinating Committee Members

LETTERS AND ANNOUNCEMENTS

Letters to the Editors

Dear Sirs,

Since last autumn, we have been developing our research on *Vicia faba* and *Orobanche crenata*. We have a lot of results on the structure and the ontogeny of the parasite. They will be published as soon as possible.

After M. Abèr's successful work with Dr. Schluter concerning the erradication of *O. crenata* from Moroccan fields, by a treatment with a herbicide, we plan to develop further research in this area. We would like to investigate the penetration, translocation and site of action of the herbicide on *Orobanche crenata* and *Vicia faba*.

Sincerely yours,
Dr. G. Salle

Universite Pierre et Marie Curie,
Paris, FRANCE

Dear Sirs,

In the 1980-81 season, I noticed a very large infestation of *Sitona limosis* Rossi in all faba bean fields. The infestation was about 100 per cent (on every stem of all plants).

The symptoms are easily seen where pods are formed but still green; the stem of infested plants shows a reddish brown discolouration (at the bottom) and brown/black discolouration in the stem tops (while the rest of the plant is still green). These symptoms can be easily confused with early maturity.

During pod formation, larvae growing inside the stem emerge as adults when the plant reaches maturity.

Dr. R. Islam (ICARDA) and Dr. J.B. Smithsom (ICRISAT) also noticed this infestation in all faba bean fields during their visit to Tunisia. Dr. Islam has taken samples of larvae and adults.

Sincerely yours,
Namissi Amor

Office des Cereales
Division Technique,
Tunis, TUNISIA

ERRATA

'Genetic Variations within *Vicia faba*'

The following errors have been brought to our attention :

p. 5 Locus Rf1 should be S45 not 8.45 (Rf1 and Rf2 should be described as 'restorers for 447 cytoplasm' not just 'restorer' to avoid confusion).
p. 12 Acyrthosyphon should be spelt Acyrthosiphon.
Aphis fabae : Miller should be spelt Muller.

Virus :
bean leaf roll : should be 'some resistance in Weirboon, Maris Bead, Maxime and Minor. Herz Freya and Minden most susceptible'. *Note spelling Freya not Freyer.

AVAILABLE

List of assessment keys free to interested parties.
Contact :

Dr. R.E. Gaunt,
Lincoln College,
Canterbury,
NEW ZEALAND

WANTED

We are looking forward to finding the most recent numeric data concerning :

1. the world production and repartition of faba beans,
2. the damage caused by *O. crenata* or other broomrapes on different kinds of crops.

Dr. G. Salle

Universite Pierre Marie
Curie,
Paris, FRANCE

GENERAL ARTICLES on
"Pests and Diseases of Faba Beans"
are required for FABIS Newsletter No. 5 (1982)
Please send your article or the name of a potential author to :

FABIS,
Training and Communications,
ICARDA, P.O. Box 5466,
Aleppo, SYRIA

WANTED

Dr. Barbara Pickersgill and Dr. Kwon-Yawi Chang will appreciate receiving seeds of different wild species of *Vicia* for their work on interspecific hybridization. The seeds may please be sent to the following addresses :

Dr. Babara Pickersgill,
Dept. of Agricultural Botany,
Plant Science Laboratories,
University of Reading,
Whiteknights, Reading
RG6 2AS, ENGLAND

Dr. Kwon-Yawl Chang,
Department of Agronomy,
Gyneongsang National Univ.
92 Chilam-dong. Jinju 620
REPUBLIC OF KOREA

If you have any

faba bean news
announcements of meetings or conferences
letters to the editors
comments on articles appearing in Newsletter No. 4
suggestions
complaints
additions to the Genetic Variation within *Vicia faba* list
changes of address
new research interests

please send them to

FABIS,
Training and Communications,
ICARDA, P.O. Box 5466,
Aleppo, SYRIA

SHORT COMMUNICATIONS on
"Any subject with faba bean research or production"
are required for FABIS Newsletter No. 5 (1982).
Please send your contributions to :

FABIS,
Training and Communications,
ICARDA, P.O. Box 5466,
Aleppo, SYRIA

All Contributors :
Please see the Style and Form guidelines on p.

STYLE AND FORM FOR FABIS CONTRIBUTIONS

All contributions should be submitted if possible before June 31st, 1982.
Please remember the following guidelines:

General Articles

☆ must not be more than 1500 words

edited articles will be returned to authors for approval if the originals were submitted before December 1st.

Short Communications

☆ must not be more than 600 words and may in addition include one Diagram/ Figure/Photograph.

☆ should contain a single theme, even if this means more than one article is submitted by the same author.

☆ contributions should not consist of outlines of research programs carried out at institutions.
☆ all references cited should be directly relevant to the content of the article. Additional references will be welcomed but not included in the newsletter (they may be published in future bibliographies).
☆ contributions must be typed double-spaced.
☆ the species should be referred to as *Vicia faba* or faba beans.
☆ sub-classes should be referred to as *Vicia faba minor, Vicia faba major* etc.
☆ numbers in the text less than 10 (except for measurements) should be written one, two, three, etc. unless they form part of a series containing numbers greater than 10 or appear at the beginning of a sentence.
☆ yields should be expressed in t/ha or kg/ha.

☆ If these Style and Form conditions are not met, the Editors reserve the right to shorten or otherwise alter the text so that it meets the requirements of FABIS. Thank you

Please Note :

While FABIS articles are not refereed as in other journals, we do reserve the right to refer individual articles back to an author in such cases where there are technical inconsistencies. This may mean that an article submitted to FABIS does not appear in the next published issue of the Newsletter. This, however, should not result in a long delay in publication, as we intend to increase the frequency of the Newsletter over the next two years. Thank you.

The views expressed in FABIS articles are those of the individual authors, and do not necessarily represent the views of ICARDA. Likewise, the results presented in FABIS articles are the responsibility of the individual authors. Thank you.

ANNOUNCEMENT :

The following reference book on faba beans is scheduled to appear in April, 1982 :

FABA BEAN IMPROVEMENT
Proceedings of the International Faba Bean Conference held at Cairo, March 7th to 11th, 1981

Edited by
Geoffrey Hawtin and Colin Webb
The International Center for Agricultural Research in the Dry Areas (ICARDA),
P.O. Box 5466, Aleppo, SYRIA

Published by
MARTINUS-NIJHOFF/D.W. JUNK PUBLISHERS
for the
IFAD/ICARDA NILE VALLEY PROJECT

Copies of the book will be distributed free to all who attended the Conference. All other request for copies should be sent to FABIS or the books should be purchased directly from the publishers.

The Lentil Experimental News Service - LENS

From March 1982 the LENS will be provided as a joint service by the University of Saskatchewan in Canada and by ICARDA. This service has been the subject of a recent grant from the International Development Research Council (IDRC) in Ottawa, Canada, to enable the service to be expanded and produced at ICARDA. Dr. Al Slinkard, who started the LENS service at Saskatoon, will continue to edit the LENS magazine and contributions should be sent to him at the following address :

Dr. Al Slinkard
Dept. of Crop Science, University of Saskatoon, Saskatchewan, CANADA

Any enquiries about information on Lentils should be addressed either to the above address, or to :

LENS
Training and Communications Program,
ICARDA, P.O. Box 5466, Aleppo, SYRIA

RACHIS (Barley, Wheat and Triticale) Newsletter

This new Newsletter by ICARDA is aimed at researchers in the Near East and North Africa Region.

Write for your copy to :

RACHIS, Training and Communications Program, ICARDA, P.O. Box 5466, Aleppo, SYRIA

GENERAL ARTICLES

NATIONAL AND FARM–LEVEL PERSPECTIVES ON FABA BEAN PRODUCTION IN CROP/LIVESTOCK SYSTEMS IN SYRIA, EGYPT AND SUDAN

Abdul Bari Salkini, Haitham Halimeh, Ahmed Mazid and Thomas Nordblom
Farming Systems Program, ICARDA, P.O. Box 5466, Aleppo, SYRIA

National Perspectives on faba bean areas and yields

In Syria the farm area devoted to faba bean green pod production roughly doubled in the decade preceeding 1978, to 7500 hectares. Over the same period, the area for dry bean production fluctuated around 8000 hectares with no apparent trend of increase or decrease. In 1978, about 39 per cent of the total faba bean area was rainfed and harvested as both green pods and dry beans, yielding 4.4 and 0.9 t/ha, respectively. The remaining 61 per cent of Syria's faba bean area was irrigated, with slightly over half being harvested as green pods, yielding 9.8 t/ha compared to dry harvest, where yields were just over 2 t/ha (Syrian Arab Republic, 1978).

The area of dry faba bean harvest in Egypt has declined from 127,000 ha in 1969-71 to 110,000 ha in 1980, with yields varying around 2.2 t/ha (FAO, 1977-1981). The area sown for green pod production is reported to be less than 15 per cent of the dry bean area. However, part of the faba bean crop ostensibly sown for dry bean production may instead be harvested early as green pod vegetables, especially under attractive fresh pod market conditions. In times when fresh market prices are less than expected, crops sown for green pods may be left to mature for harvest as dry beans. Green pod yields, for the period 1969-1979, have averaged about 8.9 t/ha (Watson, 1981a).

Essentially all faba bean production in Egypt is irrigated, and the yields reported are quite comparable to those obtained with irrigation in Syria. Syria's irrigated green pod yields are slightly higher, and dry bean yields slightly lower, than those reported for Egypt, although in neither case did the differences in yield/ha exceed 10 per cent.

Faba bean production in Sudan is concentrated in the irrigated farming schemes along the Nile, north of Khartoum. Harvested almost exclusively as dry beans, production over the past two decades has expanded due to the approximate doubling of land area sown, together with an improvement in yield/ha.

In recent years, between 14,000 and 20,000 ha have been sown to faba beans in Sudan. Citing data from the Sudanese Ministry of Cooperation, Commerce and Supply, Watson (1981b) indicated that average yields for the 1970's were just above 1700 kg/ha. However, data from the FAO Production Yearbooks (1977-1981) suggest that faba bean yields in Sudan for the period of 1975-1980, averaged only about 1300 kg/ha. By either estimate, irrigated dry bean yields in Sudan have been lower than those in Syria and Egypt.

In 1977 about one third of the land in the cooperative irrigation schemes in the Northen province of Sudan was allocated to faba bean production. Due to the emphasis on cotton in the government irrigation schemes north of Khartoum, no more than a sixth (and frequently less) of that land has been devoted to faba beans (Watson, 1981b). When one includes the great dry farming regions of western Sudan and the large irrigation schemes south of Khartoum in the denominator, faba beans can be said to occupy about 0.1 per cent of the country's farmland (FAO, 1977-81).

In Syria, also, a large proportion of the total cultivable land area is rainfed. The total area sown to faba beans for dry bean and green pod harvest covers only about 0.3 per cent of Syrian cropland (Syrian Arab Republic, 1978). A much larger proportion of Egypt's farmland (about 4 per cent) comes under faba bean production each year (FAO). Although, on national scales, little land is devoted to the crop in Syria, Egypt or Sudan, within each country there are areas where faba beans are a major crop, profitably fitting into the local cropping systems.

Faba bean farm survey indications

The focus of this section is the position of faba bean production in the economy of individual farming households in selected parts of Syria, Egypt and Sudan. Survey results are summarised on the proportions of farm income derived from faba beans, land allocated to this crop, harvest modes, bean crop and straw disposal, typical rotations and associated crops.

Agroeconomic surveys were carried out in 1979/80 and 1980/81 in conjuction with the on-farm trials conducted by the Egyptian and Sudanese national agricultural research organizations cooperating with ICARDA in the Nile Valley Project on faba beans (Basheer, *et al.,* 1981; Salkini, *et al.,* forthcoming; Salkini, *et al.,* 1981; Salkini and Taha, 1981). Only a small fraction of the information gathered in these surveys is reported here. A small survey of faba bean farmers in west-central Syria was made in January 1982, by ICARDA staff. Again, only certain economic data from that survey are summarized here.

The farmers in all the surveys were selected non-randomly, but in such a way that most parts of the sampled districts were represented. Only farmers already growing faba beans were chosen; their willingness to co-operate and ease of access to their farms also influenced their inclusion in the sample. Sufficient farm size to allow on-farm agronomy trials was another factor in the Egyptian and Sudanese surveys. Furthermore, only a few faba bean producing areas of these countries were considered. Since the degree of representativeness of the sample farmers is unknown, inferences about the sample districts and countries are dangerous and are generally avoided here. Nevertheless, the survey data do reveal some striking contrasts in the contexts and modes of faba bean production and crop disposition.

Faba bean occupied only a fifth or less of the total farmland in the Syrian sample of faba bean growers, as much as 35 per cent in the Egyptian and 60 per cent in the Sudanese samples (see Table 1). In the Syrian and Sudanese samples, farmers reported faba bean revenues, as percentage of total incomes, in excess of the proportions of their farmlands devoted to this crop. However, in Egypt this percentage was lower. For sample farmers in the northern and Nile provinces of Sudan, faba bean was the major source of income.

The weighted average proportion of the crop harvested as dry beans in the Syrian sample was 39 per cent, with the remaining 61 per cent harvested as green pods. Most of the sample farms were located close to population centers and the high proportion of green pod harvest in the sample was slightly in excess of the national tendency to market faba beans as fresh vegetables.

At the other extreme, Sudanese sample farmers, typically isolated from the main consumption centers, harvested essentially their entire crop as dry beans. Exact figures are not available to separate the proportions of the Egyptian sample into dry or green pod harvest. It is thought that most were harvested dry while some near the population centers were harvested as green vegetables, although certainly in smaller proportions than those seen in Syria.

As shown in Table 1, the majority of the faba bean crop in all sample areas went for commercial sales, with only small proportions retained for home consumption, feed and seed. In one sample area of Syria, farmers were using a large proportion of the crop as cattle feed.

Table 1. Faba bean land allocation and revenues, crop and residue uses.

Location	No. of farmers in sample	Average sample farm size (ha)	Faba bean area as per cent of sample farm size	Faba bean income as per cent of sample farm income*	CROP DISPOSITION Harvest form	Home use (incl. feed and seed) per cent		Sales per cent		Total per cent	Crop residue uses
SYRIA					Dry	0		15.0		15.0	57 per cent ploughed
Idleb	7	2.5	20	21	Green pod	4.3		80.7		85.0	into soil, 43 per cent
					Total	4.3	+	95.7	=	100.0	for fuel
					Dry	26.0		28.0		54.0	56 per cent feed,
Hama	9	3.6	9	10	Green pod	18.5		27.5		46.0	34 per cent ploughed,
					Total**	44.5	+	55.5	=	100.0	plus combinations
					Dry	0		41.5		41.5	43 per cent ploughed,
Homs	14	6.1	11	15	Green pod	0		58.5		58.5	36 per cent.feed,
					Total	0	+	100.0	=	100.0	7 per cent fuel, plus combinations
EGYPT											
Kafr El Sheikh	48	4.0	20	15	NA	18	+	82	=	100	Most for feed and
Minya	38	2.0	35	25	NA	8	+	92	=	100	fuel
SUDAN											
Northern Province	30	2.9	60	85	most						Most for
Nile Province	26	4.9	36	53	dry	15	+	85	=	100	feed

NA equals information not available
* approximate estimates
** sample includes milk cow owners using beans for feed.

Several uses for the crop residue are reported in Table 1. The Syrian sample of faba bean farmers is distinguished by the practice of ploughing a large proportion of the crop residue back into the soil. The straw was also used as livestock feed and as fuel.

In Egypt and Sudan, sample farmers used most of the crop residue for feed and fuel. In Egypt an active cash market for faba bean straw exists, making its contribution to total crop revenue most clear, estimated at between 9 and 14 per cent (Basheer, *et al*, 1981). In Sudan, most of the sample farmers owned livestock and used the faba bean straw for feed. Gifts of straw were more common than sales.

Faba beans are essentially never grown on the same plot in consecutive seasons by sampled farmers in the three countries. The crop is found in association, if not in stable rotations, with numerous other crops (see Tables 2 and 3). In the small Syrian sample, no common rotations were reported. Individual farmers, growing rainfed faba beans, reported rotations of wheat - faba bean - wheat (in Homs province), and fallow - faba bean - wheat - summercrop (in Idleb province). Wheat, barley and other food legumes were most commonly associated with faba beans in the Syrian sample.

Among the Egyptian sample farmers, two and three course rotations were most common. These include rice in Kafr el Sheikh, and cotton and maize in both Kafr el Sheikh and Minya Governorates. In addition to these crops, wheat and berseem clover (*Trifolium alexandrinum)* were also commonly associated with faba beans. One finds faba beans intercropped with berseem (on the berseem plot borders) and, less commonly, interspersed in plots with young sugarcane.

In the Northern province of Sudan, sample farmers reported a rotation of sorghum - faba bean - fallow - wheat. Onions and maize were also associated with faba beans. In the Nile province, faba beans are sometimes used as a winter crop in a cotton - winter crop - fallow rotation (in the Zeidab irrigation scheme), and in a sorghum - winter crop - fallow rotation (in the Aliab scheme). In both these schemes, haricot beans, maize, groundnuts, wheat and onions are found in association with faba beans.

Conclusions :

Faba bean is a very flexible crop, grown under both rainfed and irrigated conditions, harvested early as a green vegetable or late as dry beans, and producing residues with a variety of uses. From inspection of the survey data, it is clear that there is great diversity in the farming resources employed in faba bean production within each district studied. The best combination of practices, from the rational farmer's viewpoint, is expected to vary from area to area as relative prices and costs differ.

From the summaries given here, the reader will also have noted the diversity in practices found between districts and, more so, between countries. This leads to a *strong argument* in favour of location-specific agronomic research, carried out with proper regard for the local practices and the opportunity costs faced by farmers. It also raises a warning flag on the use of blanket recommendations for heterogeneous areas.

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Table 2. Common faba bean rotations in Syria, Egypt and Sudan

Common rotations *							
SYRIA			EGYPT		SUDAN		
						Nile Province	
Idleb	Hama	Homs	K. El Sheikh	Minya	Northern Province	Zeidab	Aliab
Stable rotations rare			R-FB-R C-FB-C C-FB-M	M-FB-M C-FB-M M-FB-C	So-FB-F-W	C-WC-F	So-WC-F
						(WC may be FB)	

*R rice; FB faba beans; C cotton; M maize; So sorghum; F fallow; W wheat; WC winter crop.

Table 3. Sample farm rankings of crops associated with faba beans in Syria, Egypt and Sudan.

Associated crop	Sample farm ranking of associated crops*							
	SYRIA			EGYPT		SUDAN		
							Nile Province	
	Idleb	Hama	Homs	K. El Sheikh	Minya	Northern Province	Zeidab	Aliab
Barley	2	2	2	–	–	–	–	–
Berseem clover	–	–	–	2	2	–	–	–
Chickpea	3	3	–	–	–	–	–	–
Cotton	8	6	7	main	main	–	main	–
Groundnuts	–	–	5	–	–	–	3	3
Haricot beans	4	4	3	–	–	–	1	1
Maize	–	7	8	main	main	2	2	2
Onions	6	–	9	–	–	1	5	5
Rice	–	–	–	main	–	–	–	–
Sorghum	–	–	–	–	–	main	–	main
Soyabeans	–	–	–	–	4	–	–	–
Sugar	–	(beet) 5	(beet) 6	–	(cane) 3	–	–	–
Vegetables	7	–	10	4	5	–	–	–
Vetch	5	8	4	–	–	–	–	–
Wheat	1	1	1	1	1	main	4	4
Other	Sunflower 9	–	–	Flax 3	–	–	–	–

*These rankings are indicative of the frequency with which crops outside the main rotations were reported to ge grown by sample farmers.
1 most frequent; 10 least frequent.

ROTATIONS IN EGYPT

'In Egypt whilst the Nile flood was secure this necessity (rotation) would not be so obvious, but in other countries a primitive rotation must have always existed. It would consist in growing wheat or such crops on the land until the yield ceased to be satisfactory and then letting it go to weed to recover whilst the crop was transferred to another place. In a primitive state with few inhabitants this was possible, but where a large number of people are dependant on the land it becomes necessary to get more out of the soil.

This necessity can be met by manuring, but more satisfactorily by a combination of carefully selected crops and judicious manuring.'

from Min. of Education, Egypt, 'Text-book of Egyptian Agriculture', Vol. II, Cairo, Nat. Printing Dept. (1910).

A SURVEY OF THE CROPPING SYSTEMS OF FABA BEAN *(VICIA FABA)* IN CHINA

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Faba bean is widely distributed in the provinces, municipalities and autonomous regions from the north to the south of China. Faba bean production is concentrated in the north-west, the east and the south-west. Faba bean is classified according to natural conditions and season of cultivation; thus we have both spring-sown and autumn-sown faba beans. Cultivation methods for faba beans are categorised as single cropping or mixed cropping. As regards tillage and field management both tillage and non-tillage systems occur. Faba bean can be grown either as food, vegetable, feed or green manure crop. In short, faba bean holds an important position in various cropping systems in different localities.

In view of its distribution, ripening and seasons of cultivation, the area of faba bean cultivation in China, apart from the transition regions, can be divided into two large regions with Qinling and Huai River forming the common boundry. The region to the north is known as the spring-sown faba bean region, which includes Qinghai, Gansu, Ningxia, Inner Mongolia, etc., where the temperature in winter always remains below 0°C, so faba bean can hardly overwinter. In this region, faba bean is grown once a year and is rotated with wheat, oats, highland barley, potatoes, peas, etc.. In China, the cultivated area of spring-sown faba bean is relatively small. The crop is usually sown between March and April and harvested before the middle of August. Spring-sown faba bean is mainly cultivated as a food crop. The varieties are characterized by few branches, poor tolerance to cold, large pods with heavy seeds, which are mostly red or brown in colour. Within this region, the Qinghai-Tibetan plateaus are noted for producing the highest yields per unit area (up to 8000 kg/ha), which is attributed to the ample solar radiation (about 190,000 cal./cm).

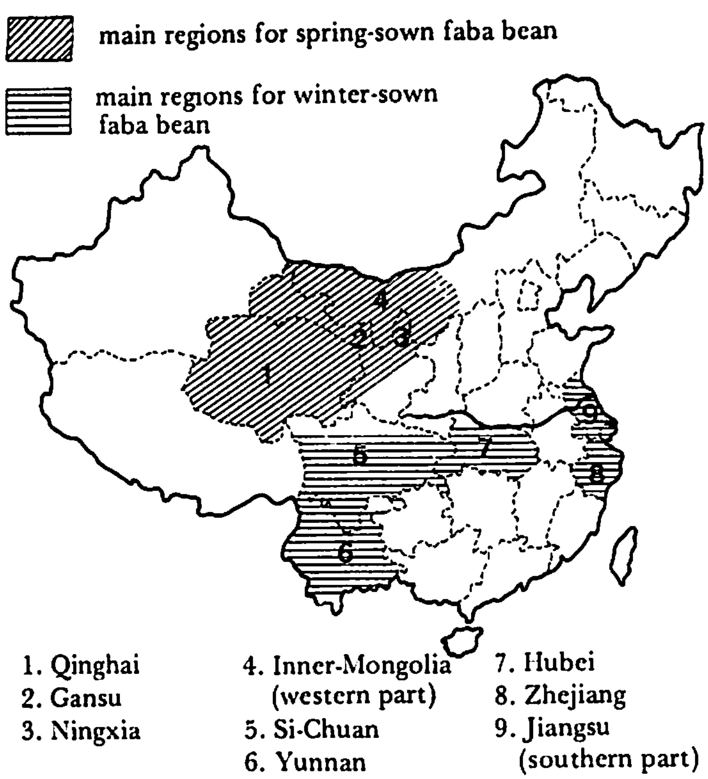

Fig. 1 Distribution of faba bean in China - main provinces and regions of production.

The region to the south is known as the autumn-sown (or winter-sown) faba bean region. This is the main faba bean growing region in China, and includes provinces such as Sichuan, Zhejiang, Hubei and Yunnan which are noted for their large cultivated areas and high yields. The cropping system here is rather complex and diverse, varying from one crop a year to three crops a year. Faba bean is grown before or after crops of rice, corn, sweet potato or cotton and is often rotated with wheat, barley, naked barley, rapeseeds or a green manure crop. In general, faba bean cultivated for food, feed or green manure is sown at the end of October and beginning of November, and harvested in March and June the following year. Most varieties are of the multi-branch type and are highly resistant to cold. Most of the beans are white but some are red. One of the defects is that these varieties tend to be late-maturing and, therefore, unsuitable for multiple cropping. In this region, the provinces, municipalities and autonomous regions along the Yangtse River are known as the largest cultivated area of faba bean with the highest yield. The region to the south of Nanling and that of the Yun-Gui plateau had fewer overwintering crops in the past, but with the extension of winter crops, the area of faba bean cultivation has also tended to be extended.

In China, cultivated land is limited and the multiple crop index is high. Since faba bean has a high N-fixing capability and can be used both for land utilization and soil improvement, several cultivation measures such as intercropping, mixed-cropping, undersown-cropping as well as rotation with non-leguminous crop have been developed in order to make full use of the natural resources (for example, solar energy, land etc.). These measures not only provide other crops with essential nutrient nitrogen but also avoid adverse effects caused by continual cultivation of one crop. For example, in the spring-sown faba bean region, faba beans and peas are interplanted to allow the latter to climb up the former so that air and light conditions are improved and the losses caused by pod rotting are reduced. Mixed-cropping between faba bean and vetch can also raise the yield of fresh matter per unit area. In the winter-sown faba bean region, faba bean is undersown with rice/cotton, or interplanted with corn/cotton in the middle and lower course of the Yangtse River. The methods which *compensate time* with space exert a positive influence on increasing seasonal and annual yields, on making full use of land, on improving soil fertility and on raising cropping index, thus furthering the development of a multiple cropping system. Besides, interplanting faba beans in orchards and mulberry gardens is another approach to realising the potential of the land and to increase the utilization rate of solar energy.

As regards soil tillage and field management, tillage and no-tillage land preparations are made in order to make full use of the growing seasons. In the areas where three crops are grown each year and the multiple cropping index is high, be it in the Tai Lake Valley or the Yunnan dammed land, and no matter whether the bean is harvested for food or for green manure, the yield of seeds or fresh matter tends to be higher for no-tillage than for tillage systems. This indicates that no-tillage is somewhat effective for both yield increase and soil improvement.

Faba bean holds its position in the cropping systems because it plays an important role in soil improvement and has various uses. With the development in breeding early-maturing varieties and with innovations in cultivation techniques, the yield per unit area will be further increased. The position of the crop in various local cropping systems is bound to become more stable and the cultivated area is expected to be extended.

SHEAVES OF BEANS

'Beans are always reaped and bound in sheaves, like wheat, and being generally late in harvest, and extremely succulent, they require being left a good while in the field; and for the same reason, they should be tied in small sheaves. In binding, there are variations : the bands are made in some places of wheat straw; in others of yarn twine, which will last two years, if the thrashers are careful to save them. Beans do very will in a stack'.

from 'The Farmer's Kalendar' (1771), by Arthur Young, reprinted in 1973, by EP Publishing Ltd., Yorkshire, England.

FABA BEANS : THE SPANISH CROP SYSTEMS

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Spain is one of the main secondary homelands of faba beans; they were already grown along the Eastern coast about 4000 B.C. and they have been popular since those days. In fact, the only decline in cultivated area has occurred in recent times, the causes being far from simple. This situation will probably change in the near future because of the interest shown by the Ministry of Agriculture, farmers and private seed producers in this crop.

Uses of the crop.

a. Green seeds and pods. These products are restricted to human consumption. In some regions, both pods and seeds are used for this purpose. In a very small area green seeds are taken out of the pod, salted and eaten directly. In recent times, green seeds are also used for canning and, mainly, freezing.

The most suitable varieties for this purpose are those belonging to the *major* group : 'Aguadulce', 'Muchamiel', 'Ramillete' in the first place, and their derivates 'Granadinas', 'Tarragona', 'Mahon', 'Segurenas' etc. in the second.

All these names refer to land-races and not to cultivars.

b. Dry seeds. These are used for animal feed, and this is the kind of use that has produced a new interest in the crop. The varieties sown for this purpose belong to the *equina* and *minor* groups (in Spanish, respectively : 'caballares', i.e. *equina* in Latin equals horse beans, and 'Cochineras', i.e. for pigs), but in practice it is very common to find *major* land races also sown for animal feed. The new cultivars selected for this purpose are mostly *equina* or *equina-major* , but the idea that the faba bean has to be 'large' is strongly impressed on the Spanish farmer, especially if he is not very well adapted to the requirements of modern farming systems.

Dry seeds can also be used for human consumption. In recent times, the use of salty fried beans *(major* group) as a snack has become very popular, particularly in the SE of Spain. The faba bean meal (that is, lentil, chickpea or common bean style) has almost disappeared; it can only be found in very isolated farms.

It is obvious that in primitive times, faba beans were used for flour : we ourselves found a bunch of carbonized faba bean seeds in the top of an iberic mill (pre-Roman period : 500-300 B.C.). This use is no longer found in Spain, but the 'porridge' was mentioned up to the XVII century.

c. Green manure, forage etc. All these uses have disappeared; they can only be found after a strong *Orobanche* attack, as a way of taking advantage of an almost certainly lost product.

Growing systems

a. For green seeds. In 1978 the total production was of 124,600 t over about 15,000 ha with an average yield of about 8.3 t/ha of green pods. Only 5600 t (that is 4.5 per cent) were used by the food industry (mostly for frozen seeds), but this figure will probably increase in the future.

Most of this production was obtained in orchards; only a small area was cultivated in an 'extensive' way, that is, sown and cultivated as for dry seeds but harvested for green ones. This system will increase depending on the future development of freezing and canning industries. At the present time, the Spanish consumer prefers the 'fresh' product.

Faba beans (broad beans) are sown from September to November. In very restricted zones (the coast from Malaga to Alicante below 100 m altitude), they are sown late in August. The rule is : the warmer the climate, the earlier the sowing. In Central Spain, with very cold winters, faba beans can only be sown in spring. Farmers do not use protected environments because of the concurrence of the earlier products coming from the coast.

Sowing is preformed in furrows or holes spaced 30-40 cm within rows. Between rows distances are usually 50-60 cm. The farmer usually places 3-5 seeds per hole. Quantities per hectare depend on the seed size and the fertility of the soil, and can reach up to 400 kg/ha. If the sowing is preformed in furrows these quantities usually range from 150 to 300 kg/ha. In the Southern coast these quantities can be as low as 30-60 kg/ha. *Rhizobium* is never applied.

Before sowing, the plot is ploughed once or twice, and very frequently the cultivator, grubber and/or harrows follow the ploughing operation. In orchards, ridges are generally preferred.

Fertilizers are applied in the following quantities : 65-80 kg/ha of P_2O_5, 90-150 kg/ha of K_2O and 20-30 kg/ha of N (as ammonium sulphate or nitro-sulphate).

Winter and spring cultivation consists of harrowing and cultivating, and sometimes hoeing. Weeding was traditionally done by hand, but nowadays herbicides are largely used.

It is essential to keep a good level of moisture. The quantity of water ranges from 3-4 waterings of 500-700 m^3/ha each to 4-8 applications of 1400 m^3/ha each NE Spain). In the SE region, usual figures are 3-7 waterings of 600-800 m^3/ha each.

The most usual herbicides are : Trifluraline (pre-sowing, 0.6-0.8 kg a.i./ha), Trialate (id., 1 kg a.i./ha), Simazine (post-sowing and pre-emergence, 0.5-0.6 a.i. kg/ha), Neburon (id, 2.4-3.0 kg a.i./ha). In post-emergence, Linuron and Dinoseb are the most popular.

In some places, the tillers are detopped to increase the size of the pods. In the S.E. of Spain, farmers have traditionally selected their own seeds for the next year, choosing those from the earliest tiller of the earliest plants. It is obvious that this intuitive method selects not only nuclear genes but also cytoplasms for precocity, because it covers the possibility of cytoplasmic diversity (by organelle segregation) between buds.

Pods are harvested when they reach 3/4 of their mature size. For some 'fresh' uses, they are harvested at a maximum of 1/2 of their size. Harvesting is performed by hand over a rather long period of time. The first green pods are in the market as early as November, and are produced in the S and SE Spanish coast. Yields can reach up to 12-15 t/ha.

For canning and freezing, harvesting is performed in the same way as peas even using the same mechanical systems. Generally, a mower places the plants in rows; these plants are taken later by a harvester-thresher taking the seeds out of the pods.

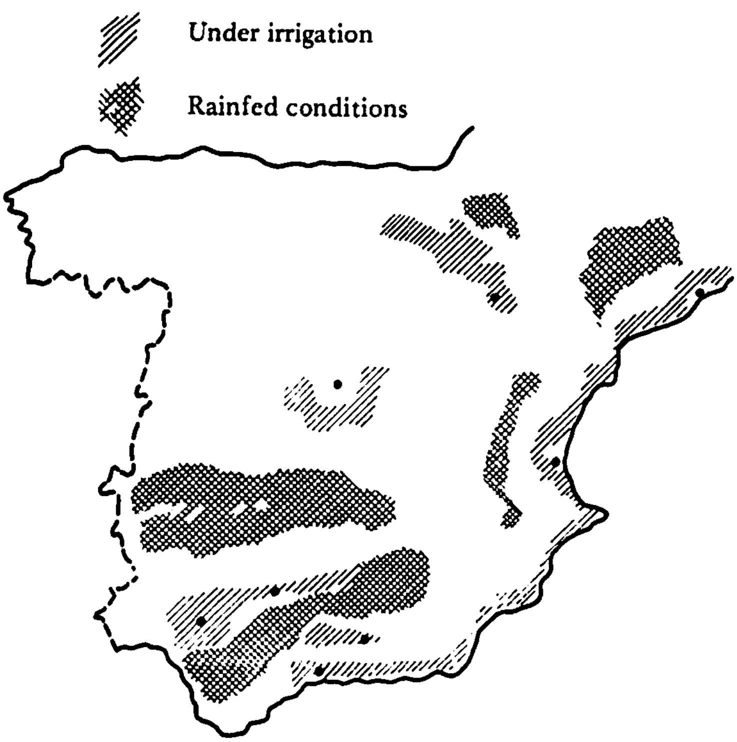
b. For dry seeds.

Faba beans are sown in October-November, after the first rains but in Andalucia they can be sown up to late in December. Most of the Spanish land-races can resist low temperatures at the 2-4 leaf stage. Thus, progressive farmers look themselves for the most convenient date of sowing in order that this stage occurs during the coldest period. However, in the cold regions of the Meseta (Central Spain) they can not be sown up to February-March, but the economic yields are lower than those obtained for harder crops as, for example, lentils.

Sowing has traditionally been performed broadcasting the seed by hand, but this 'biblic' picture has almost disappeared. Nowadays, faba beans are sown in rows (rarely in holes) using cereal sowing machines with very slight modifications. In Navarre, a common system is to broadcast the seed by manure distributing machines after a previous application of herbicide. The smaller the seed size, the easier the sowing. Thus, the small seeded varieties are a necessity.

Sowing densities depend on the seed size. Big errors were committed by farmers following uncontrolled importations of seeds from England and France in the early seventies. Farmers used to sow large seeded varieties at a density of 150-250 kg/ha and they also sowed the small *minor* varieties at the same rates. A beautiful non-productive 'forest' was obtained. At the present time, 100-180 kg/ha are recommended for the *equina* or *equina-major* types according to the seed size and the fertility of the soil. However, farmers sowing *major* types have to use up to 250 kg/ha. In some places the densities are as low as 40-100 kg/ha and in others as high as 350 kg/ha. Hole sowing in the north-east of the country uses 50-150 kg/ha.

Before sowing, the plot is ploughed once or twice and one harrow and/or cultivator stroke can follow. Very rarely nowadays the seeds are broadcasted directly over a bare fallow, followed by ploughing to cover them. Winter and spring operations consist of grubber or horse-hoe strokes.



Fertilization was traditionally nil. Nowadays, many farmers are using 50-100 kg/ha of P_2O_5 and 80-200 kg/ha of K_2O. Nitrogen is not included in the formulation in most cases. These quantities can be considered as equivalent or even greater than those used in orchards, but it is worth saying that the fertility of the soil is very different in both cases. *Rhizobium* inoculation is never performed.

When it is possible, irrigation is applied. Of course, if irrigation is possible, the most usual product is the green seed, but occasionally also dry seeds are produced.

Fields sown by the broadcast method are not further cultivated up to harvesting. On the contrary, fields sown in rows (spacing varies from region to region, according to the fertility of the soil; common distances between rows are 50-70 cm) are mechanically as well as chemically weeded; the most common herbicides have been listed in section a. under 'Growing systems'.

Harvesting (May-June in Andalucia, June-July in the other regions) is also traditionally performed by hand. When plants are showing blackish pods at the bottom, the whole plants are pulled out of the soil and piled in small heaps. Once the plants are totally dry, they are threshed by hand or by cereal threshers only slightly modified to receive the faba bean seed. More progressive farmers also harvest mechanically using cereal harvesting machines. Again, the varieties with small seeds are then a necessity, as they are for mechanical harvesting. Yields from rainfed land (without irrigation) can reach up to 3.5 t/ha, using recently selected varieties, sown in rows, and using fertilizers etc.. The barrier of 4 t/ha will probably be broken in the very near future. However average yields are low in Spain; at 0.8 to 1.5 t/ha.

c. Rotations.

Rainfed faba beans are traditionally cultivated in two or three year rotations, depending on the fertility of the soil :

- Faba bean - wheat
- Faba bean - wheat - fallow
- Faba bean - wheat - wheat or barley

In the fertile Andalusian 'campinas' faba beans are placed in rotations with sunflower, sugar beet and sometimes cotton, as well as with wheat and barley. On occasions, and when irrigation is possible, some farmers sow soybeans in June as a second crop after faba beans. Most of the farmers are conscious of the value of faba beans in improving the fertility of the soil.

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FABA BEANS AND PHARAOHS

'The crop was well known to the Ancient Egyptians. Faba beans have been found in the 5th Dynasty funerary temple of Sahure (c. 2400 B.C.), in tombs at Dra, possibly dating back to the 12th Dynasty (2140-1785 B.C.) and Kom Ouchim from the Roman era (Darby et al., 1977). They are illustrated on the wall of the tomb of Minister Rakhmire in Thebes (c. 1580 B.C.) where it is written "he receives the faba beans and sweet melon for Amon's temple" (Abdullah 1979). A stela dated the 8th year of Rames II (c. 1300 B.C.) refers to faba beans as one of the crops transported between Lower and Upper Egypt for the welfare of the workman (Dixon, 1969) and Rames III (1198 - 1166 B.C.) is said to have offered 11,998 jars of shelled faba beans on one occasion and 2,398 jars on another to the God of the Nile (Darby et al., 1977).'

Hawtin, G.C. and Hebblethwaite, P.D. (1982) from 'Background and history of faba bean production'. In : 'The Faba Bean (*Vicia faba* L.) : basis for improvement'. Ed. P.D. Hebblethwaite. Butterworth, U.K. (In Press).

FABA BEANS IN CROP ROTATIONS IN FRANCE

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In France, the area cultivated with both peas and faba beans has increased considerably over the past five years : for peas from 4000 ha to 70,000 ha between 1977 and 1981, and for faba beans from 4600 ha to 19,000 ha during the same period. The increase in area has been mainly in cash crop regions, and much less in regions where farmers produce the two crops to feed their own livestock.

Why this increase?

Farmers in cereal-growing areas look for species to incorporate in their rotations to avoid cultivating cereals (wheat and barley) too often on the same field. For several years, they grew cereal species other than wheat and barley for profit : sorghum or maize in South France, maize in the North, but there this species was limited by a climate which gave irregular yields. Other species, such as rape, sunflower, peas and sometimes faba beans, have also been of interest to the farmer, both economically and agronomically.

Economically, faba beans like peas are of interest because :

- the price is guaranteed and increases each year; the profit is attractive when farmers can have good and regular yields such as 4500 to 5000 kg/ha.
- the French and European markets offer wide possibilities because livestock need increasing amounts of protein. The two crops are particularly useful for pigs, poultry, rabbits etc..
- no extra investment is required for growing these crops except some modifications for sowing due to the large seed size.

Agronomically the use of faba bean at the beginning of the rotation is interesting because :

- nitrogen rich residues from faba bean increases the nitrogen content in the soil. Mineral nitrogen is thus saved for the next crop.
- the soil structure is improved and parasites are reduced. However, faba bean may favour some parasites when it is grown frequently. Unfortunately, agronomic information is scarce on these aspects and too often obtained in special conditions and never under real farming conditions.

What do we know?

At Toulouse, Klain *et al.* found the optimum rate of nitrogen fertilization on winter wheat to be less than 100 kg/ha after legumes, but about 150 to 200 kg/ha after cereals.

This effect largely depends on the climate : a mild and rainy winter leads to mineralisation of organic matter and leaching of nitrate nitrogen, the level of the latter being high with faba beans. In eight years on average the wheat yield after maize was about 4990 kg/ha, after alfalfa 5370 kg/ha and after faba beans 5250 kg/ha, but the variability after legumes is higher than after gramineaceous crops.

In Versailles, faba bean roots leave about 50 kg/ha of nitrogen in the soil. In another recent experiment, the straw of faba beans gave almost the same effect in the soil as did mineral fertilization with 50 kg N/ha applied in autumn, but with the advantage that this nitrogen is available for the subsequent wheat crop.

After legumes, the soil structure is less compact in the first 15 cm than is the case following maize. Thus the preparation of soil for subsequent sowing is easier after faba beans, peas or soya than after maize, sorghum or rape

Research being carried out

There is a lack of information concerning the place of peas and faba beans in farm rotations and the frequency of these legumes in the same field.

In order to define these agronomic limits, five experiments have been organized by several institutes covering an area of 800 m^2 per treatment to study rotations including the following species : wheat, rape, sunflower, peas, soya, sorghum. Faba beans are used in two experiments only, where we are trying to obtain the maximum level of protein per ha.

Three main rotations are compared :

1. wheat, peas, wheat, rape
2. wheat, rape, peas, rape
3. faba beans, peas, rape, peas.

All species are compared each year so that each experiment compares the 12 possible combinations with four replications. Began in 1977 in regions chosen for their climatic conditions, these tests have so far been carried out over a period of four years. Until now, yields vary slightly. Parasites, weeds, soil preparation may be controlled with normal techniques. We need five more years to obtain valid technical and economic results.

Conclusion

This important experimental research program is very costly and several specialists are working on it. It should give an economic answer to farmers concerning savings on nitrogen and energy, and an agronomic answer on the frequency of use of faba beans on the same field. This latter aspect may seem less interesting, but for farmers it may be useful because they cannot cultivate faba beans on all fields on the farm.

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KILLED BY BEANS?

'Pythagoras, the 6th century B.C. Greek philosopher is said to have met his death at the hands of the people of Crotonia in Southern Italy; pursued by them he came to the edge of a bean field and was killed rather than set foot in it (Arie, 1959). This same story has also been attributed to certain of the disciples of Pythogoras, who were slaughtered by the soldiers of Dionysius rather than enter a bean field (Sturtevant, 1919). Whatever the case, the Pythogorean movement clearly detested faba beans (Liddle and Scott, 1968).'

Hawtin, G.C. and Hebblethwaite, P.D. (1982) from 'Background and history of faba bean production', In : 'The Faba Bean (*Vicia faba* L.) : basis for improvement'. Ed. P.D. Hebblethwaite. Butterworth, U.K. (In Press).

FABA BEANS IN CROPPING AND CROPPING/ LIVESTOCK SYSTEMS IN THE U.K.

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U.K. farmers who specialise in growing cereals, typically winter wheat and winter or spring barley, usually feel the need of a 'break' crop to limit the increase of soil-borne fungi that damage cereals. Farmers whose systems include livestock may want a source of home-grown protein free from the risks of hay-making and the capital and recurrent costs of silage-making. Farmers of both groups do well to consider faba beans among their options.

Beans may be sown in autumn or spring and can be sown, sprayed and harvested by the equipment used for cereals. Except in rare seasons they are off the ground in time for autumn sowing of wheat and barley (though a recent trend in September sowings of cereals may make winter beans more suitable than the spring-sown crop).

Yields of beans are generally less than those of cereals grown on the same land and losses from diseases and pests are proportionally greater. Uncontrolled *Aphis fabae* ('Black fly') will occasionally make the spring beans not worth harvesting, and other insects, viruses, nematodes and fungi often cause losses which would rarely if ever be equalled in wheat or barley. Recent research at Rothamsted has produced firm or tentative answers to most of these problems. It is now clear that to ensure a full yield of beans a farmer must accept extra costs of healthy seed and of applying protective chemicals to the crop at least as great as those commonly accepted by farmers intent on growing full yields of wheat or barley. But, even with the full application of present knowledge, yields of beans vary more between seasons than those of wheat or barley.

Rotation experiments

From 1968 to 1978 spring beans were grown in crop rotations on small areas of two of the long-term or 'Classical' field experiments at Rothamsted. One, Broadbalk, has winter wheat as its chief crop and was started in autumn 1843; the other Hoos Barley, has been devoted to spring barley since 1852. Both have different plots treated annually with contrasting applications of fertilizers and organic manures, each repeated on its respective plot with little or no variation since the early years. Changes in the readily soluble P, K and Mg on many plots were rapid at first, but are now much slower, and the levels on both farmyard manure (FYM)- and fertilizer-treated plots are now above those at which we would expect beans to respond to fresh dressings of P, K and Mg. Some plots (e.g. those given no manure or fertilizer) have marked deficiencies but in this paper these are excluded. The results quoted are from plots which have received repeated applications of fertilizers providing P, K, Mg and Na (most with N also) or of farmyard manure. Changes of variety and husbandry are made only at predetermined intervals and, as far as seasonal weather permits, sowing dates etc. are held constant.

Table 1. Ranges of yields of grain at 85 per cent dry matter (Broadbalk and Hoos Barley, 1969-1978).

	grain yield (t/ha)			
	Mean	Max (x)	Min (n)	Ratio (x/n)
Broadbalk with FYM				
Beans	2.98*	5.00	1.20	4.2
Wheat after beans	6.57	8.02	5.16	1.6
Wheat after fallow	6.16	7.60	4.58	1.7
Wheat after wheat	5.48	6.54	3.63	1.8
Broadbalk with fertilizers				
Beans	2.82	4.14	0.83	5.0
Wheat after beans	5.75	6.84	3.98	1.7
Wheat after fallow	5.06	6.35	3.27	1.9
Wheat after wheat	5.06	5.65	4.00	1.4
Hoos Barley with fertilizers				
Beans	3.00	4.53	0.64	7.1
Barley after beans	5.54	6.99	4.47	1.6
Barley after barley	5.29	6.53	3.67	1.8

*omitting 1969 data when the seed drill worked badly on this plot.

In the 10 seasons 1969 - 1978 yields of beans varied much more than those of either wheat or barley (Table 1). The ratio of greatest to smallest annual yield of beans with fertilizers was 5:1 on Broadbalk, 7:1 on Hoos Barley and slightly less (4:1) on the FYM-treated plot of Broadbalk. It is fair to point out that the beans suffered unexpected damage by stem nematode *(Ditylenchus dipsaci)* during this period, damage by insects other than black-fly was not controlled, and there were substantial outbreaks of virus disease in some years; with later knowledge much of these losses could have been avoided and the range of yields might have been substantially less. Yields of wheat and barley, however, all varied by less than a factor of 2 (though they too received less treatments against pests and diseases than are normal practice now) and clearly these crops are more reliable than spring beans are likely to be in the near future.

Average yields of beans were about half those of winter wheat after beans on Broadbalk, and a little more than half those of barley after beans on the Hoos experiment.

Wheat after the two-year break of potatoes and beans, yielded more than wheat after successive wheat crops, by about 20 per cent with FYM, and by about 14 per cent with fertilizers. But barley after a two-year break of potatoes and beans outyielded barley after successive barley crops by only 5 per cent. All these crops received adequate N-fertilizer and most of the benefit to the cereals should probably be ascribed to the lessening of take-all disease *(Gaeumannomyces graminis)* by the two-year break. This is confirmed by the smaller benefit from the oneyear fallow which is known to be less effective in decreasing take-all.

Recent experiments at Rothamsted were designed to distinguish between the effect of extra nitrogen on cereal crops following beans and the effect of the control of soil-borne disease. In particular oats were compared with beans before both winter wheat and (in separate experiments) spring barley.

Oats at Rothamsted (but not universally) do not suffer from take-all and test-crops following oats and following beans had equal (and small) amounts of take-all. After barley, however, test-crops had much take-all. The nitrogen status of soil was assumed to be the same after oats and after barley and this led to the conclusion that beans made available for the succeeding crop 44 to 50 kg N/ha more than oats. This is about half the average rate of application of N to cereals in the U.K. and contrasts with the greater amount derived from some other legumes; red clover grown for one year's hay cutting, for example, provided about 90 kg N/ha. Beans, oats and several other break crops were equally effective in controlling take-all; the benefit varied greatly between sites and seasons.

Beans are less efficient competitors for weeds than cereals, but with effective herbicides available for application to beans this is not a serious fault. In general, then, provided beans are grown with the same attention to control of pests and diseases that is commonly given to cereal crops, beans are of great potential value in intensive cereal farming and in some arable-plus-livestock systems.

Much of the material in this paper is based on a chapter by R.D. Prew and myself in 'The Faba Bean *(Vicia faba* L.) A Basis for Improvement' to be published by Messrs. Butterworth, edited by P.D. Hebblethwaite (Nottingham University, U.K.) who has kindly sanctioned its use. I am grateful also to Mr. J.H. Gosling of Messrs. Dalgety Spillers for valuable information on cropping systems in the U.K.

SHORT COMMUNICATIONS

BREEDING AND GENETICS

A SPONTANEOUS VARIEGATED MUTANT IN *VICIA FABA* WITH AN UNUSUAL INHERITANCE

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About ten per cent of the plants in the partially-inbred line S45 are deficient in chlorophyll in parts of their leaves. Chlorotic mutants, both spontaneous and induced, are quite common in *Vicia faba* but this one is of interest for its unusual segregations following crosses and possible association with cytoplasmic male sterility.

Typically one side of the leaf or lamina is pale yellow and distorted in shape (see Fig. 1) but symptoms vary from a few distictive flecks on some leaves to different degrees of variegation or even completely chlorotic plants. Occasionally the chlorosis appears on some and not all tillers of a plant, and may be more obvious at some stage of growth than at others. For this reason all plants described below were examined both early and late during their growth, before final classification. Except where degree of chlorosis was assessed plants were classified and described as "Chlorotic" if they had any symptom of this form of chlorosis.

Fig. 1. (See text)

Despite lower numbers and weight of grain on severely chlorotic plants and tillers, the frequency of affected plants in Line S45 *did not* decrease over several generations of multiplication. This suggested some form of transmission other than through seed, but no virus or virus-like particles were found when sap of chlorotic plants from two multiplication generations was examined in an electron microscope (Cockbain, 1976, personal communication).

Crosses of chlorotic x normal green unrelated lines gave the following results :

chlorotic x green

chlorotic x F_1: 53 all green x green

39 green : 30 chlorotic (X^2 for 1:1 = 1.17, 0.2 < P < 0.3) | 32 green, 2 slightly chlorotic

Selfed

F_2: 446 green : 25 chlorotic

random sample open pollinated

F_3: 1292 green : 14 chlorotic

There were no reciprocal differences in backcrosses, F_2 or F_3. The progeny from the backcross to chlorotics was consistent with the hypothesis of a single recessive gene controlling chlorosis but the F_2 was widely different from the expected 3:1 ratio. Also, although 1306 plants from 105 F_3 families were grown, only 14 plants from 11 of these families were chlorotic. As most of the open pollination in the F_2 would have involved self fertilisation or sibbing and consequent further segregation, this is too low a frequency of chlorotics to be explained in terms of 1 or 2 recessive genes.

Self pollination of chlorotic plants did not result in entirely chlorotic progeny though there was a distinct tendency for the proportion of chlorotic offspring to be greater and their degree of chlorosis to be more extensive if the parent plants were extensively, rather than slightly, chlorotic (Table 1). Similar results were obtained when chlorotic tillers, not just whole plants, were selfed. Selfed green tillers on otherwise chlorotic plants produced six green and two chlorotic offspring. Crossing of chlorotic x green tillers on the same plants resulted in seven green and eight chlorotic plants with no reciprocal differences. Open pollination of chlorotic tillers gave a significantly higher proportion of chlorotic offspring than that from green tillers, but not higher than that from slightly chlorotic tillers.

Table 1. Effects of degree of chlorosis of parents on (a) proportion of chlorotic plants in progeny and (b) their degree of chlorosis.

Chlorosis of parents (Selfed)	Number in progeny				
	Green	Chlorotics with score :			
		Slight	Mod.	Extensive	Total
Slight	31	5	6	4	15
Moderate	13	0	6	8	14
Extensive	2	2	1	8	11

X^2 for slight-chlorosis parents v others (total chlorotic progeny) equals 6.53, P < 0.02

Even given some variability in expression of this character, incomplete penetrance (see Williams, 1964) would have to be postulated for the data to be consistent with control by one, or a few, nuclear genes. Moreover, penetrance would have to be said to be much lower in F_2 and F_3 than in the backcross to chlorotics which was near to a 1:1 ratio.

Another possible explanation came from crosses of Line S45 chlorotics to 447-type cytoplasmic male-steriles. When eight plants taken at random from Line S45 (a fertility-restoring line) were each crossed to two male-sterile plants the total offspring were 176 green and 23 chlorotic, and the progenies of male-steriles by one of these S45 plants totalled 13 green and 17 chlorotic. The latter are unlikely to have been misclassified since open-pollinated chlorotics gave 47 green and 62 chlorotic offspring. When the same male-sterile plants were crossed with a green inbred line no chlorotics were detected among the 63 plants of the F_1. Another male-sterile line (also 447 cytoplasm) gave, when crossed with S45, 358 green and 32 chlorotic offspring. All F_1 plants with an S45 parent were male-sterile due to the effect of the restorer gene Rf_1.

The finding of chlorotic F_1's was in contrast to the entirely green F_1s from crosses where neither male-sterility nor restorer genes were involved and female parents had been hand emasculated (53 green F_1, see above). It suggests some kind of association or interaction with the cytoplasmic spherical bodies (CSBs) known to be associated with the 447 type of sterility (Edwardson *et al.* 1976). Moreover, the lack of chlorotics in F_2 and F_3 despite a high proportion in backcrosses, and the behaviour of the character following selfing of chlorotic plants and pollination tillers, is also similar to that of the 447 sterility. The CBSs are thought to be lost during certain cell divisions resulting in fertile progeny, or in this case, a return to normal amounts of chlorophyll. However, lack of reciprocal differences rules out maternal or simple cytoplasmic inheritance, and bi-parental transmission seems possible in view of the chlorotic F_1 ex-male steriles and the high proportion of chlorotics in progenies of backcrosses to chlorotic male parents. It seems likely that inheritance is partly under the control of the cytoplasm, partly the nucleus and partly the plastids themselves.

Further investigation of the S45 chlorotic might be repaid in terms of better understanding of cytoplasmic male sterility in *V. faba*, or it might also be a tool to assist investigations of plastid inheritance. In the meantime, the chlorosis is proving useful as a marker to distinguish synthetic varieties of which Line S45 is a component from other synthetics.

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ISOENZYMATIC HETEROGENEITY IN A TETRAPLOID *VICIA FABA*

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The only fertile tetraploid known up to now in *Vicia faba* was discovered in a population grown from a set of X-ray treated seeds (Poulsen and Martin, 1977; Martin, 1978). One of the questions raised about this tetraploid was whether it was produced by one single original tetraploid plant or whether the X-ray treatment produced abnormalities in several individuals, hence giving rise to a tetraploid population (even of a small size) rather than a tetraploid line. The fact that we can select 'fertile' and 'unfertile' lines (Martin and Gonzales, 1981) within this material strongly suggests the second hypothesis, but stronger proof is required. Here we present the isoenzymatic pattern of three different tetraploid lines showing biochemical diversity. As tetraploid x diploid crosses are not fertile (Martin, 1978; 1979), this can be considered as proof of the same hypothesis.

Materials and Methods

One of the three tetraploid lines was selected for fertility (45-1-3), the two others being non-fertile (37-1-1 and 53-3). A line derived from the cultivar 'Primus', in which the first tetraploid plants were observed, was used a a check.

The method of extraction from one single seed and of staining of Glutamate-oxalacetate-transaminase (G.O.T.) and esterases (EST) were those given by Gates and Boulter (1979), and that of amlase (AMY) by Brewbaker *et al.* (1968). The dialysis was performed in distilled water for 24 hours and slots of 7.5 x 0.7 cm were used. During the first five minutes, a constant current of 1 mA/tube was maintained, being followed by 4 mA/tube to complete the run.

Results and Discussion

Fig. 1 shows the pattern obtained for each one of the three enzymes analyzed. The intensity of the band is proportional to the intensity of the staining.

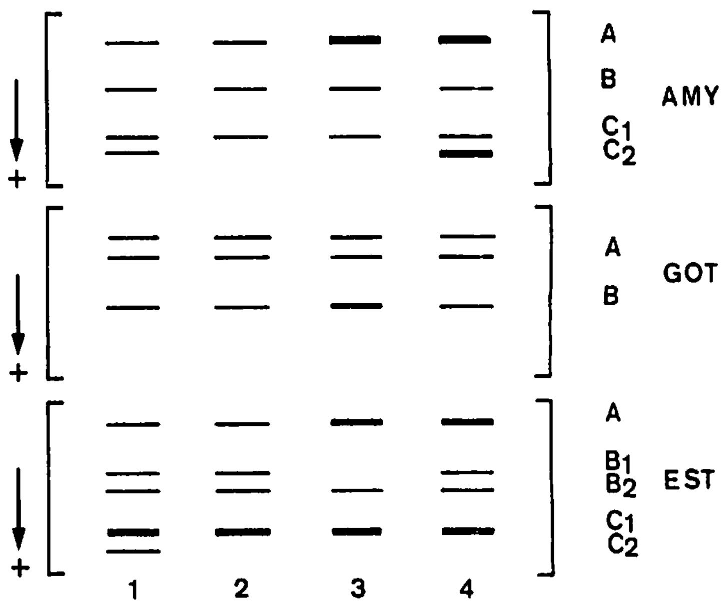

Fig. 1 Isoenzymatic pattern
1. Primus (2x)
2. 45-1-3 (4x, fertile)
3. 37-1-1 (4x unfertile)
4. 53-3 (4x, unfertile)

In general, the more intense bands in the tetraploid could be attributed to its gene dosage, but as it can be observed, this is not a general result. Those cases in which both tetraploid and diploid show the same intensity could be due to an upper limit in enzymatic activity, but this possible explanation has not been worked out.

AMY : Three zones are easily recognised. Band C_2 is lacking in the fertile tetraploid line (45-1-3). This band is clearly weaker in 'Primus'.

G.O.T. : The two zones, A and B, only show differences in intensity (line 37-1-1).

EST : Band C_2 is not present in any of the three tetraploid lines; band B_1 is not shown by 37-1-1 and is more intense in 53-3. Band A is also more intense in the two non-fertile lines.

The three tetraploid lines used in this study differ from each other in their isoenzymatic patterns, and also differ from 'Primus', even when there seems to be a 'family aspect' in the material studied. These results suggest three possible explanations :

1. that several plants, and not only one, reached the tetraploid status in the original diploid population;
2. one or several diploid plants were heterozygous for some loci, segregating in following generations;
3. the actual tetraploid plants can be genetically unbalanced because of aneuploidy always showing 24 chromosomes.

In any case, the differences in fertility have a counterpart in the isoenzymatic pattern, even when both kinds of variability have not to be correlated with each other; that is, the determinate enzymatic pattern does not indicate fertility or unfertility.

For the moment, it is not possible to decide among these hypotheses. As the tetraploidy seems to be a 'frozen accident' (i.e., crosses with diploids are not successful) in the case of *V. faba*, the problem is how the first tetraploid plant(s) was (were) produced. However, for the moment neither morphological nor biochemical analysis seem to be helpful in discovering the mechanism involved.

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INDUCTION OF GENETIC VARIABILITY IN *VICIA FABA* L.

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New, useful and genetically identifiable variation is needed in *Vicia faba*. This is one of the most important priorities recommended for *V. faba* breeding work (Chapman, 1981). Germplasm collection and induction of mutations are recognised to be two different methods to enlarge the documented variability in *V. faba* (Abdalla and Hussein, 1977). The analyses of variation in collections of *V. faba* (Sirks, 1931; Bianco *et al.*, 1979) have shown that other than for seed size, a broad variability exists in this species for number of stems/plant, number of leaflets/leaf, length of rachis and flowering time, the genetic control of which is not yet well known.

The plant features for which detailed genetic descriptions (locus and dominance relations) are reported include leaf, stem, inflorescence, flower colour, flower morphology, seed coat and hilum colour (Chapman, 1981). Most of these are useful and simply induced variants. This indicates that mutagenesis could produce a broader spectrum of genetic variation in *V. faba*.

Due to the importance of mutagenesis from the genetical and breeding point of view, a program was started three years ago in order to study the mutagenic effects of gamma-rays in inducing extreme forms of plant morphology, and disease and pest resistance. Reported here are the results of the screening made in M_2-progenies for plant morphological characteristics.

'Violetta di Policoro' was the cultivar used in the experiment. This belongs to the sub-class *V. faba major.* Two S_2 seed samples, containing 4567 and 5347 seeds, were treated with gamma-ray doses of 8.0 kR and 12.0 kR, respectively. Only 20 per cent of the seeds treated at 8.0 kR and 10 per cent of the seeds treated at 12.0

kR, germinated and produced plants. The M_1 plants were self-fertilized and almost 10 per cent of the M_1 plants from the 8.0 kR treatment and the 20 per cent of the M_1 plants from the 12.0 kR treatment were sterile. The seeds from each of the 800 fertile M_1 plants from the 8.0 kR treatment and the seeds from each of the 150 fertile M_1 plants from the 12.0 kR treatment were sown the following year, giving almost 9000 M_2 plants. Only 114 out of 800 M_1 (8.0 kR) progenies and 24 out of the 150 M_1 (12.0 kR) progenies showed at least one mutated plant. Plants from untreated seeds of the original seed stock of the cultivar were used as checks to compare the effect of each mutagenic gamma-ray treatment.

Table 1 summarises the kind of chlorophyll and morphological mutations induced by the different mutagen doses. Gamma-rays induced proportionally more chlorophyll mutations than morphological mutations. Chlorina mutants were the most frequent. Semi-sterility and changes in leaf shape were two other relatively frequent effects of gamma-ray treament.

Among the other morphological mutants, two mutant types seem to represent something not previously reported in *V. faba major*. One of these mutants could be described as a mutation affecting the shoot system, and the other as a complex mutant with extensive pleiotropic effects (Blixts, 1972). The first mutant is a determinate type with terminal inflorescence (Fig. 1a). This mutant produced 10 to 15 inflorescences before the terminal one. Seed setting was good, and the final plant height was 60 - 70 cm.

The second mutant showed greatly enlarged foliage, flowers, stem and pods (Fig. 1b). The leaves and stipules were two to three times larger than the normal type. All flowers possessed two and the stigma was geniculate. Few tillers were produced. The main stem was large and weak, green or purple coloured. Pod setting was normal, but seed set was low and irregular. Certain plants were completely sterile. Cytological analysis of root-tip cells showed the regular chromosome number of 2 n equals 14. The first meiotic division cells showed no irregularity in chromosome pairing. This

Table 1. Types of mutations and mutated progeny sizes in a mutagenic experiment using gamma-rays at 8.0 kR and 12.0 kR on *Vicia faba.*

Type of Mutation	M_1 progenies with at least one mutant individual				M_2 plants examined		M_2 plants with mutation	
	8.0 kR		12.0 kR		8.0 kR	12.0 kR	8.0 kR	12.0 kR
	No.	per cent of M_1 plants examined	No.	per cent of M_1 plants examined	No.	No.	per cent of M_2 plants examined	per cent of M_2 plants examined
Chlorophyll apparatus								
Xantha	16	22.9	2	20.0	185	22	14.6	16.6
Chlorina	43	61.4	5	50.0	503	60	16.8	23.1
Chlorotica	11	15.7	3	30.0	158	10	17.5	20.0
TOTAL	70	(61.3)*	10	(41.7)*	846	92	16.4	20.6
Morphological								
Short stature	4	9.1	–	–	39	–	20.7	–
Lack of waxiness	2	4.5	–	–	26	–	18.5	–
Leaf shape	8	18.2	1	7.1	110	8	22.3	25.0
Flower colour	5	11.4	–	–	41	–	31.0	–
Seed coat colour	6	13.6	2	14.3	72	25	20.0	24.0
Semi-sterility	10	22.7	8	57.1	150	120	25.7	25.0
Pod dimension	3	6.8	3	21.4	33	24	15.8	16.7
Terminal inflorescence	1	2.3	–	–	10	–	10.0	–
Other suspect mutations	5	11.4	–	–	–	–	–	–
TOTAL	44	(38.7)*	14	(58.3)*	481	177	20.5	22.7
OVERALL TOTAL	114	–	24	–	1327	269	–	–

* equals percentage of the overall total

mutation with manifold effects needs further investigation in order to ascertain if it could be considered as an example of the pleiotropic effect; due to chromosome mutation, or whether it is just a mutant at a locus which exerts pleiotropic effect. To such a mutant, the name of LARGE FOFLOPO (Large foliage-flower-pod), is proposed.

Fig. 1a Determinate type with terminal inflorescence.

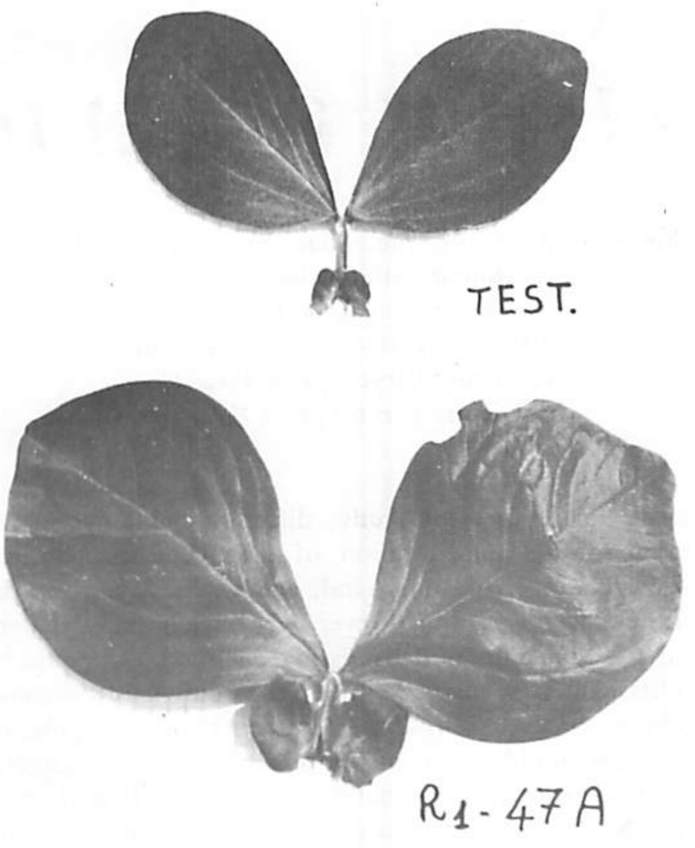

Fig. 1b LARGE FOFLOPO MUTANT (Large foliage-flower-pod).

These preliminary results on mutagenic treatment of *V. faba* showed that gamma-rays, at the tested doses, are effective in inducing chlorophyll mutations. These are more frequent than morphological mutations. The induced morphological nutations represent a contribution to the enlargement of the spectrum for useful genetic variability in *V. faba*.

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FABA BEANS IN THE NEW WORLD

'Faba beans were unknown in the New World before the arrival of Columbus in 1492 and are believed to have been introduced into Central and South America by the Spaniards and Portuguese in the 16th century (Bond, 1976). There are records that the second Spanish Governor to arrive in Colombia took seeds of faba beans with him in 1543 (Tannahill, 1973). It was mostly the large-seeded, var. major, types of Mediterranean origin which were introduced into Latin America and these types still predominate today.

Hawtin, G.C. and Hebblethwaite, P.D. (1982) from 'Background and history of faba bean production', In : 'The Faba Bean (*Vicia faba* L.) : basis for improvement'. Ed. P.D. Hebblethwaite. Butterworth, U.K. (In Press).

GIEMSA C-BANDING KARYOTYPE OF *VICIA NARBONENSIS* AS COMPARED TO *VICIA FABA*

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Vicia faba and *Vicia narbonensis* have diploid chromosome numbers of 12 and 14, respectively. The former species has been extensively used in various cytological studies, primarily because of its large chromosomes. However, only a small amount of literature is available on the cytological aspects of *V. narbonensis*. In this short communication, we describe an attempt to compare the distribution of constitutive heterochromatin in the chromosomes of *V. faba* and *V. narbonensis*, following the Giemsa C-banding technique.

Fast growing root meristems of *V. faba* and *V. narbonensis* were pretreated with 0.05 per cent aqueous solution of colchicine for three to four hours at room temperature. The root tips were fixed in 45 per cent acetic-orceine overnight and subsequently hydrolized in 2N HC1 for two hours at room temperature. Immediately after hydrolysis, squash preparations were made in aceto-orcein. The cover slip was removed by the dry ice method. After air-drying, the preparations were dehydrated in 96 per cent alcohol for 90 minutes and in redistilled alcohol for another 30 minutes; they were then kept in a desiccator overnight. Dehydrated slides were treated with saturated aqueous solution of barium hydroxide for 10 minutes at room temperature. The slides were then washed in running tap water until no barium hydroxide was left; they were rinsed twice in distilled water at 45°C and then incubated in 2X SSC at 60°C for three hours. The slides were then rinsed in distilled water, stained in Giemsa (Gurr 048200 diluted 1:20 in Sorensen phosphate buffer, pH 6,9) for 10 minutes and air-dried. After cleaning in xylene, they were mounted in Euparal. Microphotographs were taken at a magnification of 800x.

The karyotype of *V. faba* consists of one pair of large metacentric SAT-chromosomes and five pairs of acrocentric chromosomes, each about one half of the metacentric pair. In the SAT-chromosome, there was a dark, sharp band in the nucleolar constriction, two bands in the short arm close to the centromere and one proximal band in the long arm (Fig. 1a and c). In the long arm of the acrocentric chromosomes, one to three interstitial bands were observed. Faint bands were seen in the centromeric region of all chromosomes. Karyotype and distribution of Giemsa-bands in *V. faba* in the present study were in no way different from earlier reports (Dobel *et al.* 1973, Hizume *et al.* 1980). However, it may be pointed out that slight variations in banding pattern of the same species may occur, since some of the bands are not always visible.

In *V. narbonensis*, the seven pairs of chromosomes were distinctly different in their morphology from those in *V. faba*. They were sub-metacentric to sub-acrocentric (Fig. 1b and d). Heterochromatic bands were very weak and few in number. Telomeric bands in the short arm of all the chromosomes and in the long arm of some chromosomes were clear. In the centromeric region, bands were not observed for all chromosomes.

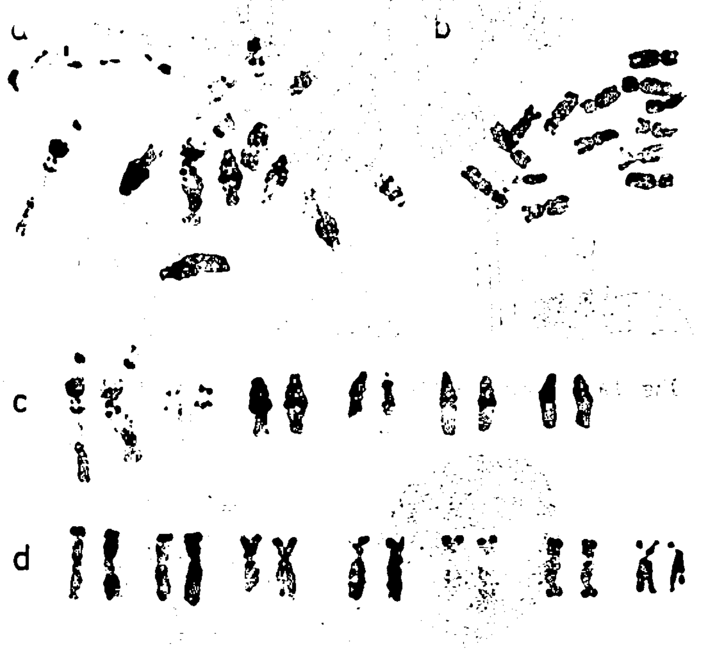

Fig. 1. a. Mitotic metaphase of *Vicia faba* after pretreatment with colchicine.
b. Mitotic metaphase of *Vicia narbonensis* after pretreatment with colchicine.
c. Giemsa-karyotype of *Vicia faba*.
d. Giemsa-karyotype of *Vicia narbonensis*.

In the present study, different combinations of temperature and duration of treatment with barium hydroxide on the one hand, and with 2X SSC on the other, were tried. However, no further improvement in the appearance of bands in *V. narbonensis* could be obtained. It seems that either the content of C-heterochromatin is less in *V. narbonensis* than in *V. faba*, or a larger modification of the present technique is necessary in order to make bands more clear in *V. narbonensis*. So far, no report has appeared in the literature on the banding pattern of *V. narbonensis*. Taking the results of the present report at face value, substantial differences in the content and distribution of C-heterochromatin exists in the two species. This finding supports the rather distant taxonomic relationship postulated between *V. faba* and *V. narbonensis* (Cubero 1981).

Acknowledgement

The authors wish to thank Mrs. Nina Hoffman for her advice in the staining procedure and for help in microphotography. Finincial support to the senior author from the German Academic Exchange Service (DAAD) is gratefully acknowledged.

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THE GREAT ENEMY

'Mice are great enemies of beans, or more properly, they love them too much as the cannibal said of his fellow-creatures. This love, however, sometimes proves extremely inconvenient to the bean planter; and, therefore, these gentry must be kept down, which they easily are, however by brick-traps, which gardeners know very well how to set. The depth at which the larger beans are sowed is about three inches, and the smaller ones about two inches and a half; but, in every case, all the earth drawn out of the drill, should be put in again upon the beans, and trodden upon them with the whole weight of the body of a stout man; for the more closely they are pressed into the ground, and the ground is pressed upon them, the more certainly and the more vigorously will they grow. and the more difficult, too, will it be for the mice to displace them.'

from 'The English Gardener' (1829), by William Cobbett, reprinted in 1980 by Oxford University Press, England.

PHYSIOLOGY AND MICROBIOLOGY

A NOTE ON THE DEVELOPMENT OF LONG PODS OF FABA BEANS CONTAINING UP TO 12 SEEDS PER POD.

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One area of work on faba bean development in the U.K. which has not been previously mentioned in FABIS is the development of *Vicia faba major* lines with longer pods than usual, containing more seeds which are more closely packed. Many years of selection at J.D. Gillett and Son Ltd. has progressively increased the maximum number of seeds per pod in locally adapted varieties - up to 9, 10, 11 and now 12 seeds per pod.

This has been achieved without controlled hybridization or mutagensis; but it represents more than a recombination of characters already existing in parental varieties because as far as we are aware, no other nationally listed variety of faba bean in any country is claimed to produce a maximum of 10 to 12 seeds per pod. A good growing environment is necessary for this number of ovules to become seeds, but even in poorer environments the number of seeds in the longest pods on a plant is significantly greater than that on any previously listed variety in the U.K.

The varieties which we selected and introduced a few years ago were named 'Imperial White and Green Longpod' and also 'Imperial White and Green Windsor'. Recent releases are 'HYLON White Longpod', 'RELON Green Longpod' while 'JUBILEE HYSOR' is a larger seeded White Windsor type capable of producing up to nine seeds per pod. The three new varieties have been awarded 'Plant Breeders Rights'.

It is the pods of 'Green Longpod' that have produced some pods containing 12 seed per pod. These seeds will be grown for the next two or three harvests.

We are also concentrating on producing both White and Green Longpod faba beans which have pods that do not hang down but instead grow outwards and upwards. A small lot of these were grown in 1981 and were found to be very satisfactory. There are, however, not so many beans in the pods - up to eight plus one ovule. These seeds will also be grown for the next two or three harvests.

SYMBIOTIC DINITROGEN FIXATION BY RAINFED FABA BEANS IN NORTHERN SYRIA

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A quantification of the amount of dinitrogen fixation is important for evaluating the role of a nodulated legume in the cropping system. It is also important for an evaluation of various agronomic variations such as moisture supply, fertilizer application, inoculation with *Rhizobium*, as well as for the comparison of various genotypes in relation to symbiotic dinitrogen fixation.

The 'A' value concept has long been used to quantitatively measure the amount of soil nutrient in terms of units of fertilizer standard, labelled with a suitable isotope (Fried and Dean, 1952; Fried and Broeshart, 1967). This concept has been used to measure the available soil nitrogen, ultilizing N^{15} labelled fertilizer nitrogen (Legg and Stanford, 1967; Saxena and Marschner, 1968) and the 'A' value has generally been independent of the rates of fertilizer used (Fried and Broeshart, 1967).

Fried and Broeshart (1975) have also shown that the amount of nitrogen fixed by a nodulated legume can also be measured in terms of fertilizer standard by subtracting the 'A' value obtained with non-nodulating crop from the 'A' value obtained with a nodulating crop. Using the fertilizer use efficiency value which is experimentally determined, the 'A' value in terms of the fertilizer units can be converted to the actual amounts of nitrogen fixed by the crop. The steps are shown in the following equations :

1. Percentage of plant nitrogen derived from fertilizer (per cent Nd ff) for the nodulating and non-nodulating crops separately :

$$\%Ndff \quad \frac{\%N^{15} \text{ atom excess in plant N}}{\%N^{15} \text{ atom excess in fertilizer N}} \times 100$$

2. Amount of fertilizer N in each crop (F_N) :

$$F_N = \left[\begin{array}{l}\text{Total N yield in}\\ \text{the crop}\end{array}\right] \left[\begin{array}{c}\%Ndff\\ 100\end{array}\right]$$

3. Percentage fertilizer use efficiency (per cent FUE):

$$\%FUE = \left[\frac{F_N \times 100}{\text{Amount of fertilizer N applied}}\right]$$

4. 'A' value of soil N for non-nodulating crop (A_{NN}):

$$A_{NN} = \left[\frac{\left(\begin{array}{c}\text{Total N yield}\\ \text{in the crop}\end{array}\right) - \left(\begin{array}{c}F_N \text{ in the}\\ \text{crop}\end{array}\right)}{(F_N \text{ in the crop})}\right] \times \left[\text{Amount of fertilizer N applied}\right]$$

5. 'A' value of soil N plus symbiotic N for nodulating crop (A_S plus SN) :

$$A_S + SN = \left[\frac{\left(\begin{array}{c}\text{Total N yield}\\ \text{in the crop}\end{array}\right) - \left(\begin{array}{c}F_N \text{ in the}\\ \text{crop}\end{array}\right)}{(F_N \text{ in the crop})}\right] \times \left[\text{Amount of fertilizer N applied}\right]$$

6. 'A' value for symbiotic N for nodulating crop (A_{SN}) :

A_{SN} equals ($A_S + SN - A_{NN}$)

7. Fixed N in the nodulating crop (S_N) :

$$S_N \text{ equals } \frac{(A_{SN})(\%\text{ FUE for nodulating crop})}{100}$$

Using the above technique, the symbiotic nitrogen fixation in two Syrian land races of faba beans, viz. local large seeded (ILB 1814) and local medium seeded (ILB 1813), as affected by phosphate application was studied under rainfed conditions during the 1977-78 cropping season at ICARDA's site at Tel Hadya.

The soil of the experimental field was clay-loam with pH 8.5, 1.11 per cent organic matter and 8.00 ppm available P in top 15 cm soil layer. The total seasonal precipitaiton was 360 mm. Wheat was used as a non-nodulating crop. Nitrogen was applied as ammonium sulphate. In the micro-plots, fertilizer nitrogen tagged with N^{15} was used. The results, which are the average of four replications, are presented in Table 1.

The yield of faba beans increased with application of 20 kg/ha of starter nitrogen. Application of 50 kg/ha of P_2O_5 as triple superphosphate further increased the grain yield in both the genotypes. Phosphate application also resulted in increased straw yield in ILB 1813. These yield increases reflected, in turn, increased total nitrogen yield in the crop. The cultivar ILB 1813 appeared more responsive than ILB 1814. The per cent increases in the total nitrogen yield with N and N plus P treatments over unfertilized control were 21 and 38 per cent

Table 1. Yield and nitrogen concentration on oven dry weight basis, total nitrogen yield, percentage of plant nitrogen derived from fertilizer (per cent Nd ff), fertilizer use effeciency (per cent FUE) of faba bean and wheat and the contribution of symbiosis, fertilizer and soil nitrogen to the total nitrogen yield of faba beans.

Treatments			Yield (kg/ha)		per cent N		Total N	per cent Nd ff		per cent	per cent N derived from		
Genotype	Fertilizer (kg/ha) N	P_2O_5	Grain	Straw	Grain	Straw	yield (kg/ha)	Grain	Straw	FUE	Symbiosis	Fertilizer	Soil
ILB - 1814	0	0	1622	1105	3.50	0.959	67.4	–	–	–	–	–	–
	20	0	1812	1338	3.54	0.872	75.7	1.00	0.25	3.35	93.9	0.88	5.13
	20	50	1915	1377	3.52	0.859	79.2	0.50	0.25	1.85	96.8	0.46	2.73
ILB - 1813	0	0	1342	675	3.31	0.971	51.0	–	–	–	–	–	–
	20	0	1667	752	3.34	0.839	62.0	2.00	1.50	6.00	95.7	1.95	2.35
	20	50	1812	952	3.48	0.783	70.6	2.25	2.00	7.85	84.8	2.20	12.90
Wheat	60	60	2155	3410	2.50	0.338	65.3	31.75	44.75	37.05	0.0	34.08	66.92

in ILB 1813 as against 12 and 17 per cent in ILB 1814. The absolute nitrogen yields were, however, lower in ILB 1813 than in ILB 1814, as was the case with the yield of grain and straw.

The total nitrogen in the plant derived from symbiosis was about 71 and 76.7 kg/ha in ILB 1814 with N and N plus P treatments respectively. The respective values for ILB 1813 were 59.3 and 59.9 kg N/ha. These values respectively amount to 93.9 and 96.8 per cent of total N yields in ILB-1814 and 95.7 and 84.8 per cent in ILB 1813. From these data it is clear that ILB 1814 showed improvement in the symbiotic N fixation with phosphate application, whereas ILB 1813 showed little improvement. The increase in total N yield in the latter, because of phosphate application, has accrued from increased uptake of soil nitrogen.

It may be mentioned that the crop was raised without artificial inoculation with *Rhizobium* but was well nodulated because of the presence of naturalised *Rhizobia* in the rhizosphere. The differences in the phosphate response of the symbiotic association, in terms of nitrogen fixation, observed in this study may emphasise the importance of host genotype - *Rhizobium* strain interaction.

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FABA BEANS IN ROME

'The Romans had a feast on June 1st, the Kalendae fabariae, at which faba beans and bacon were offered in honour of the Goddess Carna, who brought health to the vital bodily organs (Sturtevant, 1919). Pliny, although noting that the bean occupied a high place as a delicacy for the table, nevertheless wrote that it was thought to have a dulling effect on the senses and also to have caused sleeplessness.'

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RESPONSE OF FABA BEAN TO GLYPHOSATE

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Introduction

The parasitic weed *Orobanche crenata* Forsk. is one of the main problems of faba bean (*Vicia faba* L.) throughout the Mediterranean area. Several authors (Schmitt *et al*, 1979; Zahran, 1980; Jacobson and Kelman, 1980) have reported that glyphosate (N-(phosphonomethyl) glycine) applied at low rates to faba bean controlled broomrape without injury to the crop. However, Petzold (1974) reported faba bean toxicity after glyphosate was applied at 200-400 g/ha. To assess the benefit of a herbicide in a crop it is important to determine both the crop tolerance at different growth stages and the herbicide rate and its efficiency in controlling weeds. The objective of this study was to determine the influence of glyphosate on crop toxicity and final seed yield when applied at different rates and growth stages of weed-free faba beans.

Materials and Methods

An experiment was conducted in a clay soil free of broomrape seeds at Dona Sol, Cordoba. The faba bean variety 'Moruna' was planted on December 15, 1980. Faba bean growth stages corresponding to the times of herbicide application are presented in Table 1. Glyphosate was applied at 60, 120, 240 and 360 g a.i./ha with an experimental sprayer delivering 175 l/ha at 3 kg/cm^2. The experimental design consisted of a randomised complete block with a factorial arrangement of five application times and four herbicide rates plus control, with four replications. The experimental units each contained five rows, 70 cm apart and 8 m long.

Table 1. Faba bean growth stages and dates of the various glyphosate applications.

Time of application (1981)	main shoot growth: leaf number	main shoot growth: height (cm)	Growth stages
1. February 9	6	14	vegetative
2. March 2	9	25	early flowering
3. March 16	14	34	flowering
4. April 1	18	44	flowering and pod-bearing
5. April 24	20	46	late flowering and pod-bearing

Phytotoxicity was determined two and four weeks after each herbicide treatment, using the 0 to 100 visual rating system, in which 0 means no effect; 10 to 30 slight and short effect; 40 to 60 moderate and more lasting effect, which may affect yield; 70 to 90 severe effect and 100 complete crop destruction. The winter growing conditions in 1981 were unusually dry. The three central rows of each plot were harvested by hand and the seed yield obtained was recorded as a percentage of the control.

Results and Discussion

Crop growth stage and herbicide rate influenced phytotoxicity following glyphosate application. Phytotoxicity symptoms from glyphosate applied at 60 and 120 g/ha consisted of slight chlorosis (pale-green leaves) which disappeared in a few weeks. Twisted young leaves and stunted crop growth were also recorded after glyphosate was applied at 240 and 360 g/ha during the two first growth stages. Data on the effect of glyphosate application on faba bean toxicity are presented in Table 2.

Table 2. The effect of rates and times of glyphosate application on phytotoxicity to faba bean.

Rate of application (g a.i./ha)	Faba bean toxicity (0 to 100 rating system) — Time of application : (see Table 1) 1	2	3	4	5	Mean
15 days after treatment						
60	20	2	0	1	10	7
120	18	10	10	5	15	12
240	42	19	11	7	7	17
360	50	36	24	6	10	26
Mean	33	17	11	5	10	
30 days after treatment						
60	4	5	0	5	–	3
120	10	12	5	10	–	7
240	45	19	5	17	–	17
360	76	35	19	6	–	27
Mean	34	18	7	9	–	

LSD (5 %) for time of application x herbicide rates equals 6.0
LSD (5 %) for time of application averaged over herbicide rates equals 3.0
LSD (5 %) for herbicide rates averaged over time of application equals 2.7

Phytotoxicity when averaged over times of application increased as herbicide rate was increased from 60 to 360 g/ha. Crop injury when averaged over herbicide rates, was higher when glyphosate was applied at the first (vegetative) stage compared to the second (early flowering) or third (flowering and pod-bearing) stages. Glyphosate applied at any stage at 60 and 120 g/ha did not result in consistent crop injury. Glyphosate applied at the vegetative stage at rates of 240 and 360 g/ha resulted in moderate and severe crop injury respectively. However, injury was slight following glyphosate application at 360 g/ha in the three later growth stages.

Faba bean seed yield decreased significantly due to glyphosate applied at the first two stages, compared to other stages, when averaged over all herbicide rates. Yield was also significantly reduced by glphosate applied at 360 g/ha, compared to the two lower rates, when averaged over times of application. The seed yield was signficantly reduced by glyphosate at 240 g/ha applied at the first (vegetative) stage and at 360 g/ha at the first and second stages (early flowering), as compared to the control.

Table 3. The effect of time and rate of application on faba bean seed yield expressed as percentage of the control.

Time of application (see Table 1)	Seed yield as percentage of control[1] Rate: (g a.i./ha) 60	120	240	360	Mean
1	100	101	72	77	87
2	96	100	98	60	88
3	111	108	93	88	100
4	100	97	97	106	99
5	93	101	107	101	100
Mean	100	101	93	86	

[1]Control seed yield equals 1580 kg/ha.
LSD (5 %) for time of application x herbicide rate equals 22
LSD (5 %) for time of application averaged over herbicide rates equals 11
LSD (5 %) for herbicide rates averaged over time of application equals 10

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'FABA'

'The Latins called it faba. We find nothing in the works of Theophrastus, Dioscorides, Pliny, etc., which leads us to believe the plant indigenous in Greece or Italy. It was early known, because it was an ancient Roman rite to put beans in the sacrifices to the goddess Carna, whence the name Fabariae Calendae. The Fabii perhaps took their name from faba, and the twelfth chapter of the eighteenth book of Pliny shows, without the possibility of a doubt, the antiquity and importance of the bean in Italy.'

from 'Origin of Cultivated Plants', by Alphonse de Candolle, (1886), reprinted in 1967, p. 318.

PHENOLOGICAL TRAITS AND YIELD OF FABA BEANS *(VICIA FABA* L. *MAJOR)* IN NORTHERN ITALY

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Faba bean has always been cultivated in Italy, although there is little information available on the possibility of growing the crop in the north of the country (Ziliotto and Toniolo, 1979a and 1979b). One problem in the north concerns the time of sowing. In general, an autumn planting, as in Southern Italy, allows the plant a better utilization of natural resources and as a result gives higher yields compared to a spring sowing. However, winter cold may affect the whole crop when a non cold-resistant variety is used.

Table 1. Range of phenological traits and yields of seven faba bean varieties, in relation to sowing date.

Date of sowing	Date of beginning of flowering	Date of beginning of maturity	kernel yield (t/ha d.m.)
D_1 Feb. 26, 1976	Apr. 7 - 10	June 18 - 24	1.1 - 1.9
D_2 Mar. 16, 1976	May 12 - 17	June 15 - 22	1.4 - 2.1
D_3 Mar. 3, 1977	May 15 - 21	June 27 - July 16	1.2 - 2.2
D_4 Mar. 18, 1977	May 22 - 29	July 10 - 30	0.9 - 1.3
D_5 Apr. 4, 1977	May 30 - June 7	July 12 - 21	0.9 - 1.4
D_6 Apr. 14, 1977	June 9 - 16	July 19 - 28	0.7 - 1.2
D_7 Oct. 19, 1977	Apr. 6 - 13	June 27 - July 3	2.6 - 4.6
D_8 Oct. 31, 1977	Apr. 13 - 18	June 27 - July 3	2.1 - 4.5
D_9 Nov. 16, 1977	Apr. 23 - 25	June 27 - July 8	1.8 - 2.8
D_{10} Dec. 1, 1977	Apr. 26 - 28	June 27 - July 13	1.5 - 3.0

This paper reports phenological and yielding results of seven varieties in Italy sown from October through April in the Po Valley area on a medium soil. The varieties were : 'Gigante d'Ingegnoli' (country of origin Italy, 1000 kernel weight 1743 g), 'Super Aguadulce' (Morocco, 1000 k.w. 1977 g), 'Muchamiel' (Spain, 1000 k.w. 1438 g), 'Quarantina Primizia' (Italy, 1000 k.w. 1748 g), 'Supersimonia' (Morocco, 1000 k.w. 1575 g), 'Lunga d'Aguadulce' (Spain, 1000 k.w. 1610 g) and 'Quarantina Viola' (Morocco, 1000 k.w. 1149 g).

Table 1 shows that beginning of flowering is not related to time of sowing when this is in the period October to February : in all cases, flowering begins in April, that is 71 to 177 days after sowing. When sowing was on March 3 the flowering began after 76 to 82 days and a further delay of 10 to 15 days in sowing reduced the length of the vegetative phase, which became as short as 60 to 65 days according to the variety.

A smaller variation was observed for date of maturity which generally occurred at the end of June or July following both autumn or spring sowings.

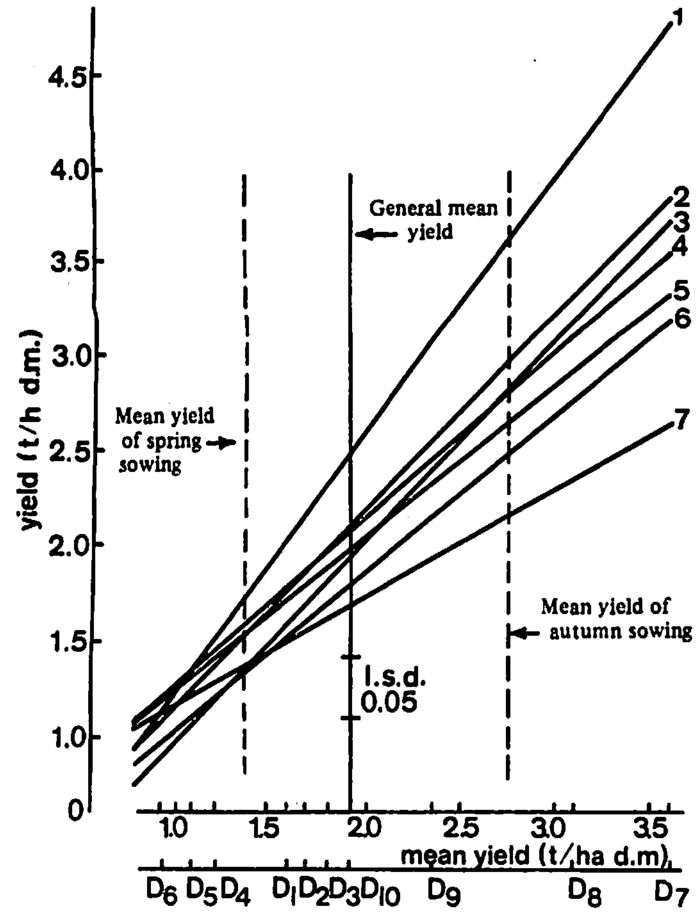
On average, 'Gigante d'Ingegnoli' was the last to flower, preceeded by 'Lunga d'Aguadulce', 'Quarantina Primizia', and 'Quarantina Viola'. 'Gigante d'Ingegnoli' resulted in the best yield, and was medium-late in maturing. 'Quarantina Viola', the worst in terms of kernel yield, was one of the earliest maturing varieties along with 'Quarantina Primizia'.

'Lunga d'Aguadulce' and 'Super Aguadulce' exhibited a longer period from flowering to maturity compared to other varieties. On the contrary, 'Quarantina Viola' matured at the same time irrespective of sowing date, indicating its high sensitivity to the spring temperature.

The mean yield is correlated with date of sowing and reaches its highest values with the earlier sowings. However, some varieties (e.g. 'Muchamiel', Quarantina Primizia', 'Quarantina Viola') when sown in the spring season yielded more than when sown in the period November to February. Thos behaviour is similar to that observed in some field bean varieties grown in the same area (Ziliotto *et al.* 1980).

Figure 1 shows the regressions of the yield of each variety on the mean yield, according to Finlay and Wilkinson (1963). The dotted lines correspond to the mean yields of spring and autumn sowings, while the solid vertical line indicates the general mean. 'Gigante d'Ingegnoli' was the best following both autumn and spring sowings, especially when tested in the best environmental conditions corresponding to the earlier sowings. Its yield reached 4.6 and 4.5 t/ha of dry seed when sown on October 19 and 31 respectively. This variety also had the highest index of stability, whereas all others were little different, with the exception of 'Quarantina Viola' which was the most stable but very low yielding.

Due to the mild weather season no data on cold resistance was collected. In any case, it seems that an autumn sowing doubles the yield compared to a spring sowing. The variability observed in this material suggests that a variety combining traits of cold resistance and sensitivity to spring temperatures could give the most promising results.



	"r"	"b"
1. Gigante d'Ingegnoli	0.941	1.466
2. Super Aguadulce	0.979	1.116
3. Supersimonia	0.949	1.119
4. Muchamiel	0.943	0.931
5. Quarantina Primizia	0.957	0.860
6. Lunga d'Aguadulce	0.974	0.891
7. Quarantina Viola	0.928	0.615

Fig. 1. Regression lines of seven faba bean varieties on ten mean yields given by different sowing dates. Dates refer to the first column of Table

N.B. All the correlation ("r") and regression ("b") coefficients are significant to P equals 0.01.

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THE USE OF *RHIZOBIUM*, SULPHUR AND NITROGEN IN FIELD EXPERIMENTS WITH *VICIA FABA*

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Faba beans are generally grown in Spain without seed inoculation, as *Rhizobium leguminosarum* is always present in the soil in sufficient quantity and quality. Farmers only add P and K as a basal dressing.

It is well known that nitrogen fertilizers applied to legumes decrease nodulation and nitrogen fixation rates. The increases in yield obtained are not always significant nor economically profitable, due to the rising cost of fertilizer.

However, nitrogen can be applied only when the requirement for it is high, and a substantial increase in crop yield may be obtained without any effect on nitrogen fixation. This is the case when fertilizer nitrogen is applied at flowering. At this stage, nitrogen fixation begins to decrease because the photosynthate is mainly devoted to pod filling (Garcia and Hanway, 1976).

Sulphur is an essential nutrient although not much research has been devoted to it. Its presence in most of the soils and fertilizers is generally sufficient to cover the total amount required for most crops. Previous greenhouse experiments, however, have provided evidence of the effects of the spray application of sulphur in its elemental form on plants of *Phaseolus vulgaris* and *Glycine max.* (Lluch *et al.* 1976)

During the past two years, field experiments with *Vicia faba* have been conducted to study the effects of both sulphur and nitrogen application together with inoculation of seeds.

Table 1. Results obtained from a field trial on *Vicia faba* carried out in 1979-80.

Treatment *Rhizobium*	N	S	Grain yield (kg/ha)	per cent increase over control
–	–	–	1962.5 ± 42.0	Control
–	–	+	2200.0 ± 54.0	12.1
–	+	–	2412.5 ± 24.5	22.9
–	+	+	2525.0 ±105.0	28.7
+	–	–	2100.0 ±145.0	7.0
+	–	+	2462.5 ±108.0	25.5
+	+	–	2462.5 ±87.0	25.5
+	+	+	2750.0 ±41.0	40.2

LSD at $P \leqslant 0.05$ equals 227.5
All treatments received P and K as basal dressing.

Table 2. Results obtained from a field trial on *Vicia faba* carried out in 1980-81.

Treatment *Rhizobium*	N	S	Grain yield (kg/ha)	per cent increase over control
–	–	–	600.0 ± 91.3	Control
–	–	+	752.5 ± 47.2	25.4
–	+	–	902.5 ± 125.5	50.4
–	+	+	1050.0 ± 159.5	75.0
+	–	–	835.0 ± 147.3	39.1
+	–	+	945.0 ± 109.7	57.5
+	+	–	1030.0 ± 168.1	71.5
+	+	+	1065.0 ± 128.7	77.5

LSD at $P \leqslant 0.05$ equals 183.4
All treatments received P and K as basal dressing.

Sulphur was applied 45 days after plant emergence at a level of 10 kg/ha. Nitrogen, as calcium ammonium nitrate, was applied once at 40 kg/ha when the first flowers appeared. Inoculation of seeds with an infective and effective *R. leguminosarum* strain (GR023) at about 10^5 cells per seed was carried out in the usual way. A split-plot design with four replications was used to test the eight treatments.

Tables 1 and 2 show the results obtained from experiments carried out in 1979-80 and 1980-81 seasons, respectively. The yields were lower in 1980-81 due to unfavourable climatic conditions.

These results show the positive and additive effect of sulphur and nitrogen application. Inoculation, as could be expected, did not give a generally positive effect. In some treatments, however, a significant increase with inoculation over uninoculated plants can be found, especially if sulphur was applied.

The effect of sulphur application was marked, in spite of the relatively high content of available sulphur in the soils used. There was no response to sulphur fertilization as sulphate, as reported elsewhere (Gates and Muller, 1979).

Further studies are needed in order to be able to explain the physiological behaviour of plants. Several different experiments are now being conducted to obtain further data.

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FABA BEANS IN CHINA AND JAPAN

'The date of introduction of the crop to China is uncertain. De Candolle (1886) wrote that the Emperor Chin-nong was said to have introduced faba beans in 2822 B.C., however modern authors consider this unlikely and it is possible that the crop was introduced with the silk trade (Hanelt, 1972). According to Kogure (1979), folk tales mention faba beans in China c. 100 B.C. and in Japan c. 700 A.D. The first written descriptions of faba beans in China was in 1313 A.D. Later documents indicated that the crop spread throughout the country in the early 15th century and that large seeded types appeared at the end of the 16th century.'

Hawtin, G.C. and Hebblethwaite, P.D. (1982) from 'Background and history of faba bean production', In :' The Faba Bean (*Vicia faba* L.) : basis for improvement'. Ed. P.D. Hebblethwaite. Butterworth, U.K. (In Press).

VARIABILITY IN FERTILITY COMPONENTS AMONG DIFFERENT GENOTYPES OF FABA BEAN

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A study on the fertility components of faba bean was started in Dijon in 1979. The aim of the study was to determine whether or not flower drop and pod drop factors limit the yield of faba beans.

Two approaches were tried :

1. Artificial modifications of the morphology of the plant were applied (apex, flower and leaf removal) to different genotypes. The effect of these treatments on the fertility components was then recorded (Duc and Picard, 1981).
2. Genetic variability in fertility components was also estimated among 38 genotypes in our collection during 1980. These genotypes were very variable as far as canopy and origin are concerned. The plants were sown at a nursery density of 15 plants/ m^2 in three row plots, and the characters were recorded on ten plants in the center row. There was no replication.

Tables 1 and 2 show the results obtained for the more characteristic genotypes. With respect to their fertility components we can consider two mechanisms of abortion :

a. flower drop
b. young pod (1-2 cm) drop

A measure of the first (a.) is given by the young pod/ flower ratio : the range was large, 0.24 - 0.94. A measure of the second (b.) is given by the pod/young pod ratio: the range was also large, 0.29 - 0.78. The product of the two giving the pod/flower ratio, had a wide range of 0.12 - 0.67. The inheritance of these characteristics is now being studied at Dijon.

Two correlations appear to be of interest : among the 38 genotypes, the pod/flower ratio was negatively correlated (S 1 per cent) with the number of nodes above the last podded node on a stem, and positively correlated (S 1 per cent) wtih the ratio of number of podded nodes/ number of flowering nodes. This result, which has yet to be confirmed, may indicate an indirect way of selecting for a high pod per flower ratio, i.e. by looking for genotypes having a limited growth above the last podded node ('partly' determinate types) and a pod set well distributed over all flowering nodes. The latter characteristic could be the expression of a lower competition between developed pods and developing pods.

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Duc, G. and Picard, J. (1981). 'Study on the fertility components in faba beans (*Vicia faba* L.).' In '*Vicia faba* Physiology and Breeding.' R. Thompson (Ed.) Martinus-Nijhoff, The Hague.

Table 1. Characteristics of the whole plant for a number of genotypes

Genotype	Yield/ plant (g)	Protein content (% of DM)	No. of pods/ plant	No. of seeds/ plant	Weight of 100 seeds (g)	No. of podded stems	Plant height (cm)	Flowering Date	Maturity Date	Pods/ podded node
1. Herz Freya	40.5	30.1	37.2	115	353	1.1	102	29/5	8/8	3.1
2. Strube	47.8	32.7	27.0	86.5	552	1.4	102	23/5	8/8	1.7
3. Wierboon	51.7	30.1	16.0	48.7	1063	1.7	89	20/5	10/8	1.3
4. Feve de Seville	34.6	35.2	5.8	23.0	1504	2.9	51	23/5	17/8	1.3
5. Felix	52.7	30.6	12.5	47.4	1112	2.4	47	18/5	8/8	1.3
6. Compacta	34.9	31.1	15.1	46.9	744	2.2	33	20/5	5/8	1.6
7. Topless	15.5	36.4	39.9	71.8	216	12.7	30	28/5	1/8	1.7
8. 34 India *Paucijuga**	7.3	34.2	20.3	54.0	135	4.4	21	24/5	5/8	1.0
9. 106 Poland *minor**	25.0	36.6	29.8	80.9	308	1.9	110	8/6	26/8	2.1
10. 159 Yugoslavia *minor**	30.0	32.9	35.7	94.3	318	4.1	109	5/6	20/8	1.3
11. 337 Sudan *minor**	19.4	36.0	22.7	58.4	332	3.3	53	24/5	5/8	1.7
12. 454 England *major**	58.7	28.9	10.2	37.7	1557	2.0	65	18/6	12/8	1.1
13. 896 Peru *major**	59.7	29.7	27.1	49.7	1201	5.2	61	2/7	5/8	1.4
14. 901 Peru *major**	39.7	30.3	10.9	24.7	1607	3.1	59	23/5	14/8	1.4
15. 25 hybrid*	60.6	31.0	34.4	91.1	665	3.3	91	23/5	14/8	1.7

*Genotypes arising from Dijon collection and selection

Table 2. Plant characteristics on the main stem for a number of genotypes.

	Level of the first flowering node	No. of flowering nodes	No. of nodes after the last podded node	Flowers/ flowering node	Podded node/ flowering node	Young pods/ flower	Pods/ young pods	Pods/ flower
1.*	5.9	14.5	7.8	5.3	0.80	0.74	0.63	0.48
2.	4.8	17.5	8.7	5.1	0.74	0.49	0.52	0.26
3.	4.8	16.9	10.5	5.8	0.56	0.29	0.42	0.12
4.	5.2	4.1	8.1	1.6	0.46	0.82	0.54	0.45
5.	4.9	12.8	13.4	3.4	0.38	0.24	0.63	0.15
6.	4.3	9.1	7.7	3.8	0.56	0.39	0.59	0.23
7.	4.6	5.5	0.5	3.8	0.95	0.98	0.64	0.64
8.	1.9	9.7	2.3	1.0	0.60	0.85	0.76	0.66
9.	9.4	15.7	8.6	5.1	0.67	0.63	0.45	0.29
10.	6.7	16.0	6.6	7.1	0.66	0.37	0.33	0.12
11.	5.1	9.8	5.3	2.2	0.74	0.84	0.78	0.67
12.	4.3	14.3	10.1	3.3	0.41	0.26	0.52	0.14
13.	8.5	8.3	8.1	3.0	0.63	0.94	0.29	0.28
14.	4.9	5.8	7.4	1.7	0.67	0.92	0.68	0.64
15.	4.3	13.6	10.5	5.1	0.74	0.49	0.54	0.27

* 1. to 15. represents the Genotypes (as for Table 1.)

THE EFFECT OF SHADING AT DIFFERENT PERIODS DURING FLOWERING ON FLOWER ABSCISSION IN *VICIA FABA* L. *MINOR*

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Flower abscission is recognised as one of the most important factors affecting yield of faba bean (Kambal, 1969; Jaquiery and Keller, 1978; Smith, 1982). In order to investigate the effect of limiting photosynthetic assimilates on this process, a shading experiment was performed during June and July 1981 at the Plant Breeding Institute, Cambridge.

Three genotypes of spring field beans, 'Cockfield', 'Maris Bead' and 'TI Col', were used and the plants were sown at normal density, 8.5 cm plant spacing, with 30 cm between rows, according to a modified randomized block design, consisting of blocks of the three varieties. Three treatments and a control were employed, each lasting for two weeks. The treatments began at the following stages of flowering :

1. bud initiation,
2. first flowering node with fully opened flowers, and
3. all nodes fully flowering.

Three varieties in each subplot were shaded at one time by means of hessian screens placed over the appropriate plots selected at random. The north side of the frame was left open to allow bee access. Each screen allowed approximately 60 per cent of the ambient light to reach the canopy vegetation.

Shading differentially affected the growth of the plants, according to the stage of flowering at which the shading was applied. In all cases, etiolation of the haulms was observed. However, 'Maris Bead' and 'Cockfield' in Treatments 1 and 2 attained the same final height as control plants, once the screens were removed. Compared to the control, 'Maris Bead' and 'Cockfield' in Treatment 3 were 22 cm and 26 cm taller, respectively. The terminal genotype, Ti Col, did not vary significantly in height between the control and the other treatments.

Shading at Treatment 1 slowed down the initiation of flowering racemes in 'Cockfield' and 'Maris Bead'. Once the screens were removed, flowering resumed and continued for approximately two weeks after the plants in the control plot had set pods. The non-terminal genotypes in Treatment 2 had fewer flowering nodes as opposed to the control and other treatments. 'Maris Bead' had a mean value of 7 flowering nodes 'Cockfield' 8, whereas control 'Maris Bead' and 'Cockfield' had an average of 11 inflorescences.

Five plants of each genotype were picked at random from each subplot (15 plants per treatment). Each plant was scored for position of flower drop and pod set within each *raceme.* All treatments showed increased flower drop compared to the control (see Fig. 1). The significance of this increase varied between varieties, when subjected to a chi-squared analysis. Only contrasting treatments giving results with a chi-squared value of $p = 0.1$ will be mentioned here.

The terminal genotype, TI Col, only showed a significant increase in flower drop, with plants subjected to Treatment 3, compared to the control. With 'Cockfield', abscission was significantly greater for all treatments. 'Maris Bead' indicated a signficant increase in flower drop in Treatments 1 and 3.

These results show that for the varieties tested here, plants are most sensitive to shading, as regards flower abscission, during the period of late flowering and early pod set. Most of the increased abscission observed during Treatment 1 in 'Maris Bead' and 'Cockfield', was due to bud abortion. This accounted for 24 and 40 per cent of the total abscission recorded for the two genotypes respectively.

It has been shown by Hodgson and Blackman (1956) that at high density, an increase in flower abscission was observed. From the above results, this must in part be due to a limitation of photosynthetic assimilates.

Perhaps more importantly, these results (see Fig. 1) indicate that most of this enhanced abscission occurs on the upper positions of each raceme. A similar situation was also observed when plants of different genotypes were subjected to irrigation (Smith, 1982). In appears, then, that interaction between flowers developing acropetally on a raceme such that basal flowers have a developmental advantage over those at the apex, could be an influence on the plastic response of field beans to environmental stress. Evidence to support this hypothesis will be presented in a subsequent paper (Smith and Gates, in preparation).

Acknowlegement

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SOULS OF THE DEAD

'The Elder Pliny, in Naturalis Historiae, written in the 1st century A.D., said "as others have reported, the souls of the dead are contained in a bean and at all events it is for that reason that beans are employed in memorial sacrifices to dead relatives" (Rackham 1950). The 2nd century A.D. writer Lucian represents a philosopher in Hades as saying that to eat beans and to eat ones fathers head were equal crimes and the flamen Dialis (the high priest of Jupiter), among many other taboos and restrictions, was not permitted to eat faba bean or even mention the name (Sturtevant, 1919)'.

Hawtin, G.C. and Hebblethwaite, P.D. (1982) from 'Background and history of faba bean production', In : 'The Faba Bean *Vicia faba* L.) : basis for improvement'. Ed. P.D. Hebblewaite. Butterworth, U.K. (In Press).

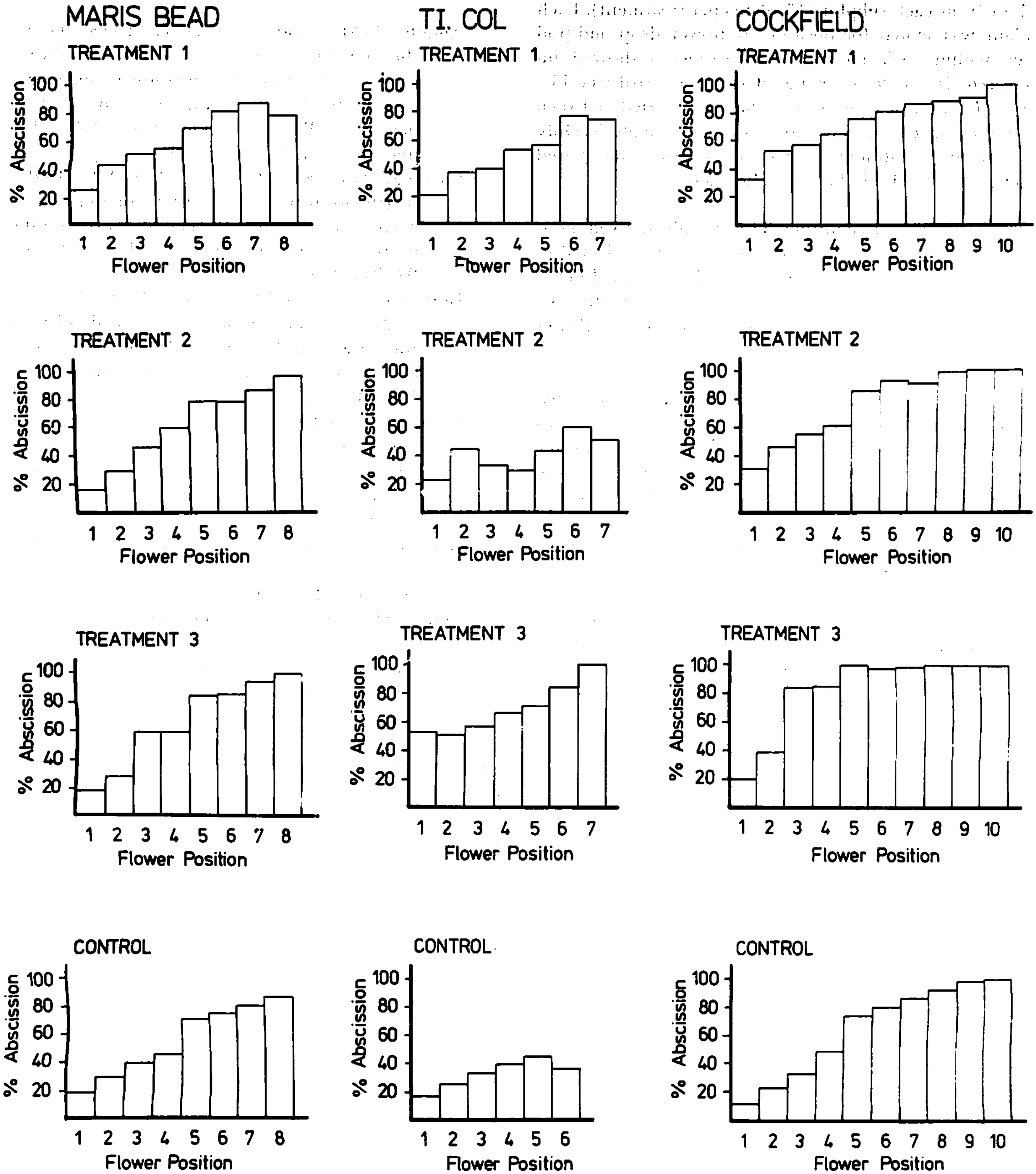

Fig. 1. Effect of shading at different stages of flowering on floral abscission within racemes of *Vicia faba* L.

THE RESPONSE OF FABA BEANS TO MANURE AND NITROGEN APPLICATION IN SALINE AND ALKALINE SOILS IN THE SUDAN

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Summary

Faba beans grown at Soba, where the soil is saline and alkaline, particularly in the subsoil, responded significantly to manure application. Chicken manure plus nitrogen gave the highest yield increase (48.7 per cent over the control), while farmyard manure (FYM) alone and nitrogen alone both decreased yield. Yield increases from sewage application were intermediate. However, the yield increases from nitrogen incorporation with chicken manure or sewage were not significant. In another experiment, increasing the rate of application of FYM to 25.6 t/ha significantly increased yield. This increase was attributed to the increase in pods per plant.

Introduction

Faba beans are a very important food in the Sudan. The crop is usually grown in the northern part of the country in narrow strips along the Nile. Further increases in production could be achieved by increasing the cultivable land area. However, this land is in the arid zone and could be adversely affected by salt and alkali. There is little information on the production of faba beans in the area south of Khartoum. This area amounts to about 78,000 ha and is affected by salt and alkali to varying degrees. The production of faba beans in this vast area could therefore be limited if no soil improvement measures are taken. El Karouri (1976) reported that farmyard manure (FYM) was used as one of the soil amendments at the Soba research farm. Yield increases in faba bean were reported following application of 25.6 t FYM/ha. There is little imformation on the use of other soil amendments. These amendments, primarily chicken manure and dry sewage, could become more readily available with increases in the population and in poultry farms, to the extent that they may create health hazards.

The overall objectives of this study were twofold: first to provide a means of disposal of these by-products and secondly to enable land to be reclaimed in order to raise a staple food for the densely populated areas of the country. Nitrogen was included as a treatment in this study.

Materials and Methods

Faba bean variety B.F/2/2 was tested for its response to organic manures (dry sewage, chicken manure and FYM each at 12.8 t/ha) and nitrogen (46.5 kg N/ha) in the saline and alkaline soils of Soba research farm (Long. 32^{o} 28 Lat. 15^{o} 24 , annual rainfall 160 mm). Eight treatment combinations, as listed in Table 1, were replicated four times. The land was first disc ploughed and lightly irrigated to break up the big clods of soil. After two to three days, it was harrowed and well levelled. The land was then ridged at 80 cm. The plots received two irrigations to ensure the mixing and chemical reaction of amendments with the soil and to avoid the high level of salinity created by these amendments. After the plots were dry the seeds were sown, and nitrogen (46.5 kg N/ha) was added to treatments 2, 4, 6 and 8. Sowing was done on both sides of the ridge with 15 cm spacing between holes. After sowing (completed November 7) the plots were watered at regular one-week intervals. Yield and yield components were determined at harvest. Another experiment with levels of FYM of 0, 6.4, 12.8 and 25.6 t/ha was similarly prepared and started at the same time.

Table 1. Yield and yield components of faba bean as related to manure and nitrogen application.

Treatment	Seed yield kg/ha	Pods/ plant	Seeds/ plant	Branches	Height (cm)	1000 seed wt.(g)
Chicken manure	1466ab*	11.5	25.4	4.3	70.5	380
Chicken manure plus N **	1533a	13.3	30.3	4.9	72.0	370
FYM	885bc	9.7	19.2	3.9	59.4	385
FYM plus N	1243ab	11.8	26.2	3.7	66.4	403
Sewage	1156bc	11.6	26.2	3.8	68.2	398
Sewage plus N	1020c	11.0	25.0	3.7	61.4	365
Control	1031c	9.7	21.9	3.8	62.0	393
N alone	800c	8.8	20.8	3.3	57.5	370
S.E. (±)	98.9	1.1	2.9	0.4	3.4	13.5

*Mean yields followed by the same letter(s) are not significantly different (P equals 0.01) according to Duncan Multiple Range Test.
**N equals application of nitrogen at 46.5 kg N/ha; organic manures were applied at 12.8 t manure/ha.

Results and Discussion

Table 1 presents yield and yield components in relation to the treatments used. Seed yield was significantly affected by manure. Chicken manure alone, or with nitrogen, produced the highest seed yields. FYM with nitrogen also produced significant yield increases over the control; while sewage alone or in combination with nitrogen and FYM alone did not increase the yield significantly. In fact, yield was reduced by application of FYM alone or by addition of nitrogen alone. The number of pods/plant, seeds/plant, branches and plant height, generally followed the same pattern of seed yield but the effect was not significant. Seed size was not affected by soil amendment or nitrogen.

Table 2 shows that the application of FYM at 25.6 t/ha was significantly superior to other treatments. Seed yield, number of pods/plant and seeds/plant were significantly increased by this treatment. Branches and plant height increased with increasing rate of FYM, but this increase was not significant. Seed size was not affected by treatment.

Table 2. Yield and yield components of faba bean in relation to levels of FYM.

Manure (t/ha)	Seed yield (kg/ha)	Pods/ plant	Seed/ plant	Branches	Height (cm)	1000 seed wt. (g)
0	787b*	9.0b	18.2b	3.1	66.3	373
6.4	938b	10.3b	21.5b	3.3	68.5	382
12.8	971b	8.5b	20.8b	3.0	71.3	392
25.6	1476a	13.5a	32.7a	3.6	75.1	386
S.E. (±)	61.8	0.9	2.1	0.4	3.0	9.6

*Mean followed by the same letter(s) within each column are not significantly different (P equals 0.05) according to Duncan Multiple Range Test.

Conclusions

It became very clear that organic amendments could affect the yield of faba bean. Chicken manure had the most conspicuous effect since it is easily soluble and contains some organic acids and nitrogen. This effect may be due to the reduction of exchangable sodium and improvement of the soil's physical and chemical condition. The other amendments might produce similar effects, but at a slower rate. Soil analysis is very important in this regard, but due to lack of facilities, only yield data were reported. In the future, such analyses could be done to focus on the role of these amendments in marginal lands. A further line of research is the evaluation of the residual and cumulative effects on soil properties and crop yield. Yields reported for faba bean were higher than those reported for the Gezira Research Farm (1980).

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BROOMRAPE–FABA BEAN COMPETITION

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Introduction

Competition studies can be used to estimate the influence of weed density and the duration of weed competition on crop development and yield. Such studies basically determine :

a. the economic threshold of weed control measures, and,

b. yield losses due to weeds in a particular field or over an entire region.

The parasitic weed broomrape (*Orobanche crenata* Forsk.) is one of the main problems of faba bean (*Vicia faba* L.) in the Mediterranean area. Faba bean yield reductions due to broomrape are well known to farmers and agronomists. However, no report is yet available that relates broomrape infestation to faba bean seed yield. The objective of this study was to determine the faba bean seed yield reduction due to competition with broomrape at different densitites (number of broomrape spikes/faba bean plant).

Materials and Methods

Samples were collected from three faba bean fields infected with broomrape in 1981, at the following locations in Andalusia, in the south of Spain: D. Sol (Cordoba), Villamartin (Cadiz) and El Trapero (Cordoba). Each field was divided into three or four sub-plots (replications) and 30 to 70 faba bean plants infected with a variable number of broomrape spikes, ranging from zero to five, were collected in each replication.

Plant material was dried in the oven at 60°C and then the following data were taken per faba bean plant: number of broomrape spikes (BN), broomrape spike dry weight (BDW), number of faba bean shoots (FBSN), faba bean main shoot height (FBH), faba bean dry weight (FBDW), number of pods (PN), pod weight (PDW), faba bean grain dry weight (GDW), and faba bean and broomrape spike dry weight (TDW).

For each replication data of the plants infected with the same number of broomrape spikes were averaged. Within each field, the GDW was expressed as percentage of grain dry weight of faba bean plants without broomrape spikes (GDW per cent). Correlation coefficients and linear regression equations between BN and GDW per cent were determined for each field separately and for three fields combined. Correlation matrices between the rest of the above mentioned indeces were also determined. The significance at P equals 0.05 of the correlation coefficient and an F test of significance for each regression equation were also calculated.

Results and Discussion

Correlation coefficients and linear regression equations between BN and GDW per cent are indicated in Table 1. BN-GDW correlation coefficients were -0.71, -0.79 and -0.44 at D. Sol, Villamartin and El Trapero, respectively. The low BN-GDW correlation coefficients at the El Trapero were due to heterogeneity of replications. Linear regression equations of BN and GDW per cent were significant at P equals 0.05 at D. Sol and Villamartin and at P equals 0.01 at El Trapero. Regression coefficients varied considerably between locations. The number of broomrape spikes per plant required to reduce faba bean seed yield by half (BN 50 per cent) ranged from 2.9 at Villamartin to 6.3 at El Trapero. The linear regression equation for the three locations combined was GDW per cent = 93.8 – 9.1 BN, with a BN 50 per cent value of 4.8.

Faba bean plants were not very uniform at any location, whether or not they were being parasitized by broomrape. This non-uniformity was mainly due to the allogamy of the faba bean and to variations in time of emergence, plant spacing and diseases.

The indeces PN, PDW and GDW were highly correlated with each other. Correlation coefficients between number of broomrape spikes (BN) and several indices are indicated in Table 2. BN and BDW were highly correlated at the three locations, which indicated that the mean size of broomrape spikes infecting a faba bean plant was uniform.

Table 1. Correlation coefficients and linear regression equations between the number of broomrape spikes per faba bean plant (BN) and the faba bean grain dry weight expressed as percent of the control (GDW per cent).

Location	No.of plants	No.of reps.	r[1]	a	b	F	BN 50%
D. Sol	223	4	-0.73**	95.4	-8.6	13.4**	5.2
Villamartin	85	3	-0.79**	91.5	-13.5	17.0**	2.9
El Trapero	270	4	-0.44*	87.7	-6.2	4.1*	6.3
Total	578	11	-0.62**	93.8	-9.1	33.8**	4.8

[1] r = correlation coefficients, a = intercepts, b = regression coefficients, F = F test of analysis of variance of regression, BN 50 per cent = number of broomrape spikes which reduce GDW per cent by half.
* = sinificance at P 0.01
** = significance at P 0.05.

Table 2. Correlation coefficients between number of broomrape spikes (BN) and several indeces of the faba bean plant.

Indices[1]	Location: D. Sol	Villamartin	El Trapero
BDW	0.93	0.97*	0.90*
FBH	-0.09 n.s.	-0.09 n.s.	0.10 n.s.
FBSN	0.03 n.s.	0.34 n.s.	0.09 n.s.
TDW	0.42*	0.63*	0.68*

[1] BDW = faba bean dry weight, FBH = main shoot height, FBSN = number of shoots, TDW = total dry weight of faba bean and broomrape spikes.
* = significant at P = 0.05
n.s. = not significant at P = 0.05

BN were not related to FBH and FBSN (Table 2). The parasitism of broomrape could normally reduce the final height and shoot number of faba bean if it occurs at an early stage of development. The very low BN-FBH and BN-FBSN correlation coefficients obtained indicate that the active phase of broomrape parasitism occurred when faba bean vegetative development was *almost* complete and therefore affected mostly the reproductive phase. The BN was not related to the total dry weight of the faba bean and broomrape association

(TDW). From our data (Table 2), it was not possible to deduce a clear tendency for the influence of the number of broomrape spikes (BN) on the total dry weight of faba bean and broomrape spikes (TDW).

INFLUENCE OF SEED SIZE AND SOWING DATE ON YIELD AND YIELD COMPONENTS OF FABA BEAN

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The objective of the experiment described here was to determine whether or not growing faba bean from seeds of different sizes at different sowing dates, would influence seed yield and other yield components.

Seeds of the faba bean cultivar 'Hudeiba 72' were sorted by hand to obtain lots of small, medium and large seeds. The 1000 seed weight was then determined. The three seed sizes and the ungraded seeds (bulk) were planted on October 15, 30 and November 14, during the 1977 and 1978 seasons.

A split plot design with five replications was used in both seasons with sowing date as the variable in the main plots and seed size as the variable in subplots. Spacing between and within rows was 60 and 20 cm, respectively. Three seeds were sown per hole and after two weeks these were thinned to two (about 17 plants/m^2). Each trial received 10 irrigations, at intervals of 10 to 12 days.

The results of both seasons showed that the effects of sowing date and seed size tended to be independent of each other for all tested traits, as indicated by the non-significant F-values obtained from the interaction of seed size x sowing date.

Seed size had no significant effect on seed yield in both seasons. This was in agreement with what had been reported by Salih and Salih (1980). In the 1977 season, the larger seed size out-yielded the small, medium and ungraded seed sizes by 8, 6 and 13 per cent, respectively. However, in the 1978 season, the yield differences among the seed size lots were very small (Table 1).

Seed size had a significant effect on 100 seed weight in both tests. The heaviest seeds were produced from the large seed size lot, which was not significantly different from the medium and the ungraded seed size categories in both seasons (Table 1). Seed size had a significant effect on number of pods/plant in only one test in the 1978 season. The ungraded seed size lot had the highest average number of pods/plant. None of the other yield components were affected by seed size.

Table 1. Yield and yield components of faba bean as affected by different seed sizes

Seed size category	Grain yield kg/ha	Plant stand per cent	1000 seed weight (g)	No. of pods/ plant	No. of seeds/ pod
			1977 Season		
Small	2242	82.3	350	22.3	2.70
Medium	2292	81.6	381	22.1	2.57
Large	2428	82.1	379	22.8	2.59
Ungraded	2104	80.7	377	22.7	2.64
S.E.	±88		±4.47	±1.2	± 0.05
			1978 Season		
Small	2984	69.5	360	23.9	2.62
Medium	3125	71.5	393	26.0	2.57
Large	3046	71.1	406	24.3	2.57
Ungraded	3058	70.8	374	25.7	2.70
S.E.	±83	±1.40	±3.95	±0.84	±0.07

Grain yield was greatly affected by time of sowing in both seasons (Table 2). In the 1977 season, mid-October sowing led to an increase in seed yield of 27 and 69 per cent over the yields obtained from October 30 and November 14 sowing dates, respectively. Also, sowing on October 30, out-yielded mid-November sowing by 57 per cent. In the 1978 season, the best yields

Table 2. Yield and yield components of faba bean as affected by different sowing dates

Sowing date	Grain yield kg/ha	Plant stand per cent	1000 seed weight (g)	No. of pods/ plant	No. of seeds/ pod
			1977 Season		
15 October	3332	83.6	431	26.4	2.45
30 October	2423	88.3	365	25.9	2.63
14 November	1042	73.1	319	15.1	2.80
S.E.	±169		±5.27	±1.6	±0.06
			1978 Season		
15 October	3679	73.6	415	28.3	2.50
30 October	3372	71.5	381	26.6	2.54
14 November	2099	67.5	355	20.1	2.80
S.E.	±83	±0.65	± 6.72	±103	±0.07

were obtained from October 15 and 30 sowings, there being no significant difference between the two. The yields from these sowings exceeded that from the November 14 sowing by 43 and 38 per cent, respectively. In both seasons, sowing date had a significant effect on all the yield components studied (Table 2). There was a progressive decrease in 1000 seed weight, number of pods/plant and plant stand percentage, as sowing date was delayed from October 30. The reverse was true for number of seeds/pod.

It may be concluded that grading faba bean seeds would, therefore, be of little or no economic value to the farmer. The period from October 15 to November 1 was the best time for planting.

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RESPONSE OF FOUR GENOTYPES OF SPRING FABA BEANS *(VICIA FABA* L. *MINOR)* TO IRRIGATION DURING THE FLOWERING PERIOD IN THE UNITED KINGDOM

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There have been numerous studies on the effects of irrigation on the growth and yield of faba beans in arid environments (Jones, 1968; El Nadi, Brouwer and Locker, 1969; El Nadi, 1970). However, very little research has been performed in Northern Europe on the effects of irrigation on flower abscission and subsequent final yield. Stolp (1955), however, did indicate that under field conditions, broad beans *(V. faba major)* gave their greatest yield response to irrigation when water was applied during the flowering period.

An experiment was performed during June, 1980, at the Plant Breeding Institute, Cambridge, to assess the effects of irrigation on flower drop using four genotypes of faba beans *(V. faba, minor),* i.e. 'Cockfield', 'Deinol', 'TI Col' and 'Maris Bead'. Plants in one half of a four by four randomised block design plot, were irrigated for two hours on alternate days from bud initiation until pod set. The other half of the plot was left unirrigated. The weather at Cambridge during May, 1980, was dry (total rainfall 13.5 mm), and during the first ten days of June there was no rainfall at all, this approximately coincided with the flowering period. The second half of June was much wetter (total rainfall 66.5 mm) during the period of pod set.

The effects of irrigation on the growth of faba beans were very pronounced. The non-determinate genotypes were on average 41 cm taller than the equivalent non-irrigated plants; the terminal genotype, TI Col, was 23 cm taller. The irrigated plants showed a greater amount of vegetative growth; canopy cover was more dense, creating shading on the lowermost flowering nodes. They also continued flowering longer than the non-irrigated plants, where flowering was confined to approximately 12 flowering nodes. Pod set was delayed by approximately one week, compared to the non-irrigated plants, although flowering was not significantly delayed by irrigation.

Five plants of each genotype were picked at random from each subplot (ten plants per treatment). Each plant was scored for position of flower drop and pod set on each raceme. In all genotypes, the irrigated plants sampled showed a substantial increase in flower abscission (see Fig. 1). Most of the flower drop occurred after the petals had withered. Irrigation depressed the final yield of all four genotypes to 52 per cent of that of the unirrigated plants.

From this experiment, it is evident that irrigation favours vegetative growth at the expense of reproductive growth. An hypothesis is presented here, which states that irrigation has the effect of limiting the amount of assimilates reaching newly fertilized flowers because of altered competition between the vegetative and reproductive parts of the plant. Some evidence for this hypothesis comes from Jacquiery and Keller (1978 a; b, 1980), who found that during flowering there is a strong competition between young grains or pods and the vegetative parts. Also, Chapman, Fagg and Peat (1979) concluded that increasing plant competition in *V. faba* will predispose the plant to flower drop and premature pod drop.

Therefore, it appears that one of the major factors contributing to the unstable yield of faba beans in Northern Europe, is heavy rainfall during the flowering period. Present varieties of faba beans prefer relatively dry weather over the flowering period, and a subsequent wet period after flowering to facilitate rapid growth of

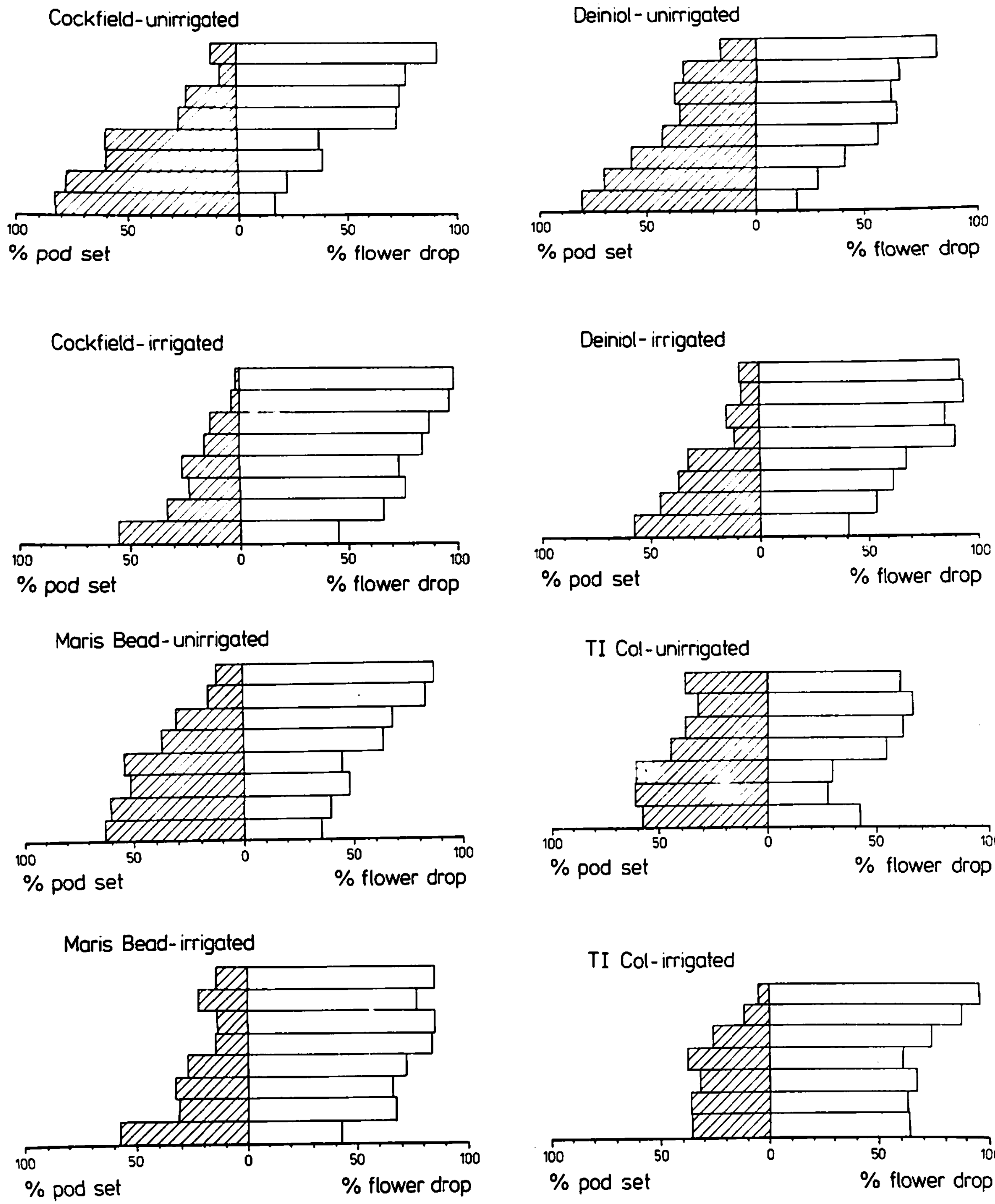

Fig. 1. Average percentage flower drop and pod set of all racemes derived from a sample of 10 plants for each genotype, taken from both irrigated and unirrigated plots. The bottom bar is the average abscission/pod set percentage for the flower on the lowest position of a raceme, the top bar the highest.

the young pods. The sensitivity of faba beans to irrigation in the U.K. calls for the development of faba bean lines that are minimally affected by similar environmental conditions. This development would almost certainly contribute to the yield stability of the crop.

Acknowledgement :

I thank Dr. D.A. Bond, PBI Cambridge, for his kind help and assistance with this work; also Prof. D. Boulter and Dr. P.J. Gates of Durham Univeristy, for help in preparation of this manuscript. I gratefully acknowledge a SRC CASE Studentship.

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PESTS AND DISEASES

MEASUREMENT OF DISEASE IN FABA BEANS CAUSED BY *ASCOCHYTA FABAE*

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Introduction

The main purpose of measuring disease is to obtain quantitative data on disease development and occurrence. The methods adopted are to some extent determined by the type of study envisaged. For example, disease may be measured and related to the economic significance of different diseases of agricultural crops. In crop loss appraisal programs, disease measurements are used together with yield data to determine the empirical relationship between the level of disease and crop loss so that losses over large production areas can be calculated from disease surveys. Disease measurements are also used in fungicide screening trials, where they complement the direct comparison of yields, and in variety trials where small differences in disease resistance may be quantified. Methods of measurement may be varied to suit these particular objectives.

Disease can be measured either by direct methods such as descriptive keys, standard area diagrams and remote sensing, or by indirect methods such as spore population counts and assaying fungal chitin content in host tissues. While there are standardized disease diagnostic methods, which are universally accepted, there is a need for increased uniformity in disease measurement. Attempts have been made to standardize methodology by James (1971a; b, 1974), FAO (Anon, 1971) and MAFF (Anon, 1976). Berger (1980) stated some of the criteria that must be satisfied during the development of disease measurement methods. Such methods should be easy to use, allow for rapid estimation, be applicable over a wide range of conditions and be accurate and reproducible. One method of disease assessment that meets most of these criteria, and is widely accepted, is the use of standard area diagrams. This method, in contrast to the descriptive keys which utilize arbitrary scales and indices, is most commonly based on a percentage scale of the actual area of infection and appears to be the more reliable field method of disease measurement (James and Teng, 1979).

A growth stage key for beans developed in Britain by the Ministry of Agriculture (Anon, 1976) described the major developmental stages, a necessary prerequisite for disease measurement (James and Teng. 1979).

However, we have found a modification of this key, embodying the principles of a decimal scale such as that for cereals (Zadoks *et al.*, 1974) to increase the usefulness of the key in the field (Fig. 1). We recommend this modified key for adoption as a standard for general usage.

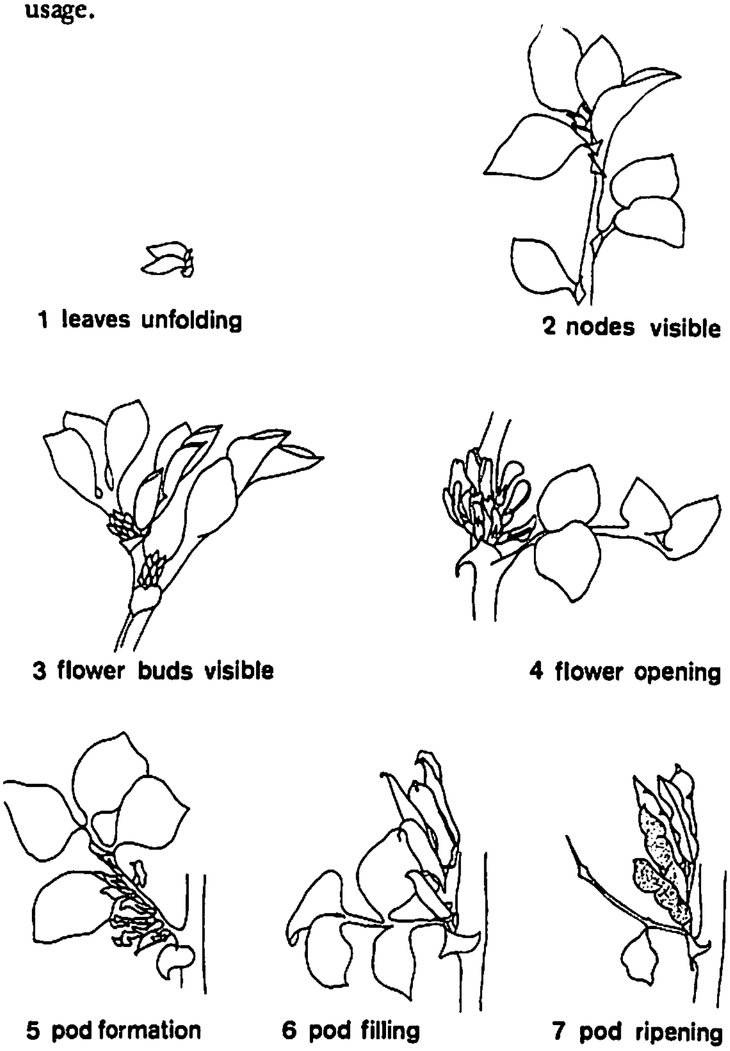

Fig. 1 Growth stages of faba bean (*Vicia faba*). Each stage can be subdivided to describe the number present.

e.g. 1.5 5 leaves unfolded.
3.10 10 noded with flowers formed.
5.8 8 nodes with pods formed.

At any one time, several stages may be quoted if such detail is required, otherwise the 'primary' scale may be used to describe the most advanced stage of development.

The disase assessment keys developed in Britain (Anon, 1976) for pod infection were found to be adequate. However, the leaf infection diagrams, based on single leaflets, were not adequate for our purposes and we therefore developed a more detailed set of keys as described below.

Materials and Methods

A faba bean crop that had a severe level of infection was sampled at different times of the crop growth cycle. Leaves with two to six *leaflets* and varying degrees of disease severity were collected from the field and stored, until examined, between moistened paper in plastic bags at 5°C.

The leaf area of each sample was determined using a Lambda Instruments Corporation area meter, model LI-3100 which measures the amount of light intercepted by opaque shapes. The area of infected tissues including the necrotic tissues associated with the disease was then traced onto a transparent film (overhead acetate) and this was used to determine the actual area of infection. From these data, percentage areas of infection were calculated and suitable examples used to produce the leaf area diagrams (Figs. 2 to 6).

Results and Discussion

In the preparation of the standard area diagrams reported in this paper, only six levels of disease severity were depicted (1, 5, 10, 20, 30 and 50 per cent). It was found that intermediate levels could be obtained through interpolation. Initial results were checked with actual measurements and the errors associated with the method and with different operators were found to be acceptable. The diagrams were used in subsequent disease surveys conducted to establish the significance of disease in *V. faba minor*, and *V. faba major* crops in New Zealand (Gaunt and Liew, 1981a), in trials to assess the efficacy of fungicides for disease control (Leiw and Gaunt, 1980; Gaunt and Liew, 1981b), and in trials to assess the transmission of the pathogen from *seed to* seedlings (Liew, 1981). From these experiences, we suggest that disease be measured as follows :

Initial infection

To be assessed one and two weeks after appearance of first symptoms, but results after pycnidiospore production should be disregarded. Sampling as recommended in the key by the Ministry of Agriculture, Britain (Anon, 1976).

Infection of leaves during crop growth

The number of infected leaves by itself has proved to be of little use in our studies, and we have placed more reliance on mean percent area affected by disease for different zones of the plant. In particular, mean disease severity on the lower non-reproductive zone has been a good predictor of subsequent epiphytotics, and mean disease severity of the flowering and podding zone has been useful on more mature crops. We have generally paid little attention to the leaves produced

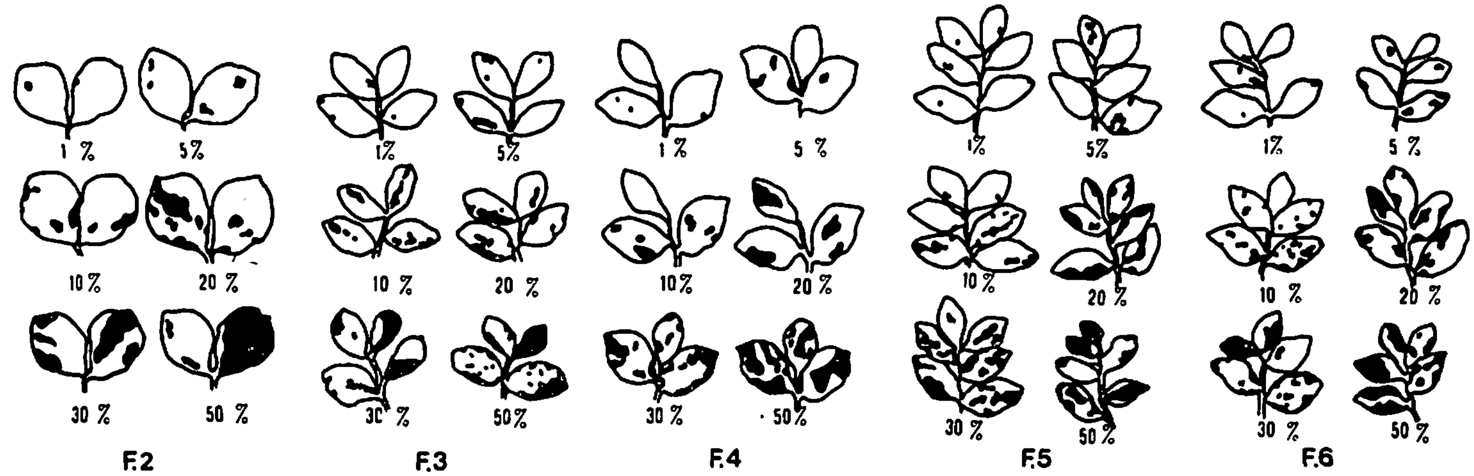

Fig. 2-6 Standard area diagrams.

above the podding zone, and in more mature crops have found pod infection to be a more useful measure of disease development. For yield studies, percent severity of individual leaves subtending pods at the pod set and early seed filling stages have been found to correlate well with yield.

The use of the detailed standard area diagrams of whole leaves has increased the accuracy and speed of disease measurement. In particular, difficulties of assessment associated with compound leaves have been circumvented by the diagrams portraying compound leaves of different complexity.

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ANCIENT SEEDS

'Seeds unearthed in a pre-pottery Neolithic layer at Beidha in southern Jordan, and dated about 6,500 B.C., were probably the related species Vicia narbonensis (Renfrew, 1969). The oldest seeds claimed to be V. faba were found at Jericho (Hopf, 1969) and dated c. 6250 B.C., but they too were very small (5.3 mm in length), and may also have been a related species.'

Hawtin, G.C. and Hebblethwaite, P.D. (1982) from 'Background and history of faba bean production' In : 'The Faba Bean *(Vicia faba* L.) : basis for improvement'. Ed. P.D. Hebblethwaite. Butterworth, U.K. (In Press).

SURVEY ON PESTS AND DISEASES OF FABA BEANS *(VICIA FABA)* IN EGYPT, MOROCCO AND TUNISIA

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The most important faba bean growing regions in Egypt, Morocco and Tunisia were visited during the spring of 1981. In a representative number of fields, 10 samples containing five plants were examined for pests and diseases. The samples were selected randomly using the diagonal line technique. Disease intensity and insect damage were classified into four classes, according to the percentage of destroyed leaf area or number of insects detected. Field diagnoses were confirmed by identification of the pathogens and insects in the laboratory.

In Egypt, 32 fields in the delta area and in Middle Egypt up to Assiut were examined. The most abundant species found are listed in Table 1. The most prevalent insect pest was the leaf miner *Liriomyza* sp. Four different aphid species were identified : *Aphis craccivora* was dominant throughout the area studied; *A. fabae* occurred only in the delta area; *A. gossypii* and *Myzus persicae* were present in the southern region. Diseases played a significant role only in the delta area, where humidity levels were higher than in the Nile Valley. Five foliar diseases were detected at low intensities during the survey.

Table. 1 Pests and diseases on faba beans in 32 fields in Egypt (February 11 to 25, 1981).

Pest, Disease	fields infested (per cent)	infested plants/field (per cent)
Liriomyza sp.	80	36
Aphis craccivora	38	7
Sitona lineatus	10	9
Aphis gossypii	6	12
Aphis fabae	3	2
Myzus persicae	3	6
Alternaria sp.	16	25
Botrytis fabae	16	29
Uromyces fabae	13	7
Stemphylium botryosum	10	3
Peronospora viciae	6	5

In Tunisia, the northern provinces and the oases Gafsa and Nefta were visited. The dominant pest was the *Sitona* weevil, followed by *Aphis fabae* and *Bruchus rufimanus* (Table 2). Similar to the results in Egypt, *A. fabae* occurred in the north, whereas *A. craccivora* was found in the southern oasis. Chocolate leaf spot, caused by *Botrytis fabae*, was the most prevalent disease. Other foliar diseases seemed to be of minor importance.

Table 2. Pests and diseases on faba beans in 43 fields in Tunisia (March 9 to 22, 1981).

Pest, Disease	fields infested (per cent)	infested plants/field (per cent)
Sitona lineatus	86	88
Aphis fabae	69	9
Bruchus rufimanus	58	10
Sminthurus viridis	23	31
Liriomyza sp.	21	15
Aphis craccivora	9	8
Lixus algirus	9	–
Botrytis fabae	47	35
Alternaria sp.	40	18
Ascochyta sp.	28	9
Stemphylium botryosum	14	9
Uromyces fabae	12	26

In Morocco, nearly all fields in the north and west provinces, including the centers of faba bean production, (Fes, Meknes, Taounate, Taza and Settat) exhibited symptoms of infestation with the *Sitona* weevil, which occurred at high levels (Table 3). However, the most destructive pest seemed to be the stem borer, *Lixus algirus* (Fig. 1). The distribution of the various species of aphids was not clearly demarcated as in Egypt and Tunisia. *Aphis craccivora* and *A. fabae* occurred in all regions, sometimes with both species appearing on the same plant. *Aphis craccivora* was dominant. In some regions, the plants were severely attacked by the stem nematode *Ditylenchus dipsaci*. The disease with the highest frequency of occurrence was *Botrytis fabae*, followed to lesser extent by *Alternaria* sp.. In the coastal region, high levels of rust, *Uromyces fabae*, were encountered. *Orobanche* was common and in some fields was attacked by *Trifidaphis phaseoli* (Homoptera : Pemphigidae) and *Phytomyza orobanchia* (Diptera : Agromyzidae).

These results are based on one year's observations, which may not therefore be typical, since environmental conditions often vary greatly from year to year. In Egypt, for example, the winter was abnormally cold and the vegetation as well as the development of pests and diseases was suppressed. In Tunisia, rainfall was higher than nórmal, whereas in Morocco there was an extreme drought.

Table 3. Pests and diseases on faba beans in 93 fields in Morocco (March 30 to April 17, 1981).

Pest, Disease	fields infested (per cent)	infested plants/field (per cent)
Sitona lineatus	94	88
Liriomyza sp.	83	59
Lixus algirus	75	—
Aphis craccivora	71	31
Aphis fabae	40	29
Acyrthosiphon pisum	6	3
Ditylenchus dipsaci	42	—
Botrytis fabae	53	30
Alternaria sp.	42	16
Uromyces fabae	30	39
Cercospora zonata	13	41
Ascochyta sp.	3	31

Fig. 1. Larva stage of the stem borer *Lixus algirus*.

In addition, the economic importance of the observed pests and diseases varies. Damage which was clearly apparent, e.g. feeding of the adult *Sitona* weevil or leaf miner, does not necessarily cause yield loss. Maher Ali *et al.* (1974) showed that even with an 80 per cent infestation of leaf minor *Liriomyza* there was no significant yield loss. Similar conditions can be assumed with respect to the attack of the adult *Sitona* weevil. In defoliation experiments, Wien and Tayo (1978) found that various grain legumes have considerable compensatory ability.

Detailed studies on the attack-loss-relationship must be made before estimating the relevance of pests and diseases for the faba bean crop.

Acknowledgment

This study was supported by the Federal Ministry for Economic Cooperation (BMZ) and the German Agency for Technical Cooperation (GTZ), FB 131, P.O. Box 5160, D - 6236 Eschborn, FR Germany, from whom a detailed report is available. I am grateful to those scientists in Egypt, Morocco and Tunisia who helped in conducting the surveys.

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IABOUEN

'Lastly, I shall mention a sign of the ancient existence of the bean in the north of Africa. This is the Berber name ibiou, in the plural iabouen, used by the Kabyles of the province of Algiers. It has no resemblance to the Semitic name, and dates perhaps from a remote antiquity. The Berbers formerly inhabited Mauritania, where Pliny asserts that the species was wild. It is not known whether the Guanchos (the Berber people of the Canaries) knew the bean. I doubt whether the Iberians had it, for their supposed descendants, the Basques, use the name baba, answering to the Roman faba.'

from 'Origin of Cultivated Plants', by Alphonse de Candolle, (1886), reprinted in 1967, p. 320.

TECHNIQUES FOR SCREENING FABA BEANS FOR RESISTANCE TO *ASCOCHYTA FABAE* IN THE FIELD

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Introduction

The incidence of *Ascochyta fabae* has been contained in Britain by the imposition of stringent phytosanitary regulations for certified seed (Hewett, 1973). In order to facilitate production of certifiable seed, varieties with extreme susceptibility need to be avoided and increased resistance is desirable. There is little evidence of variation in resistance among UK varieties and breeding material, except that Bond and Pope (1980) recorded fewer *Ascochyta* lesions on some entries than on others in a naturally infected trial. However, a winter-hardy 'topless' population bred at the Plant Breeding Institute from Sjodin's (1971) *ti* mutant is more frequently infected by *A. fabae* than other breeding material (D.A. Bond and G. Lockwood, unpublished observations). The experiment reported here was carried out to investigate possible methods of assessing field resistance to *A. fabae* and to examine whether or not the 'topless' population is more susceptible than the widely grown winter variety 'Throws MS'.

Materials and Methods

In October 1980, seed of 'Throws MS' and 'Topless' population was drilled into four row plots, 4 m x 1.2 m in size, with 12.5 cm row spacing and 60 cm between plots. There were five entries of 'Throws MS' and one entry of the 'topless' population in a Latin Square design. Before sowing, a sample of 1000 seeds of both 'Throws MS' and the 'topless' population was assayed for infection with *A. fabae* using the technique described by Hewett (1966). Plants were inoculated with *A. fabae* on 8 April, 1981. Five treatments were applied to 'Throws MS' :

1. Spraying every plant in the middle two rows with a spore suspension.
2. Spraying every fifth plant in every row of the plot and covering the plants with polythene bags for five days.
3. Wrapping cotton wool soaked in spore suspension around the stem of the fifth plant in every row of the plot.
4. Scattering a mixture of sand and maizemeal inoculated with *A. fabae* around the base of each plant in the middle two rows.
5. Untreated control.

Plots of the 'topless' population were inoculated using method 4.

A mixture of six isolates of *A. fabae* was used for all inoculations. A spore suspension was produced by growing cultures on potato dextrose agar for 12 days at 20°C and then for nine days under ultraviolet light at room temperature to produce pycnidia (Leach, 1962); the pycnospores were released by covering the agar with sterile distilled water for a few minutes. The spore concentration was adjusted to 10^4 spores/ml using a haemocytometer. Sand-maizemeal cultures were produced by mixing 1 kg of dry sand with 30 g of maizemeal and 130 ml of distilled water in a 1 l flask stoppered with cotton wool. These were sterilized at 15 psi for two periods of one hour and inoculated with discs of mycelium growing on potato dextrose agar. Eighteen flasks provided enough inoculum for 12 plots.

After inoculation, the experiment was irrigated from an overhead system during dry weather. The proportion of plants visibly infected with *A. fabae* was estimated on three occasions and the incidence of pod infection was recorded on a 20 per cent sample of plants taken just before ripening. In addition, a sample of 200 dried seeds of both 'Throws MS' and the 'topless' population from each replicate of the sand-maizemeal treatment was assayed for infection with *A. fabae.*

Results and Discussion

Seed from both 'Throws MS' and the 'topless' population assayed before planting had approximately one per cent *A. fabae* infection. This is unlikely to have been sufficient to produce the amount of infection recorded in the control plots (Table 1) since Hewett (1973) found that only 2 to 15 per cent of seeds carrying *A. fabae* produced seedlings with leaf lesions. Furthermore, infection was unevenly spread across the experiment, the heaviest infection being adjacent to, and windward of, heavily infected 'topless' breeding material.

There was little spread from plant to plant over the scoring period in the control plots, so that any increase in infection represented the effect of the inoculation treatment. Of the treatments applied to 'Throws MS', only Method 2 (spraying and bagging) produced a significant increase in the proportion of infected plants, although Methods 1 (spraying, no bags) and 4 (sand-maizemeal) had a small effect. Methods 2 and 4 significantly increased the incidence of pod infection but Method 3 (cotton wool) was ineffective. There was a significantly higher incidence of foliar, pod and seed infection on the 'topless' plants than on 'Throws MS' when both were inoculated by the sand-maizemeal method, confirming earlier observations of the susceptibility of the 'topless' population.

Spraying plants with a spore suspension and bagging, and applying sand-maizemeal inoculum, was effective in increasing pod infection under English conditions and will be of value in varietal resistance trials and fungicide screening trials. The former method has been used successfully to inoculate a fungicide-screening trial of spring-sown faba beans and the latter method is being used to simulate infection from over-wintering debris in a trial of winter-sown material.

Table 1. Incidence of *Ascochyta fabae* following various inoculation techniques.

Inoculation method	% plants infected			%pods	%seeds infected*
	April 27	May 6	May 19	June 23	After harvest
1. Spray ('Throws')	23.6	27.5	33.6	14.4	
2. Spray plus bag ('Throws')	30.5	35.8	40.6	16.8	
3. Cotton wool ('Throws')	20.2	22.0	24.0	12.7	
4. Sand-maizemeal ('Throws')	27.2	27.3	31.9	16.8	15.3
6. Sand-maizemeal ('Topless')	38.1	43.5	47.9	21.5	20.3
5. Control ('Throws')	23.8	23.5	26.0	10.9	
LSD (p equals 0.05)	7.79	7.86	7.73	4.47	

*angular transformation

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EFFECT OF STORAGE-PEST DAMAGE ON SEED GERMINATION, SEED QUALITY, AND YIELD OF FABA BEANS

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Some farmers growing faba beans believe that seeds damaged by storage pests have germination and yield potentials comparable to undamaged seeds. It was the aim of this study to evaluate the real performance of such seeds under experimental conditions. Chickpeas and peas were included to broaden the inference of the final result. The experiment was done during the 1978/1979 season.

Seeds of faba beans, chickpeas and peas were selected according to the number of holes per seed as a criterion for the severity of damage caused by *Callosbruchus maculatus.* Seeds with a similar number of holes were selected to represent a treatment. The treatments were 0, 1, 2, 3, 4, 5 or more holes per seed. Such seeds were then treated with Pphostoxin to kill any insects inside the seeds, so as to fix the number of holes per seed and to stop any further damage.

Seeds of each crop were then planted on the northern side of the ridge on Nov. 3, 4, and 21 for faba beans, chickpeas and peas respectively. The seed rate was two seeds per hill. Ridges were 60 cm apart and in-row spacing was 10 cm for both faba beans and peas and 25 cm for chickpeas. Each crop was planted as a separate experiment. A randomised complete block design was used. Insecticide was applied weekly during the first three weeks after germination to control laphygma, followed by Malathion which continued to be applied for four more weeks to control aphids. The results are presented in Figs 1 and 2 and Tables 1 and 2.

Figures 1 and 2 show the effect of No. of holes/seed on the rate and date of flowering of faba beans. There were no significant differences or even a general pattern between the treatments for the growth analysis data obtained for faba beans (Table 1.).

There were no significant differences in crop yield between the treatments for the three crops studied. In chickpeas and peas the seeds with the least number of holes (i.e. 0, 1 or 2 holes per seed) gave higher yields than the rest, while in faba beans, except for the treatment with the maximum number of holes per seed, all treatments gave similar yields (Table 2.)

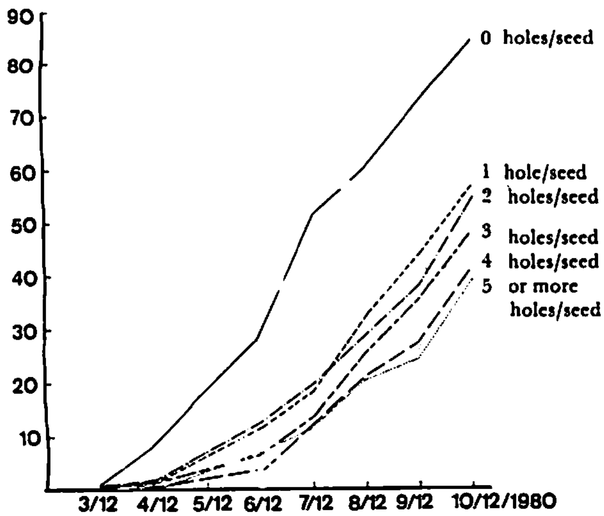

Fig. 1 The effect of number of holes/seed on the rate of flowering of faba beans. 0 holes/seed; 1 hole/seed; 2 holes/seed; 3 holes/seed; 4 holes/seed; 5 or more holes/seed.

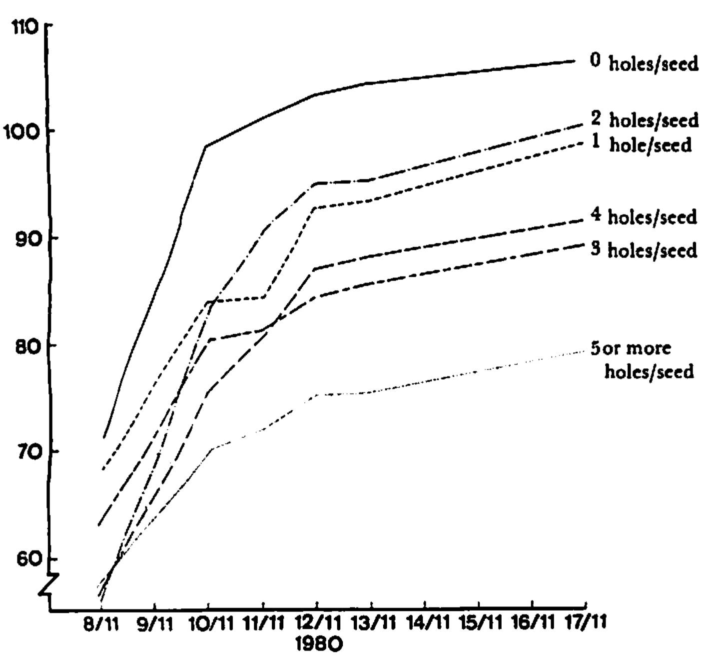

Fig. 2 The effect of number of holes/seed on rate of seed germination of faba beans. 0 holes/seed; 1 hole/seed; 2 holes/seed; 3 holes/seed; 4 holes/seed; 5 or more holes/seed.

Table 1. Effect of storage-pest damage on yield components of faba beans.

No. of holes/ seed	Stalks per plant: length (cm)	Stalks per plant: weight (g)	weight of *leaves per plant* (g)	Pods per plant: total No.	Pods per plant: average pod weight (g)
0	65.1	7.6	9.5	124	2.0
1	56.9	5.4	6.2	78	1.7
2	65.6	11.9	14.2	64	2.4
3	61.1	7.3	12.4	122	1.7
4	71.0	8.4	8.9	90	2.4
5 or more	60.1	9.0	12.3	133	2.6

Table 2. Effect of storage-pest damage on yield of faba beans, chickpeas and peas.

No. of holes/seed	Yield in kg per plot ($21 m^2$): faba beans	chickpeas	peas
0	2.3	1.1	0.3
1	2.8	1.1	0.3
2	2.4	1.0	0.5
3	2.4	0.6	0.1
4	2.7	0.6	0.2
5 or more	1.7	0.4	0.2

BEANS OF WORCESTERSHIRE

'Beans are grown considerably upon the strong lands of Worcestershire, and none but the greatest slovens now think of sowing them broadcast; they are very generally either set by hand, or drilled by a machine; in the former women and children are principally employed, who set from 3 to 4 bushels per acre, at from 1s. 6d. to 2s. per bushel (of 9 gallons) with the allowance of a quart of cyder per day each; the average expense of this setting may be reckoned at about 8s. per acre; the time of setting is February and March'.

from 'General View of the Agriculture of the county of Worcester' (1813) by, W. Pitt, reprinted in 1969 by Clarke Doble and Brendon Ltd., Plymouth, U.K.

SITONA LINEATUS L. ON FABA BEANS IN BRITAIN

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Of about thirty recorded faba bean pests in Britain, the best known is the black bean aphid, *Aphis fabae* (Scop), but others which are less conspicuous also decrease yields. Amongst these is the pea and bean weevil, *Sitona lineatus* L., which makes characteristic semi-circular feeding notches in the edges of leaves. The effects of pest and disease control on faba bean yields are being studied in multidisciplinary experiments at Rothamsted (McEwen *et al*, 1980), and results so far support our views that *Sitona lineatus* is one of the most important pests of the British crop. Most British entomologists formerly believed that *S. lineatus* seldom decreased yields, though workers in central and eastern Europe have often remarked upon the damage done to various leguminous seed crops (e.g. El Dessouki, 1971; Hans, 1959; Kokorin, 1964; Turaev, 1939). We consider that *S. lineatus* decreases yields to an extent that justifies control but that larvae rather than adults are the damaging agents.

Spring populations of adults on faba beans are commonly several thousand per hectare but they often escape notice as the weevils are only about 5 mm long and of a dull grey-brown colour. Once a suitable food crop is found they do not move far and late-sown crops that emerge after the main flight period have few weevils.

Adult weevils fly into crops during the first spell of warm and sunny spring weather, and if the weather remains warm they often start laying immediately. Female weevils can lay about 1000 eggs between April and July; eggs hatch after about 10-14 days and the white legless larvae then enter the root nodules, taking about 35-65 days to complete development before pupating in the soil. Larvae of all ages can be found between late April and mid August, though commonly the greatest numbers occur during the first half of July, when pods are developing rapidly. There may be from 3 to 30 larvae per root at this time, with many injured nodules. In Britain there is only one generation a year, emerging adults being more abundant in August. At first these also feed on faba beans, but as the crop becomes senescent they disperse to other leguminous plants, where they continue to feed until the onset of cold weather. They seem to hibernate in many habitats, including the stubble of old cereal crops.

To investigate injury by larvae we commenced a series of field experiments in 1969 in which non-systemic insecticides were cultivated into the soil before spring beans were sown. These insecticides did not appear to affect feeding by adults, but in nearly all cases decreased larval infestation by 70-80 per cent. In 23 out of 26 comparisons yields were improved, the mean increase being 0.15 t/ha, or 6.6 per cent. The maximum was 0.5 t/ha. No other pests were found whose control might have contributed to these yield increases (Bardner and Fletcher, 1979). Subsequently, treatments which control *S. lineatus* have been shown to increase nitrogen uptake, raising the amount of nitrogen in the grain (normally about 4.5 per cent) by 0.1-0.3 per cent (McEwen *et al*, 1980). Crops with large infestations of larvae often develop the yellowed foliage characteristics of nitrogen deficiency. Added nitrogen fertilizer does not usually compensate for *Sitona* injury, and seed weight being particularly great in pods from the upper nodes. Other factors which possibly contribute to decreased yields in attacked crops are reduced water uptake (damage is worse in dry conditions), and possibly easier entry of soil-borne pathogens into injured root tissue.

We are investigating various insecticides and application methods, and also the ecology of *S. lineatus* , to determine if it is possible to monitor or predict infestations and to establish economic thresholds.

Our investigations into the effects of larval injury used γ -HCH or dieldrin to protect plants against attack, but these leave residues unacceptable in normal British farming practice. Two other methods are possible - foliage treatments to kill adults before they lay eggs, and soil treatments with systemic organophosphates or carbamates (Barder, Fletcher and Griffiths, 1979). A foliage spray of permethrin at 0.15 kg a.i./ha is effective against adults, but may need repeating if beetles continue to fly into the crop. More certain are phorate or carbofuran at 2.24 kg a.i./ha applied as granules in the seed furrow at the time of sowing. These can kill both ovipositing adults feeding on the foliage and larvae entering the root nodules and increase yields by 6-30 per cent. A disadvantage is that they are not persistant enough for use on autumn-sown beans, now about 30 per cent of the British crop; for these it may be possible to apply systemic granules to the foliage in the spring. An advantage of systemic insecticides is that they may control other pests, such as nematodes or viruliferous aphids.

If insecticides are to be used more effectively, practical methods are needed to identify situations where control is justifiable. Counting weevils or feeding notches is not a satisfactory quide to subsequent root damage. In Britain a network of suction traps now samples aerial populations of insects, especially aphids (Taylor, 1974; 1977). These traps can also be used to monitor the size of invading populations of weevils and their dates of flight. They also catch newly emerged adults leaving pea and bean crops in late summer. We are trying to relate numbers caught in the traps to subsequent larval populations and to use both trap and meteorological data to time foliage applications of insecticides to kill beetles before they lay eggs. Other factors which influence the size of larval populations are also being investigated. There is plenty of work still to be done, but our results show that in the British spring bean crop *S. linaetus* causes losses of the same order as *Aphis fabae.* It is also common in peas and autumn-sown beans and in both these crops losses are similar to those found in spring-sown beans (Bardner, Fletcher and Biddle, 1980).

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MEANS OF BEANS

'A farmer, that has land proper for beans, should, on no account, avoid giving particular attention to the crop; for it will prove one of his surest funds of profit. By means of beans, he may be able to banish the unprofitable custom of fallowing; for a crop of beans, rising in single rows on three feet ridges, or double rows at one foot on four feet ridges, gives so good an opportunity for ploughing the intervals, and also admits hand-hoeing the rows, that the land may be cleaned as well as any fallow, and the crop succeeded by corn; but , if the soil is in such terrible order, that this culture is insufficient to clean it, then let a second crop of drilled beans succeed, which will be very profitable husbandry; and cannot fail of bringing it into garden order.'

from 'The Farmer's Kalendar' (1771), by Arthur Young, reprinted in 1973 by EP Publishing Limited, Yorkshire, England.

SURVEY OF THYSANOPTERA (THRIPS) ON FABA BEANS *(VICIA FABA)* IN NORTH AFRICA

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Thrips are considered as a pest on many different crops. Singh *et al.* (1978) recorded nine thrips species on grain legumes. According to their list, the most important species was *Megalurothrips sjostedti* (Trybom), syn. *Taeniothrips sjostedti* (Trybom). Cowpea, soybean and lima bean were particularly heavily attacked.

During a survey in the spring of 1981 in Egypt, Morocco and Tunisia, samples of thrips on faba beans *(Vicia faba)* were collected and identified according to Schliephake (1979) after being treated as follows (slightly modified from Lewis, 1973):

1. Collected with a small brush, slightly wet.
2. Preserved in small tubes with 1 part 75 per cent lactic acid and 2 parts 95 per cent ethanol.
3. Dehydration : 24 h in 60 per cent ethanol
   1 h in 70 per cent ethanol
   20 min. in 80 per cent ethanol
   10 min. in 95 per cent ethanol
   2 x 5 min. in absolute ethanol
4. Clearing : 10 - 20 min. in saturated chloral hydrate, heated in a water bath.
5. Mounting : (in Berlese mixture)
   30 ml distilled water
   6 g gum arabic
   10 g chloral hydrate
   4 g glycerine

The following thrips species were identified :

- *Thrips* sp. (Tunisia)
- *Odontothrips* sp. (Egypt, Tunisia), Fig. 1
- *Melanthrips pallidor* Priesner (Tunisia, Morocco), Fig. 2
- *Taeniothrips* sp. (Tunisia), Fig. 3
- *Aeolothrips intermedius* Bagnall (Tunisia, Morocco), Fig. 4 to 8

All species were considered as pests except for *Aeolothrips intermedius,* which accounted for more than 50 per cent of the sampled specimens. *Ae. intermedius* is a predator of other insects and mites (Lewis 1973; Schliephake 1979). Bournier *et al.* (1978, 1979) observed adults of this species in the flowers of several different plants. Larvae, however, were found in colonies of herbivore thrips, psyllids and aphids. Laboratory trials showed that the larvae developed faster when different thrips species were offered; mites were less suitable and aphids were not preyed upon. One single larva can feed on 20 to more than 100 individuals.

Further field investigations will show if there is any significant predatory effect of *Aeolothrips intermedius* on pests of *Vicia faba* in the field.

Acknowledgement :

This study was supported by the Federal Ministry for Economic Cooperation (BMZ) in Bonn and the German Agency for Technical Cooperation (GTZ), FB 131, P.O. Box 5160, D 6236 Eschborn, West Germany. I am grateful to those scientists in Egypt, Morocco and Tunisia who helped in conducting the surveys.

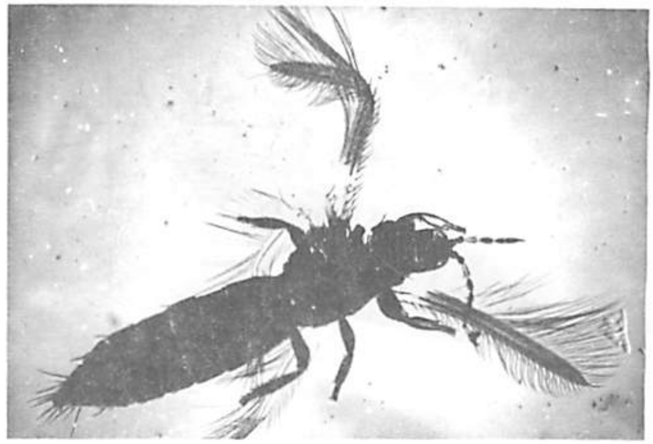

Fig. 1 *Odontothrips* sp., magnification x 35. Characteristics : antennae 8-segmented, veins of the forewings regularly covered with setae.

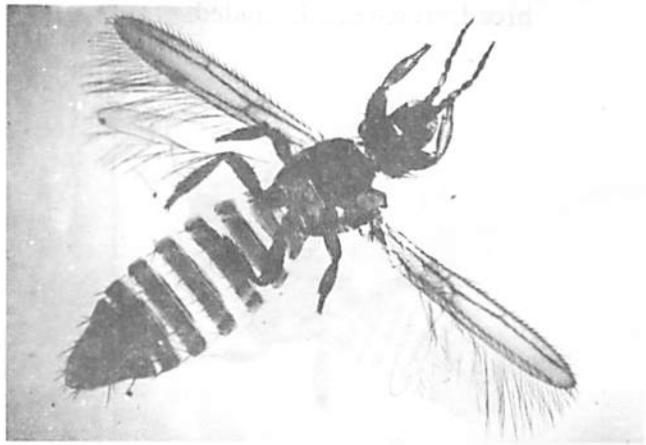

Fig. 2 *Melanthrips pallidior,* magnification x 35. Characteristics : antennae 9-segmented, segment No. 3 lighter than the others, segment No. 3 and 4 with sensoria around the top. Forewings cross-veined.

Fig. 3 *Taeniothrips* sp., magnification x 43. Characteristics : antennae 8-segmented, segment No. 7 and 8 deformed to a "stylus"; ovipositor curved downwards.

Fig. 4 *Aeolothrips intermedius* female, magnification x 35. Characteristics : forewings evenly broad, cross-veined, banded.

Fig. 5 *Aeolothrips intermedius* male, magnification x 43. Characteristics : smaller than female, wings similar to female.

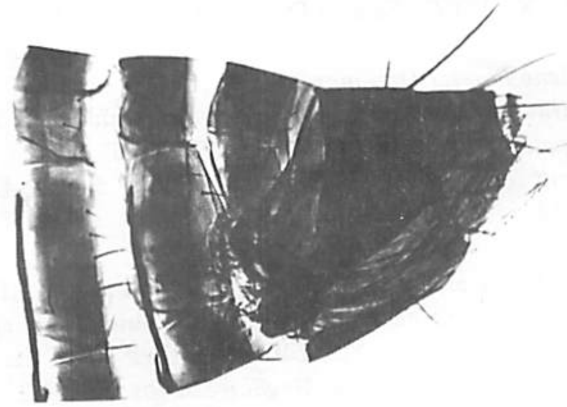

Fig. 6 *Aeolothrips intermedius,* abdomen of female, magnification x 140. Characteristic : ovipositor curved upwards.

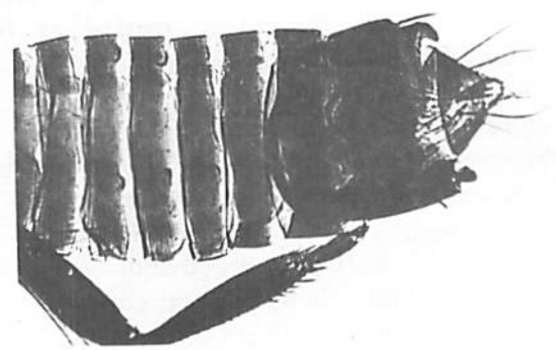

Fig. 7 *Aeolothrips intermedius,* abdomen of male, magnification x 140. Characteristic : claspers on the 9th abdominal segment.

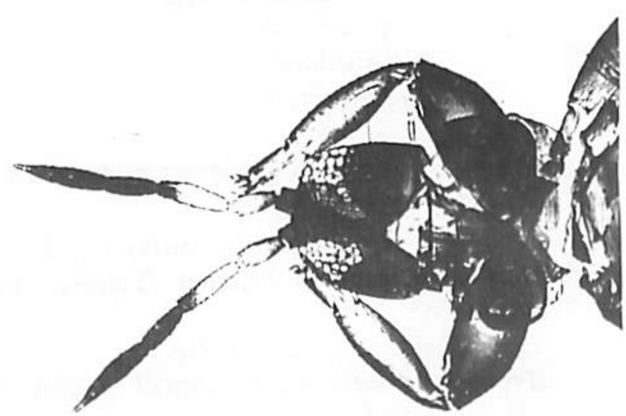

Fig. 8 *Aeolothrips intermedius,* head of female, magnification x 140. Characteristics : antennae 9-segmented, segments 5-9 blend into one, sensoria on segment 3 and 4 from base to top. Apart from top of segment 2 and basic 3/4 of segment 3 dark colour.

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RESISTANCE TO CHOCOLATE SPOT *(BOTRYTIS FABAE)* IN ICARDA ACCESSIONS OF *VICIA FABA*

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Introduction

Chocolate spot *(Botrytis fabae)*, is the most serious disease of winter-sown faba beans in Great Britain. Aggressive attacks occur about once a decade and their effects are serious enough to deter farmers from growing the crop. Therefore, sources of resistance are being actively sought.

Material received from ICARDA with possible resistance to chocolate spot was screened in a polythene tunnel using artificial inoculation in the spring of 1981. The objective was to identify potentially useful sources of resistance which could be used by breeders in Great Britain and elsewhere.

Materials and Methods

Eight accessions, some already inbred, were obtained from ICARDA in 1979, multiplied in 1980 and tested for resistance to choclate spot in 1981 (Table 1). Most of the accessions had originally been selected because they showed some resistance in either Egypt or Syria. One accession, BPL 356, was multiplied in Cambridge as two separate lines. Two winter-hardy faba beans, PBI line 76 and the widely grown variety 'Throws MS', and two spring faba bean varieties, 'Maris Bead' and 'Kristall', were included as controls. In previous tests, comparing British winter beans, line 76 was rated very susceptible to chocolate spot and 'Throws MS' as moderately susceptible. Harrison (1981) found 'Maris Bead' to be the most resistant variety to chocolate spot, and 'Kristall' to have above average resistance in a trial of 12 spring varieties.

Each of the 13 entries in the test were represented by four replicated plots, each consisting of one, two or three rows with 11 plants per row. Plots were separated by three spreader rows, planted with a mixture of susceptible lines. The plots were sown at the end of February and covered with a polythene tunnel on the first of May.

Glasshouse-grown plants with three pairs of expanded leaflets, were inoculated with a single-spore isolate of *Botrytis fabae* derived from naturally infected faba beans at the Plant Breeding Institute. The isolate was grown on potato dextrose agar under ultraviolet light (Leach, 1962) at room temperature to produce freely sporulating cultures. Spores were washed from the plates with sterile distilled water and the concentration adjusted to 10^4 spores/ml. Antibiotic assay discs, 13 mm in diameter (Whatman Ltd., England) were soaked in this suspension and two discs were placed on separate leaflets on each plant. The leaflets were then covered with small self-sealing polythene bags. After three days, the bags were removed and the infected plants transformed to the polythene tunnel; two plants were placed at each end of the center row of each spreader plot. The plots were mist-irrigated as required to maintain high humidity.

The incidence of chocolate spot was scored by two methods. The distal pair of leaflets on leaves at the sixth and tenth nodes on every third plant in the row, was scored using a 0-6 scale based on the key published by the Plant Pathology Laboratory, Harpenden (Anon, 1976). In addition, an overall assessment of disease incidence in each plot was made using a 0-9 scale. The two assessments were made by different people in the first week of June, 1981.

Results and Discussion

Only accessions with good resistance to the aggressive phase of chocolate spot disease, during which the foliage was completely destroyed (Wilson, 1937), were of interest and so the scoring date chosen to demonstrate differences was five weeks after inoculation, when the most susceptible accessions were severely affected. The only accession significantly more resistant than

'Maris Bead' was ILB 938, which still retained a considerable area of healthy tissue (Table 1, Fig. 1). BPL 666 was the only other accession with resistance at least comparable to that of 'Maris Bead'.

Table 1. The incidence of chocolate spot on ICARDA accessions and control varieties five weeks after inoculation.

Entry	0-6 Scale 6th node	10th node	mean	0-9 Scale overall score
ILB 938	4.67	1.67	3.17	2.00
Maris Bead	5.45	3.45	4.45	4.91
BPL 666	5.12	3.17	4.15	5.50
BPL 112	6.00	4.77	5.39	5.75
NEB 159	6.00	5.20	5.60	6.23
Kristall	6.00	5.27	5.36	6.75
BPL 256	5.82	4.75	5.29	6.83
ILB 368	6.00	5.73	5.87	7.00
BPL 365(5)	6.00	5.57	5.79	7.50
Line 76	6.00	5.55	5.77	7.58
BPL 244	6.00	5.75	5.87	7.58
Throws MS	5.97	5.57	5.77	7.67
BPL 356 (1-4)	6.00	5.50	5.75	7.83
LSD (p= 0.05)	0.804	0.894	0.568	1.52

Some differences between accessions in the intermediate range could be detected from the assessments made on leaves at the tenth node and also from the overall assessment, which was probably largely influenced by the appearance of the upper leaves. With both these assessment methods, BPL 112 was significantly better than the most susceptible accessions.

Since conducting the trial in Cambridge, the accessions have been further assessed by ICARDA, at Lattakia, Syria, and there is a general agreement between results at the two sites. At Lattakia, ILB 938 was rated resistant, BPL 666 partially resistant, BPL 112 moderately resistant and BPL 256, 244 and 356 susceptible (M.C. Saxena, personal communication). There was no evidence of an interaction between genotype and isolate, such as that reported by Mohamed *et al.* (1981), who tested similar accessions using detached leaves and inocula from different regions of Egypt. However, the result confirms the resistance of NEB 938 (re-coded ILB 939) reported by El-Sherbeeny and Mohamed (1980) following detached-leaf tests.

Fig. 1. (See text)

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ENRICHMENT OF PROCESSED CHEESE WITH FABA BEAN FLOUR

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Introduction

In Egypt, the cow and buffalo milk shortage is so serious that every possible means of supplementing dairy products must be investigated. Recently, Abou-Donia and Salam (1981) studied the effect of adding faba bean *(Vicia faba)* extract to cow's milk in Zabadi (yoghurt) making; they found that titratable acidity, fat, and volatile acidity decreased, while total N increased gradually with increasing faba bean levels. Zabadi samples made from milk plus up to 70 per cent faba bean extract were highly accepted by the testing panel. In this communication, the effect of adding faba bean extract to processed cheese and its effect on chemical and organoleptic properties is described.

Materials and Methods

Preparation of faba bean flour : faba bean seeds were soaked in cold water (1:2) for 24 hours, dehulled, dried at 105°C for 2 hours, ground and sieved through an 80 mesh sieve. The flour product was stored in sealed glass bottles prior to use.

Preparation of processed cheese : 1/2 kg of immature Ras cheese plus half of six month old ripened Ras cheese were mixed. Disodium hydrogen phosphate was added as emulsifying salt at 5 per cent. The faba bean flour was added in concentrations of 1.8, 3.6, and 5.4 per cent and made up to 2.5 kg with cultured butter milk and throughly mixed. The mixture was heated in a water bath with agitation until it was a smooth plastic mass. The resulting hot mass of processed cheese was poured into transparent polyethene bags, cooled, stored in the refrigerator, prior to analysis.

Chemical analysis : in the processed cheese samples, fat, protein, titratable acidity, pH and volatile acids were determined according to Lees (1975).

Organoleptic scoring : processed cheese samples were judged by the regular panel on a basis of a composite score developed from a maximum of 40 points for flavour, 40 for body and texture, 10 for appearance, 5 for salt and 5 for finish.

Results and Discussion

The chemical composition of processed cheese with and without added faba bean flour is summarised in Table 1. The data revealed that the chemical composition was greatly affected by the addition of faba bean flour. Fat, protein, total solids, pH, and volatile fatty acids increased gradually with increasing levels of faba bean flour added.

The average tasting panel score of processed cheese with or without added faba bean flour (Table 2) showed that the control as well as the three faba bean added samples were highly acceptable to the panel. This could be attributed to the fact that in Egypt, faba beans are eaten in the stewed form for breakfast as well as in sandwiches at any time of day. They are eaten on their own or mixed with Zabadi or any variety of Egyptian native cheese. The faba bean flavour is distinctly Egyptian. The only undesirable change occurring with increasing faba bean levels was the slight browny colour which was due to high carbohydrate content in the faba bean flour and its browning in the heating process.

Table 1. Chemical analysis of processed cheese with and without added faba bean flour.

Level of faba bean flour added (%)	Fat content (%)	Protein content (%)	Total solids (%)	pH	Volatile acidity*
0	15.0	15.4	39.2	4.1	2.6
1.8	15.5	16.3	40.5	4.2	3.3
3.6	15.6	16.9	42.5	4.7	4.0
5.4	15.7	17.8	44.6	5.1	4.6

*ml 0.05 M NaOH/100 g cheese.

Table 2. Average scoring of processed cheese with and without added faba bean flour.

Level of faba bean flour added (%)	Average Score					
	Flavour	Body & texture	App.*	Salt	Fin.**	Total (%)
0	40	40	8	4	5	97
1.8	39	39	7	5	5	95
3.6	39	39	6	4	5	93
5.4	36	39	5	4	5	89

*App. equals Appearance
** Fin.** equals Finishing

References :

Abou-Donia, S.A. and Salam, A.E. (1981). 'Preliminary attempt to enrich Zabadi (yoghurt) with faba bean flour.' FABIS Newsletter, 3, 62-63.

Lees, R. (1975). 'Food analysis analytical and quality control methods for the food manufacturer and buyer.' 3rd Ed., Leonard Hill, London.

PROTEIN AND FIBRE CONTENT IN SEVERAL LINES OF TETRAPLOID *VICIA FABA*

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We present here some of the results concerning nutritional characteristics, which are among the different studies being conducted in our laboratory in order to characterize the fertile tetraploid of *Vicia faba.*

Protein, acid detergent fibre (ADF) and acid detergent lignine (ADL) were analysed in nine lines of the tetraploid, and selected for and against fertility during two generations. 'Primus', the cultivar in which tetraploid plants were first discovered, was also analysed. The results are compared with the average values of our overall collection, as shown in Table 1. Neutral detergent fibre (NDF) was not analysed becaused of its strong correlation with protein content (Haro *et al.*, 1980).

Results showed that :

1. seven out of the nine tetraploid lines had a greater protein content than 'Primus'. The maximum protein content of these lines was approximately the uppermost limit in our collection.
2. The opposite was true for ADL : only one of the tetraploid lines had more ADL than 'Primus'.
3. All of the tetraploid material had a greater content of ADF than 'Primus'. However, the range was less than half of the overall collection, i.e. the differences were not very important.
4. The two fertile lines were placed among the richest three lines in protein; however, the fact that the third one on the top is not fertile removes, for the moment, any possible correlation between fertility and protein content.
5. A similar conclusion can be reached for ADF.
6. For ADL, fertile and unfertile lines did not show different values; therefore, the lack of correlation is more perceptible than for protein.

Table 1. Seed composition of nine tetraploid lines and one diploid cultivar of *Vicia faba*

Line/cultivar	per cent protein	per cent ADF	per cent ADL
4x :			
29-1	31.5	13.5	0.96
32	32.4	13.8	1.04
32-1	31.9	13.9	1.44
33-1	29.1	13.6	1.12
37-1	32.2	13.6	1.22
45-1*	33.1	14.3	0.86
45-2*	33.5	14.2	1.27
53-3	27.3	12.3	1.21
58-1	33.3	14.0	1.10
2x :			
'Primus'	29.6	9.9	1.30
Average (collection)	25.6	15.8	–
Range (collection)	20.3-32.5	10.0-19.7	–

* = selected for fertility
ADF = acid detergent fibre
ADL = acid detergent lignine

It is obvious that more tetraploid lines are required in order to correlate different morphological and biochemical characters. These lines are being obtained, and perhaps the very provisional conclusions mentioned here will be modified subsequently.

Reference :

Haro, A., Martin, A., and Cubero, J.I. (1980). 'Studies on nutritional factors in *Vicia faba'*, pp. 83-106, In : *'Vicia faba,* Feeding Value, Processing and Viruses'. Ed. D.A. Bond, Martinus-Nijhoff, The Hague.

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