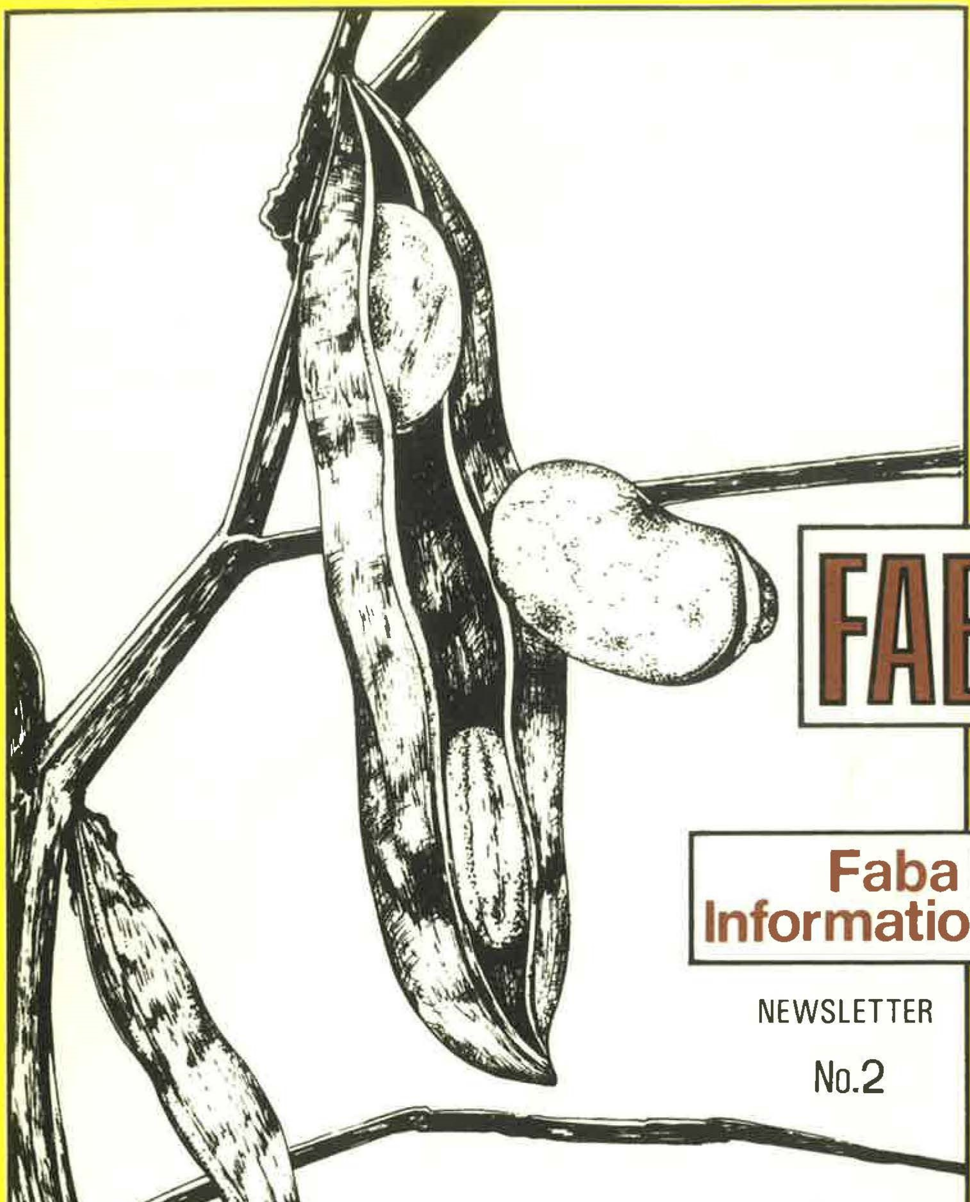


FABIS

Faba Bean Information Service

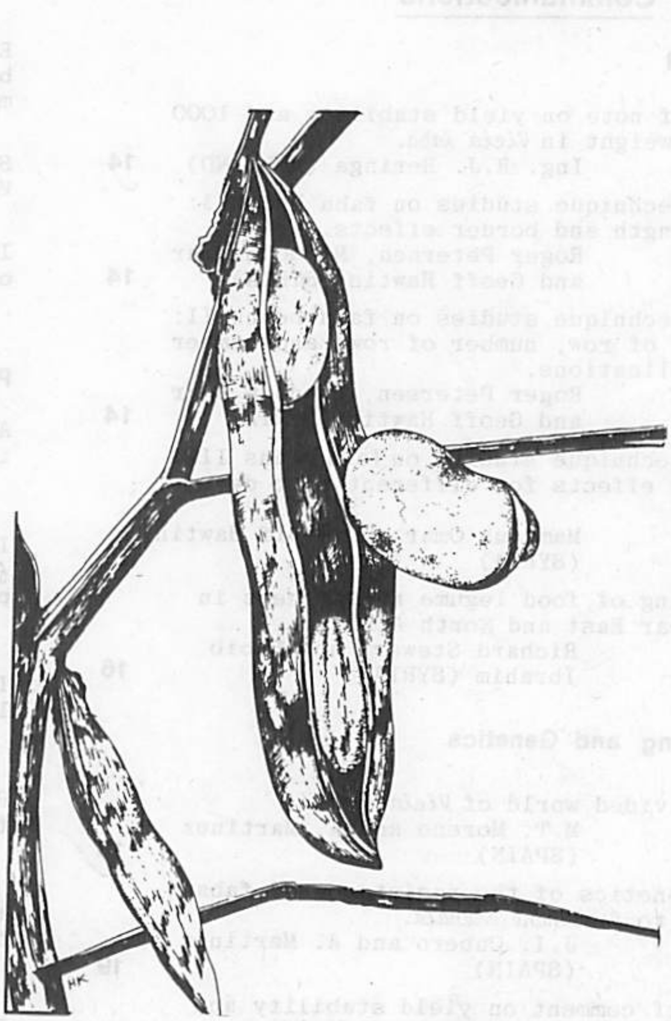
NEWSLETTER

No.2

MARCH 1980

THE INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS
ICARDA

Contents



FABIS

Introduction

Feedback

We have had a lot of feedback from FABIS Newsletter No.1 and it seems clear that the news service can be very useful to faba bean researchers around the world.

Articles appearing in FABIS are now liable to be abstracted and listed by the Commonwealth Agricultural Bureaux (CAB) and FAO and stored in their data banks. The information contained in FABIS is therefore readily available to researchers not on our mailing list.

Based on your letters, corrections and additions have been made to the list of names and addresses (at the back of the Newsletter). No 'fields of interest' have been included in this issue, as we are intending to publish a directory of world faba bean research later this year provided you reply to the questionnaire enclosed. Some of you have already sent us details of your present and future research (in response to the circular of October 17th, 1979) but most of you have not!

This issue

The General Articles in this issue concern Agronomy and Physiology. The number of Short Communications submitted was a substantial increase on the first Newsletter (despite the fact that only 3 were received before the December 1st deadline!). Could authors please note the Style and Form for Contributions for future submissions. In order to cope with the growing number of Short Communications it is necessary to ask contributors to write no more than 600 words plus one Table and/or one Figure. Good quality black and white photographs can be reproduced in the Newsletter.

Several new sections appear in FABIS Newsletter No.2: Letters and Announcements, Institution Reports and In-Press Abstracts. The Letters and Announcements section enables readers to comment critically on the Newsletter and to make brief announcements of meetings etc. The Institution Reports section allows researchers to summarise the research being conducted at their institution. This will help make sure that the Short Communications remain as reports of research results rather than summaries of research programs. In this issue the In-Press Abstracts section is introduced. This section will contain abstracts of articles which have been accepted for publication by recognised journals. In this way FABIS can at relatively short notice help to communicate outlines of papers which may otherwise wait some considerable time before appearing in print.

Editing

All submissions to FABIS are subject to editing, which is intended to standardise the format and style of each article. Edited copies of General Articles will be returned to authors if originals were received before December 1st.

FABIS in Arabic

FABIS Newsletter No.1 is being translated into Arabic. A circular is being sent with this issue to researchers in Arabic-speaking countries asking for the numbers and names of people likely to be interested in this publication.

The Editors :

Geoff Hawtin

Richard Stewart

Habib Ibrahim

All correspondence should be addressed to :

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

Letters and Announcements

The following are extracts from some of the letters we, as editors of FABIS, have received. Addresses of correspondents can be found at the back of the newsletter.

Readers are invited to contribute further suggestions and information, in the form of a letter or a brief announcement.

March 26, 1979

The term 'broadbean' should be cleared up. Is 'broadbeans' a common name for the species *Vicia faba* or does 'broadbeans' characterise the large seeded subspecies *Vicia faba major?* In my opinion there is no definite distinction between *Vicia faba major* (broadbean?) and *minor* (fieldbeans?) and the problems of breeding and cultivation are similar. Therefore I think that your newsletter will be open for all *Vicia faba* research, including our work. To avoid confusion I would like to propose the name 'FABIS' (Faba Bean Information Service) for the newsletter.

Yours sincerely,

M. Frauen
University of Gottingen
WEST GERMANY

March 25, 1979

I am writing in response to your circular concerning the newsletter on broadbean research to be issued by ICARDA. I strongly voice my support to this timely idea and would certainly like my name to be placed on your mailing list.

Since the 1st issue is intended to be an introductory one, I wonder if it would be feasible for it to contain some basic information on the research stations or institutions engaged in broadbean research throughout the world. A few lines on the geographical, climatical, soil irrigation and similar aspects might, I think, be useful and appropriate. (A map with these research stations dotted and distributed together with the newsletter perhaps?). Just a suggestion.

Best of luck.

Sincerely,

Dr. Mustafa M. Hussein
Hudeiba Research Station
SUDAN

November 26, 1979

Thank you for sending me FABIS Newsletter which I found to be very informative and interesting.

As to our future work, we plan to test new synthetic germination stimulant of *Orobanche* seeds, identify and select *Orobanche* resistant varieties of broadbeans, lentils and dried peas, and assess potential false hosts and trap crops to determine their capability to reduce the number of viable *Orobanche* seeds in the soil. We also plan to compare various herbicides for *Orobanche* control, and to study the germination and growth patterns with attention to dormancy and periodicity behaviour among *Orobanche* seeds.

Wishing you good luck in the publication of FABIS, I remain,

Sincerely yours,

A.R. Saghir
American University of Beirut
LEBANON

August 15, 1979

I did not know that so many people were working on *Vicia faba*! But this shows the value of the newsletter in that it has brought me, and probably several other people, into touch with other *Vicia faba* workers in various parts of the world.

The value of the newsletter, to my mind, lies just as much in the short articles. From December to March is quite a short time and people will know that they can get a short piece of 'news' published fairly quickly this way, and if people use it for that purpose it will help us to keep up to date with what is going on.

Your sincerely,

D.A. Bond
Plant Breeding Institute
ENGLAND

Paris, le 26 Novembre 1979

Messieurs,

Je vous serais obligée de bien vouloir me faire parvenir les 2 premiers numéros de la revue FABIS qui présente un grand intérêt pour notre organisme, et de me faire savoir quelles sont les conditions d'abonnement.

Je vous en remercie vivement à l'avance et vous prie d'agréer, Messieurs, l'expression de mes sentiments distingués.

C. Dion
Oleagri Recherches et Developpements
FRANCE

September 24, 1979

Thank you for sending me the first issue of FABIS Newslètter which I enjoyed reading. It is certainly of great help to acquaint researchers with what is going on all over the world concerning faba beans.

With best wishes,

Dr. A.M. El-Tabey Shehata
University of Alexandria
EGYPT

October 15, 1979

It was nice to receive your letter of August 20 and two copies of FABIS you sent to our Director.

As our Germplasm Resource Institute was just set up, our research section is in charge of germplasm resource work on small red beans, small green beans and broad beans. We are just beginning our research work on broad beans. We are very pleased to contact you in this field and do some exchanges in the future.

Yours sincerely

Zheng Zhuo-jie
Chinese Academy of Agricultural Sciences
CHINA

October 30, 1979

'FABIS' is an excellent publication. It has the tremendous advantage of involving ICARDA's cooperating scientists immediately, and therefore you should be able to make future issues responsive to their needs. The emphasis, as it should be in a newsletter, is on letting people know what is happening right now rather than what was done three years ago and published one year ago. In this regard the lists of institutions and individuals interested in *Vicia faba* research are an important means of improving communications among scientists. They might eventually be reissued as seperate publications.

A newsletter should do as its name suggests and provide news. Eventually, you may find that an annual issue is too infrequent, and that semi-annual or even quarterly issues might be more appropriate, despite the higher printing and mailing cost that might be incurred. A more important factor in keeping 'FABIS' as a newsletter, however, is the temptation to turn it into a scientific journal. I am told that one so-called newsletter .... referees its contributed items, though I must admit that I have never seen this newsletter myself. This would not only introduce production delays, it might prejudice the publication of more detailed papers in the existing scientific literature.

Yours sincerely,

M. Brandeth
IDRC
CANADA

August 23, 1979

I acknowledge with many thanks two copies of the FABIS Newsletter No. 1, and would like to congratulate you and your colleagues on the fine job you have done in initiating this important periodical. I am sure it will supply much-needed information of faba bean research.

I have forwarded one copy to the FAO library.

With kind regards,
H.A. Al-Jibouri
FAO Rome
ITALY

November 8, 1979

Congratulations of FABIS Newsletter No. 1. I think your newsletter will fill a very important role in bringing together researchers on *Vicia faba*.

Yours faithfully,

Basil Baldwin
Roseworthy Agricultural College
AUSTRALIA

October 25, 1979

Thank you for your letter of October 9th.

From the letter head you will see that I no longer work for the Rowett Research Institute and though I retain an interest in beans I am no longer carrying out active research. My current interests are confined to documentation and I shall see that FABIS is fairly dealt with in Nutrition Abstracts and Reviews. I found the first issue most interesting and I wish your Newsletter well.

Yours sincerely,
Dr. A.A. Woodham
CAB
SCOTLAND

Setember 17, 1979

I am really very grateful to you for sending me copies of the first issue of the 'FABIS' newsletter.

Please accept my hearty congratulations on the starting of 'FABIS'. I am satisfied with the appearance and contents comparing with documents of other International Centers for Agricultural Research. I hope, however, some consideration should be paid for too much broad width of paper and too narrow space of lines.

As for the nomination of a suitable author of the General Article for 'FABIS' No. 2, I will write it because we have few researchers in Japan now, though many researchers engaged in faba beans till twenty years ago. So, I am intending to write the short history of research accompanying with the transition of production in Japan and a review of current research. I will also write an up to date list of names and addresses of researchers together with a brief summary of their work.

With best wishes and kind regards.

Yours sincerely,

Kiyoshi Kogure
Kagawa University
JAPAN

October 16, 1979

I have received the first issue of FABIS Newsletter, and I have really appreciated the distinctive characteristics, the immediacy of style, the form and essentiality of information reported in the articles.

I think that FABIS Newsletter could also include in its spaces heading regarding the following topics:

- an up-to-date bibliography on the current research on *V. faba* on the basis of what the authors can submit to you as abstracts or reprints of their published or in press results.

If this service was extended to a more complete collection from the Abstract's Review of the articles published in the whole world on *V. faba*, it could be possible to realise a useful tool.

- the inclusion of a descriptive list of genes, till now localised in *V. faba* genome, would constitute a useful reference for the breeders who are also involved in genetical studies of simple inherited characters.
- a reference of the newly released *V. faba* varieties would be greatly appreciated.

Yours sincerely,

Ciro de Pace
University of Bari
ITALY

November 26, 1979

I enclose a list of colleagues at this Research Station who are working on field beans for your next newsletter. Also I have outlined the areas of research in which each person is working, - information that I hope you will include in the seperate publications planned next year.

We found Newsletter No. 1 very interesting and stimulating in the way that it drew together reports from many different disciplines from all over the world. Carry on the good work!

Yours sincerely,

D.G. Hill-Cottingham
Long Ashton Research Station
ENGLAND

September, 3, 1979

I would like to add my congratulations on the first appearance of the FABIS newsletter, which fulfills a useful function in promoting collaboration between many disciplines involved in *Vicia faba* research.

Yours faithfully,

Richard Bardner
Rothamsted Experimental Station
ENGLAND

January 9, 1980

I should like to congratulate you on the launching of FABIS. I am particularly interested in maintaining contacts with research on the pulse crops and leguminous oilseeds which is being carried on world-wide. FABIS does fill a substantial gap in legume coverage, *Phaseolus* beans, peanuts, soyabeans and lentils are covered by similar specialist newsletters and there is also "Bean Bag" which does serve a valuable function.

I know that I shall make full use of all these publications when the time comes to revise my own book "Tropical Pulses".

With best wishes for your continuing success.

Yours sincerely,

Dr. J. Smartt
Southampton University
ENGLAND

WANTED

Botrytis fabae isolates from different parts of the world. Dr. J.G. Harrison, Mycology Section, Scottish Horticultural Research Institute, Invergowerie, Dundee, SCOTLAND.

WANTED

Germplasm from as many different countries as possible for inclusion in the world germplasm collection maintained at ICARDA. See short communication on faba bean germplasm by Hawtin and Omar.

WANTED

Information on plot equipment, particularly seeders, threshers and seed cleaners which can be used for faba bean field research. Information is particularly needed about equipment which can handle the full range of seed sizes in the species up to the largest *major* types. The experience of FABIS readers in this respect may be of great value to other readers. Please send information for inclusion in FABIS Newsletter No. 3 to the editors.

THE EIGHTH NORTH AMERICAN RHIZOBIUM CONFERENCE
will be held at the
University of Manitoba, Winnipeg, Manitoba, CANADA
from August 2nd to 7th, 1981

For further details please write to:
Dr. K.W. Clark,
Plant Science Department,
University of Manitoba,
Winnipeg,
Manitoba,
CANADA, R3T 2N2

Style and Form for FABIS Contributions

All contributions should be submitted if possible before December 1st for inclusion in the March issue of the newsletter. When writing articles it is hoped that the following points will be borne in mind:-

General Articles

- should be approximately 1500 words.
- edited articles will be returned to authors for approval if the originals were submitted before December 1st.

Short Communications

- not more than 600 words, and may in addition include one Table and/or 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 should be typed double-spaced.
- the species should be referred to as *Vicia faba* or faba beans or preferably both.
- sub-classes should be referred to as *Vicia faba minor* 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.

General Articles

The articles in this section were commissioned by the Editors on the advice of the Co-ordinating Committee. With the exception of Prof. Kogure's article they are concerned with Agronomy and/or Physiology. The subject for the General Articles for FABIS Newsletter No.3 is Seed Nutritional Value and Processing; if any readers other than members of the Co-ordinating Committee would like to propose authors for these articles, they are welcome to do so.

General Articles should be submitted before December 1st. for inclusion in the March 1981 issue.

Faba bean rhizobiology and agronomy

K.W. Clark
Plant Science Department, University of Manitoba, Winnipeg, CANADA.

As a grain legume and as a forage silage crop faba beans can be grown successfully in Manitoba from the 49°N latitude border with the U.S.A. to latitude 53°N. Comparative trials throughout the province have indicated that this grain legume can be a valuable addition to the farmers' cash cropping program and can also play an increasingly valuable role in crop rotations to alleviate, in part, nitrogen fertilizer costs. The objectives of this paper are to report some of our findings with respect to the nitrogen fixation capabilities, and secondly some of the results from a rotation experiment.

Fields are selected for faba bean production on the basis of previous cropping history, with a four year gap between seeding of beans, peas, lentils or sunflowers. This prevents disease transfer from the legumes, and negates the residual toxicity of the sunflower stubble on *Rhizobium* which may result in poor nodulation and depressed bean yields. Weed control is initiated by an autumn soil-incorporated application of Treflan (trifluralin) at a rate of 1.12 kg a.i./ha. In the spring, seeding is as early as possible with phosphate and potash fertilizer applied as recommended by soil tests. Seed treatment with a suitable fungicide ensures a healthy seeding even if soil temperatures are low. Faba beans can withstand a late frost or two in the seeding stage.

No. 1 Canada Seed grade must have less than 0.5% perforated damage and total damage must be less than 2%, with splits less than 3%. It is found that only whole non-perforated seed can be expected to give 100% stand when sown to a depth of 10 cm. *Rhizobium* inoculum is purchased each spring in either a peat base, a granular or a granular implant form depending on the seeding equipment and method used by farmers. Many have devised mixing and augering equipment that will not damage the seed. If a slurry application method is used, farmers indicate that one extra man is needed for this work. A commercial sticker of powdered milk slurry may be used.

Figure 1 shows the pattern of N fixation attained by faba beans when inoculated with *R. leguminosarum* "C" as recommended for pea fields in comparison to "Q", the *R. leguminosarum* strain selected specifically for faba beans. Note that the "C" alone is very little different from no inoculum, which probably means that the 'no inoculum' beans were nodulated with a resident "C" type strain. Note also the competition effect of the "C" and "Q" powder.

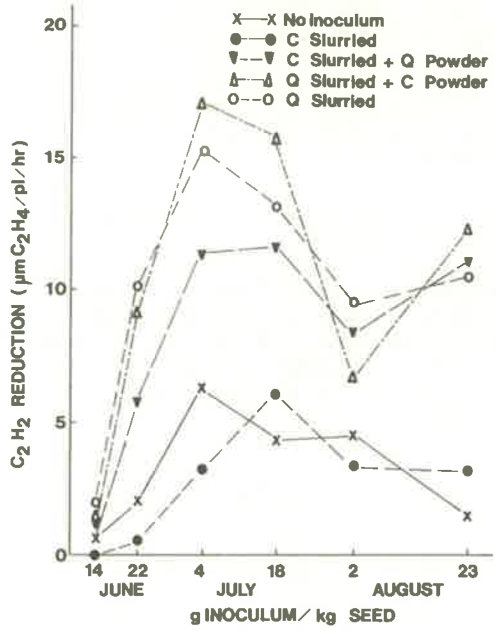


Figure 1. Acetylene reduction by faba bean roots inoculated with specific and non-specific inoculum in different combinations (1977).

Strain Selection. For the plant breeder we have been interested in Cultivar x *Rhizobium* strain compatability and any interactions which may result in high yield or higher % N being stored in the grain or total plant. Single strain activity as shown in Figure 2 has indicated a general pattern often dictated in part by soil

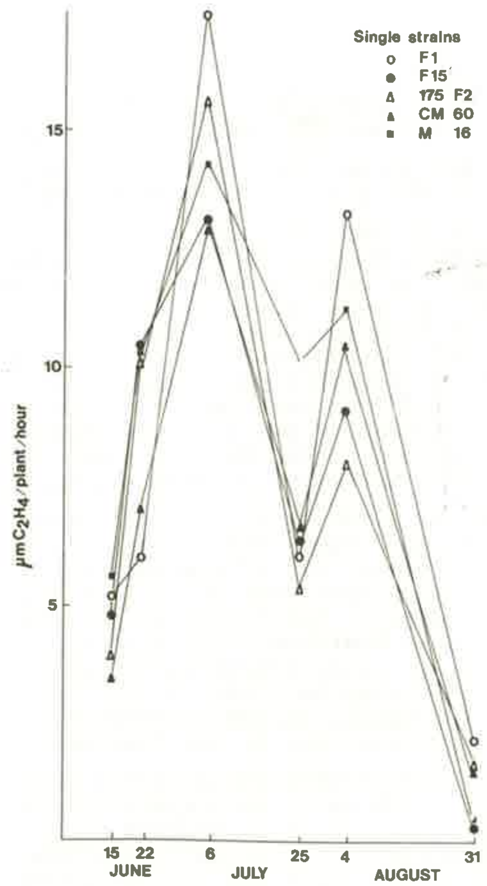


Figure 2. Acetylene reduction by selected grains of *Rhizobium leguminosarum* in faba beans.

moisture conditions. F_1 and F_{15}, two *Rhizobium* strains from Morocco, have given excellent results in Manitoba soils, where soil temperatures are often high at the time of pod development and grain filling. It will be noted in later figures how these strains have supported high fixation rates and have given high N content in the seed.

Multiple strains have been generally used in formulation of commercial inoculants. We have noted that single strains compatible with a particular recommended cultivar will result in higher N fixation rates than the multiple strain combinations. In Figure 3 it can be seen that the "Q" commercial inoculant resulted in the poorest performance under the climatic and soil conditions of this experiment.

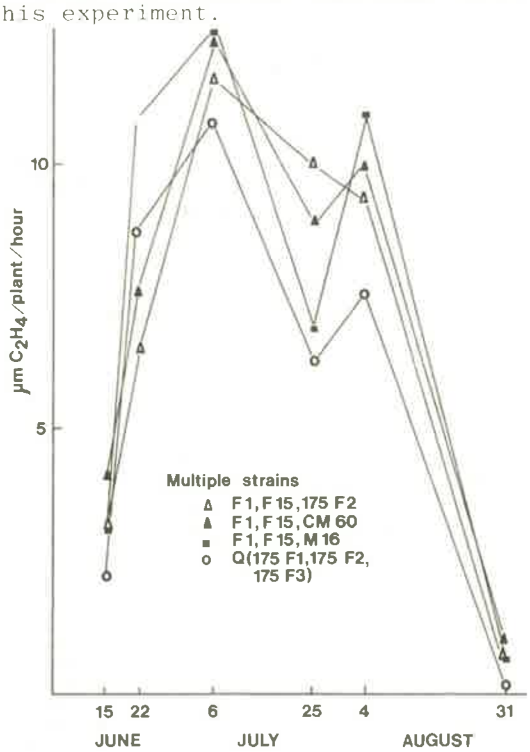


Figure 3. Acetylene reduction by multiple strains of *Rhizobium leguminosarum* in faba beans.

Our excitement over the use of faba beans in Manitoba as both a grain legume or a forage silage crop comes in part from the Figure 4 data, where it is seen that in comparison with soybeans or peas the N fixation without any starter nitrogen fertilizer applied, is significantly greater than either of the other two legumes, and in fact the N fixed from the regrowth beans exceeds that of the soybean or pea fixation throughout their total growth cycle. In this experiment the faba beans were harvested on August 22nd.

Note that the flush of N fixation occurs some short time after autumn rains initiated further growth of the beans, which when harvested with a self-propelled swather were cut off at a height which left the lower nodal area intact. Fixation by faba beans in Manitoba soils has still been quite active with soil temperatures below 10°C. It may be noted also in Figure 4 that the pea and soybean N fixation system is more sensitive to applied nitrogen than is the faba bean.

Agronomic studies have shown that a seeding rate exceeding 150 kg/ha is required to maximise yield. Deep seeding at 7 to 10 cm with a hoe drill is preferable so that soil moisture is adequate to ensure rapid and even germination. The seed should be placed on top of the soil implant inoculum, and phosphate fertilizer where required is side-banded. Faba beans grown in a

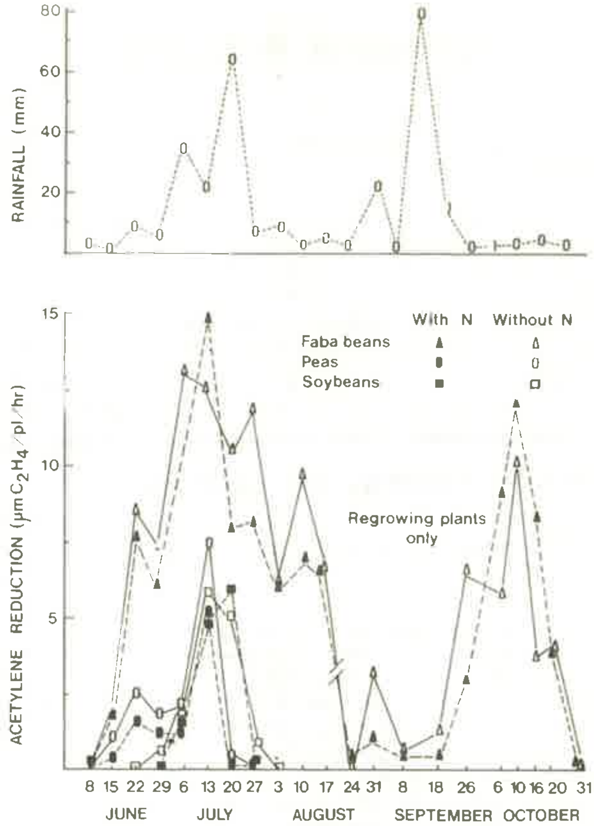


Figure 4. Effect of 20 kg N/ha applied with the seed, on acetylene reduction in faba beans, peas and soybeans in 1978.

rotation with small grains or corn have been shown to be an ideal break crop with benefits exceeding those calculated from nitrogen fixation. Wheat after faba beans has yielded 75% more grain than continuous wheat cropping. In the second season the increase of wheat after beans was 27%.

Typical results of the use of faba beans in a small grain rotation are shown in Tables 1 and 2. In 1978 the faba bean yield increase with addition of 50 kg N/ha in rotation 2 was only 1.3% and in rotation 7 only 3.3%, indicating an uneconomic return to the application of fertilizer.

Table 1. Crop yields for 1977 with and without N fertilizer.

Rotation No.	1976 crop	1977 crop	Crop yield (kg/ha) without N	+50 kg N/ha	% increase due to N
1	wheat	faba beans	3131 bc	3433 b	9.6
2	"	barley	1959 d	2807 c	43.3
3	"	wheat	1948 d	2827 c	45.1
4	"	corn*	4223 a	4618 a	9.4
5	corn	faba beans	3534 b	3817 b	8.0
6	"	barley	2737 c	2939 c	7.4
7	"	faba beans	3141 bc	3595 b	14.5
Mean			2953 y	3434 x	

*Silage dry matter.
a-d means followed by same letter are not significantly different by Duncan's multiple range test at $P \leq 0.01$ (within columns). x,y means are significantly different by F test at $P \leq 0.05$.

Table 2. Percentage difference in available N in 1978 compared to the continuous crop, in wheat and corn rotations.

1977 crop	Available N in 1978 (as % of continuous crop)
wheat rotations	
wheat No. 3	100
barley No. 2	104
faba beans No. 1	182
corn rotations	
corn No. 4	100
barley No. 6	110
faba beans No. 5	155
mean increase	
barley	107
faba beans	169

Similarly, faba bean silage has given excellent returns in terms of dry matter yield, live weight gain on beef steers, milk production and in feed efficiency. Faba bean silage at our Glenlea Research Station has been superior to corn silage or any small grain silage in four out of five years' trials. In addition to the advantages gained in feeding livestock this high protein (17%-20%) high energy silage, there is the benefit of residual nitrogen in the soil, with significantly increased levels of N available for the next crop in the rotation. With an expected doubling in the cost of nitrogen fertilizer in the next five years, this added value in the use of grain legumes becomes a major economic consideration to Western Canadian farmers.

Current research on the major agronomic problems of Vicia faba in Northern Sudan

Farouk A. Salih
Hudeiba Research Station, P.O. Box 31, Ed-Damer, SUDAN.

Vicia faba is grown as an irrigated crop in Northern Sudan, its cultivation being limited to a zone between latitudes 13°N and 22°N. An estimated 20,000 ha of faba beans were grown during the 1978/79 season. The Northern Province is the main region of production in the Sudan, responsible for about 77% of the total area grown; this is followed by the Nile Province with 21% and the Khartoum Province with only 1%. The average yield for 1978/79 was about 1800 kg/ha, with lift irrigation pumps now the main method of irrigation.

Agronomic research problems and progress from 1975 to 1978

The agronomic research problems during this period were a continuation of those existing in the period 1960 to 1974. Emphasis has been put on studies of the interactions between the factors which had previously been studied individually. As well as these factorial experiments, some studies have been made of the area of seed as one factor affecting germination, crop establishment, yield and cooking quality. The major agronomic experiments conducted during this period can be summarised as follows:

Sowing date. The yield potential of different varieties sown at different dates has been examined in order to find the best sowing date for each variety. Work carried out over a three year period at Hudeiba showed that 15th October to 1st November is the best time for planting *Vicia faba*. Delayed planting revealed conspicuous varietal differences for yield reduction (Ageeb, 1975; 1976; Salih, 1976; 1977; 1978).

Fertilization. Studies of the effects of level and time of nitrogen fertilizer application on *Vicia faba* have been made. Application of 43 kg N/ha gave seed yield increases ranging from zero to 23% (Salih, 1976; 1977). However, splitting a similar dose of N into three equal portions, applied at sowing, at one and at two months after sowing, increased seed yields by about 20% (Salih, 1976). Babiker (1975; 1976; 1977) found that *Vicia faba* did not respond to application of phosphorus when broadcast on top of the ridge, better results are being obtained with foliar application.

Seed size and orientation. Large seeds have resulted in a significantly higher density of established plants per unit area compared to smaller seeds. Seed size has been found to have only a small (not significant) effect on *Vicia faba* grain yield (Salih, 1977; 1978; Salih *et al*, 1979). Mohamed and Salih (1974) found no significant differences when seeds were placed in different orientations, but putting the seed in a dorsal position resulted in lower percentage emergence compared to other positions (hilium up, ventral to the side, side position).

Time of harvest. The effect of time of harvest of *Vicia faba* (var. Hudeiba 72) on grain yield and hard seed percentage was studied for three seasons. The best time for harvest seemed to be about 110 days from date of sowing. Delaying harvesting can result in 15 to 30% yield losses through shattering. Harvesting 10 days before maturity could lead to losses of a third of the grain yield.

Seed germination. *Vicia faba* seeds have been shown to have high germination percentages (88 to 93%) throughout the first five years of storage under laboratory conditions (Salih and Salih, 1976). In the sixth year germination percentage dropped to about 42%, and after eight years to about 20%. The yields of crops grown from these stored seeds fell gradually from 1761 to 1119 kg/ha from one year old to five year old seeds. Eight year old seeds yielded only 107 kg/ha.

Watering interval, sowing date. Water stress has been shown to reduce the absolute growth rate of leaf area and total vegetative growth in faba beans. Increasing the watering interval at pod formation from 7 to 14 and 21 days has been shown to decrease seed yields by 36% and 76% respectively (Ageeb, 1975; 1976). This may be due to the fact that water infiltration is slow as a result of the soil type and evaporation may be considerable. Grain yields have shown significant responses to watering, sowing date and the interaction between the two. Highest yields were obtained from plots irrigated until maturity (Salih, 1977; 1978). Two seasons' results indicate that Hudeiba 72 requires about 110 days from planting to the time of last irrigation to give high yields, and shortening the period of water availability results in yield reductions.

Spacing and position. Two seasons' results indicated that neither changes in row spacing (20, 40 and 60 cm) nor in plant spacing (5, 10, 15 and 20 cm) had significant effects on grain yield (Ageeb, 1975; 1976). It appeared that the *Vicia faba* plant has a high degree of plasticity which makes it insensitive to wide variations in plant spacings. Planting on both sides of the ridge in general had no significant advantage over planting on top of the ridge. However, there were varietal differences in plant plasticity (when the plant stand was varied). Yields of the varieties NEB 152.S and NEB 153 when planted on both sides of the ridge exceeded yields from top of the ridge plantings by 9% and 22% respectively (Salih, 1978).

Hard seededness. The presence of hard seeds (those seeds which fail to germinate readily when all conditions necessary for germination are provided) reduces the emergence percentage and also has an adverse effect on the cooking quality of faba beans. Salih (1979) found considerable varietal variations for this character. Percentage hard seed was found to vary from 22.8% in the cross RB40 x 188 to a mere 0.1% in Triple White. There was no correlation between the percentage of hard seeds in sown seed lots and final yield. There was a gradual reduction in the percentage of hard seeds as the generation level of selection was advanced; early water closure from the crop in the field increased this percentage. The percentage of hard seeds decreased with both the age of the crop at harvest and the length of the storage period (Salih, 1979).

Soil salinity. Babiker (1975; 1976; 1977) used Gueir, Karu and High Terrace soils in pots but found no effect of salinity on the growth and yield of *Vicia faba*. El Karouri (1977) found that environmental conditions modified the salt tolerance of the crop. Faba beans sown in October in saline soils at Soba had lower plant survival, dry matter production and yield than November sowings, which had the advantage of relatively low temperatures coupled with higher humidity. El Karouri (1979) found a negative relationship between soil salinity and the dry matter yield of faba bean shoots at Soba. The results suggested that faba beans could survive when the electrical conductivity of the saturation extract approached 22 mmho/cm. Dry matter yields appeared to be reduced by 50% at a conductivity of 10.5 mmho/cm. There was also a negative correlation between conductivity and yield.

Other research carried out between 1975 and 1978 included studies of the effect of sowing date and watering interval on disease incidence (particularly wilt and root rot) and the effects of different methods of sowing on the yield performance of different varieties.

Present and future agronomic research

Experiments set up in the 1979/80 season have been designed to make good the deficiencies in information on certain aspects of cultural practices for faba beans. There has been an increase in the number of studies of interactions between different factors, and of the effects of different locations on each of the agronomic factors investigated. Newly established experiments have included the following:-

- a variety/sowing date trial at six locations along the Nile and in the Northern Provinces.
- study of the response of faba beans to irrigation in relation to the different phases of plant growth.
- the effects of different methods of fertilizer placement/application and the interaction with level of application.
- interactions between plant population density and watering interval.
- comparison of the different weeding schedules on faba bean growth and yield.
- study of the water requirement of *Vicia faba* to determine the consumptive use of water by the crop, to study the effect of soil temperature and to study the effect of seed placement.

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The major agronomic problems of the cultivation of faba bean (Vicia faba L.) in France

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Vicia faba has been grown in France since very early times. The large seeded types *V. faba major* (broad bean) were used for human consumption either as the green or dry vegetable, whereas the small seeded types *V. faba equina* and *minor* (field bean) were reserved for animal feed or were sometimes used as green manure. A small proportion (1.5%) of each type was used in bread making to improve the baking qualities of wheat flour, although these needs were most of the time met by importers.

The evolution of human food habits, the expansion of new perennial forage (Lucerne), the very marked decline in the livestock that consumed *V. faba* (horses, sheep) and the introduction of the maize-soya meal system, have considerably reduced the area assigned to this species in France. In 1862, the statistics show 150,000 ha for all cultivated types of *V. faba*. At the beginning of the next century there were only 110,000 ha left; 27,00 ha of which were field beans and 83,000 ha broad beans. The acreage has continued to decrease, particularly for broad beans, although there was a rise for field beans in the fifties (35,000 ha in 1955). The lowest level was reached in 1972 before the soya bean crisis, with only 8,920 ha of field beans and 860 ha of broad beans. Since then the acreage has increased a little; it has now reached 20,000 ha, only 4% of which is for broad beans.

Fifty percent of the acreage is now located in the Northern Central area, 30% in the East, 10% in the West and only 10% in the South-West. The last location used to represent more than half the acreage forty years ago.

This modification of the area assigned to field beans went along with the disappearance of local populations : spring populations of the North, of Picardie, and Lorraine, winter populations of Cote d'Or, Vendee, Gers, and Aquitaine. These have been replaced by spring varieties which are more or less synthetic and more productive, or which have particular characteristics (e.g. for pigeon feeding). Winter variations have only been at the farmer's disposal more recently, which accounts for the fact that most of the varieties grown are spring ones.

Vicia faba is used more and more exclusively for its seeds, whose lysine and protein content make a good complement to cereals in feeding monogastric animals. Its use as green or silage, or even as green manure, has been given over to species better adapted to this purpose. Until 1976, except for partial use in milling, field beans were mainly consumed on farms in pig and cattle production. The creation of three associations, AFPP, AMSOL and UNIP*, has allowed the faba bean sector to be organised for the industrial use of consumable grains rather than only for the the production of certified seeds. This has also contributed to obtaining help for faba bean cultivation; the main aim being to encourage cattle feed manufacturers to use increasing quantities of French produced faba beans, which accounts for, at present, only 25% of the faba bean area cultivated and a very small proportion of the imported protein (1%)

At the national level, an initial acreage of 4,000 ha was financed in 1974 by FORMA** at a maximum premium of 330 Francs per ton, for yields not exceeding 3 t/ha. In 1978, this was replaced by an E.E.C. system without acreage limitation, which subsidises the cattle food manufacturers under contract with the production sector, and guarantees a minimum price calculated in reference to that of soya meal. It is still too early to know if this aid will be sufficient to extend the areas assigned to faba beans in a decisive way and start the cycle of its industrial use. For the last ten years an important research program has quantified the nutritional value of faba bean by means of analytic tests as well as experiments on animals. Its protein content, which is lower than that of soya meal, leads to greater incorporation rates in animal feed. The low level of sulphur amino acids can easily be corrected by addition of synthetic methionine.

The presence of some antinutritional factors seems, for the time being, to limit the incorporation to 15 to 20% of the total feed, particularly for broiler chickens and pigs. The location of some of these factors, such as tannins, in the seed coat makes it easy to get rid of them by mechanical means. However, because of others located in the embryo (antitrypsin and antiniacin factors, lectins, phytins, vicine and convicine etc.), it should be necessary to complete the protein balance of the ration by other protein sources which in turn increase formulation and manufacturing problems. This shouldn't represent however, an insuperable obstacle for food technology.

The problem of dependability and regularity of supply is more important. In fact it is only when the crop is available in important and stable quantities that it will really have a place in cattle feed formulations. And at the present time, the quantities available are still insufficient: 19,000 tons as compared to 3,500,000 tons for oil cake consumed in 1978. This situation may be accounted for by the low mean yields at the national level which in the last 20 years have only increased from 1.7 to 2.4 t/ha, whereas the mean wheat yield increased from 2.5 to 4.7 t/ha in the same period. Average yields also fluctuate widely from one location to another. The best yields are obtained in Picardie and in the North, where they are about 3.0 to 3.5 t/ha, or twice those of the Southwest or Lorraine areas. Such irregularities may occur from year to year on the same farm, and may be accounted for by the physiological responses of the species to different environments.

Physiological requirements of faba bean

As a leguminous crop, faba bean fixes atmospheric nitrogen in symbiosis with *Rhizobium*. These bacteria exist in most soils, but research carried out in France at Dijon and in Great Britan at Aberystwyth show that not all strains have the same efficiency, and there are interactions between them and host varieties. Moreover, in too acid or anaerobic soils symbiosis cannot easily occur. On the other hand, the very existence of this symbiosis, which allows a saving of artificial nitrogenous fertilizers, prevents as accurate a control of plant nitrogen nutrition as in the case of cereals. Soils containing too much organic matter, or residue of nitrogen fertilizers, often lead to an excessive vegetative growth to the detriment of seed production.

The second important characteristic of faba bean is its important need of water during flowering and pod setting. During this period the maximum evapotranspiration is 25% more than that of Tall Fescue (taken as reference). Practically it can be said that a mean rainfall of 100 to 200 mm is necessary during May and June to obtain a yield of 4 t/ha, a rain deficit of 10 mm resulting in a loss of 0.2 tons of grain per ha.

Faba beans are also very susceptible to some parasites the most important being the black aphids (*Aphis fabae* scop.), which may cause considerable damage to spring faba beans in continental regions where the threshold of economic damage which ranges from 600 to 1000 aphids per plant, is often exceeded. The lost of yield, which also depends on the date of infestation within the crop, may reach 95%. Another insect which may cause losses of yield and reduce grain quality is the bean beetle (*Bruchus ruffimanus* spp.) whose larvae develop inside the seeds and which is mostly found in the southern regions. The rate of infestation remains at a rather low level of about 7%.

Among the fungus parasites, *Botrytis fabae* Sard., responsible for chocolate spot disease, is by far the most important. It attacks winter faba beans more than spring ones because the transition to the aggressive stage of the disease occurs when the day temperatures are about 17°C and when humidity is high. Under our oceanic climate this mostly occurs in the course of the second week of May, when winter faba beans are in the full growing and flowering stages and the spring ones have not yet started flowering, presenting a much less advanced vegetation. The most important damage occurs on the flowers and the young pods due to wilt or abort. The fall of the leaflets due to their total necrosis also contributes to reducing photosynthesis, and consequently the yield may be reduced to nil. Although the epidemiology of the disease is not fully understood yet, the regions where winter and spring are both mild and wet are known to favour it together with all the factors resulting in an excess of vegetation (too dense a crop, too early a sowing, excessive nitrogen manuring etc.).

The rust disease, *Uromyces fabae* Pers., unlike *Botrytis fabae*, attacks spring faba beans more than winter ones, because it needs higher temperatures and lower humidity in order to develop. It causes the grain to decrease in size and even to shrivel. The later varieties are more exposed to the disease. For the time being *Ascochyta fabae* Speg. is not a very serious parasite but its transmission by seeds and its persistence in the soil would favour its spread in regions where the spring is wet and cold.

The frost hardiness of winter faba bean is not very high. In France, the Cote d'Or populations which used to have the best genes for frost hardiness could not stand temperatures under -15°C in bare ground. Only regular snow cover allowed it to hold its ground in this eastern region. The western and south-western winter populations were killed at about -8°C. The winter hardiness limits of contemporary varieties are slightly lower than that of Cote d'Or but their recovering ability, inherited from the more vigourous seedlings of the English populations, (except for the more susceptible Spanish variety Talo) is better (Table 1). Spring varieties are resistant to -6°C which is generally enough to overcome the late frosts.

Faba bean has an entomophilous pollination. The most efficient pollinators being the long tongued bumble bees (*Bombus hortorum*) and solitary bees (*Eucera and Anthoptora*). *Bombus terrestris* frequently make holes in the lower part of the corolla and 'rob' the flower. Honey bees often use these holes to collect nectar and so become inefficient too. Most of the faba bean varieties need visits

Table 1. Varieties of winter faba bean cultivated in France. (INRA Rennes, 1974-1979).

Name and Source	Seed yield %M. Beagle	1000 kernel weight (g)	Earliness(in days) c.f. Maris Beagle to flower	to maturity
Avrissot INRA	102	569	+ 6.1	+ 2.8
Survoy INRA	100	558	+ 4.3	+ 3.1
Soravi INRA	103	536	+ 2.5	+ 2.9
Throws RHM	100	615	+ 0.3	+ 1.2
Bulldog PBI	103	645	- 2.1	- 0.5
Maris Beagle PBI	100	625	30/4	28/7
Talo CUSESA	79*	611	+ 20.0	+ 14.4

* killed by frost in 1979.

by these insects to produce pods and the presence of efficient pollinating fauna is an important factor for yield, though this is difficult to quantify since it also depends on the environmental conditions. There are autofertile varieties that can produce pods even without insect tripping of the flowers. The genes that determine this autofertility are very frequent in the Mediterranean populations where natural selection has favoured autogamy imposed by the lack of pollinators (this is the case in particular for the Spanish variety Talo).

Table 2. Varieties of spring faba beans cultivated in France (INRA Rennes, 1953-1979).

Name	Seed Yield (as % of Ascott)	No. of years	1000 kernel weight (g)	Earliness(in days) c.f. Ascott to flower	to maturity
Strube	110	27	602	+ 4.5	+ 2.4
Skladia	98	8	413	- 1.5	- 0.3
Pavane	94	14	516	+ 0.5	+ 0.3
Ascott	100	27	432	2/6	9/8
Herra	92	6	332	- 3.0	- 0.5
Diana	90	7	366	+ 0.9	+ 1.3
Columba	84	26	391	- 7.1	- 5.2
Maxime	80	6	345	- 5.8	- 5.0
Primeperle	78	9	331	- 1.2	+ 1.0

Faba bean growth is indeterminate. If for climatic reasons or as a result of pest or disease attack the lowest nodes do not produce pods, the resulting deficit may be made up by the upper nodes. This is an advantage of the species, but this plasticity may in extreme cases prove to be a drawback because it may lead to an excess of vegetation causing lodging and lateness. There is a mutation with determinate growth ('Topless'; Sjodin, 1971) but its use in selection has not given any results yet. It would be useful to select types with improved harvest index as well as small seed for easier sowing. With the currently grown types the seed rates are comparatively low (25 pl/m^2 in winter, 50 pl/m^2 in spring) which result in a weed control problem.

Solutions to the main agronomic problems

The different characters of faba beans discussed above set agronomic problems to which cultural and varietal solutions must be found to give more stable and increased yields in the near future.

The choice between the generally higher yielding winter types and the spring types must be made in the knowledge that earlier rooting and flowering of the former usually results in the crop escaping the effects of drought and damage caused by black bean aphid. On the other hand, winter types are exposed to winter injuries and their frost hardiness is known to not be as good as that of wheat. They are also more susceptible to *Botrytis* attacks.

Choice of location must take climatic factors into account : the spring rainfall ensures good pod set for spring varieties but increases the risk of *Botrytis fabae* for winter types. The frequency of heavy winter frosts will prevent the cultivation of winter types in the continental eastern regions.

Edaphic factors are equally important. Deep soil with good water retaining power (loamy, clayey and clay-lime soils) are preferable to lighter soils. Excess clay must be avoided as damp conditions lead to anaerobic conditions, preventing the development of *Rhizobium* strains. Moreover, faba bean prefers a pH over 6.

The improvement of cultivation techniques in the short-term will result in more stable and increased yields.

The place of faba bean in the rotation and its manuring must take into account the fact that it is a leguminous crop which results in a sowing of nitrogenous fertilizer; however the crop cannot stand high levels of nitrogen in the soil.

The preparation of the land must be done so as to store maximum water and to allow deep sowing (6 cm) which will protect the seed against frost and bird damage and against the phytotoxicity of surface herbicides.

Early sowing (end of February, beginning of March) limits the water requirements of spring faba beans and reduces the risk of black aphid damage. Earliness must not preclude good preparation of the land. As for winter faba beans a compromise between too early and too late sowing must be found. The former causes exposure to frost damage in winter time and *Botrytis* in the middle of spring, the latter means the crop will not be harvested before the weather gets colder in the autumn.

Table 3. Relation between dates of sowing and seed yields of spring faba bean varieties (I.N.R.A., Rennes, FRANCE).

Variety	Dates: Early March	Mid March	Early April	Variety LSD = 0.43
	Seed Yield (t/ha)			
Strube	5.49	4.87	3.97	4.78
Ascott	5.00	4.33	3.65	4.33
Columba	4.88	3.87	3.37	4.04
Niki	4.09	3.70	2.96	3.58
Date of sowing LSD = 0.41	4.87	4.19	3.49	

Faba beans for health

"They are plants of Venus and the distilled water of the flower of garden beans is good to clean the face and skin from spots and wrinkles ... Flour of beans and fenugreek mixed with honey, and applied to felons, biles, brusies, or blue marks by blows, or the imposthumes in the kernels of the ears, helpeth them all, and with rose leaves, frankincense, and the white of an egg, being applied to the eyes, helpeth them that are swollen or do water, or have received any blows upon them, if used in wine. The husks boiled in water to the consumption of a third part thereof, stayeth a lax, and the ashes of the husk, made up with hog's grease, helpeth the old pains, contusions, and wounds of the sinews, the sciatica and gout".

From 'Culpeper's Complete Herbal' by the astrologer physician Nicholas Culpeper (1616-1654).

The seed rate has a direct influence on yield. The seed cost and the risk of lodging determine the higher limit, which is 25 pl/m^2 for the winter faba bean and twice as much for the spring ones. The row width has little importance. It can range from 20 to 50 cm, the larger widths allowing a better airing of the crop and the possibility of hoeing. Most drills are suitable. Nevertheless some large seeded varieties (weight over 0.7 g) need to be drilled deeper. To make sure of obtaining the required plant population all seed should be dressed by maneb, thirame or benomyl.

Crop protection is required mostly against the following three: weeds, *Botrytis* and Aphid control. Except for the grass-killers, which are incorporated in the land before sowing (di- and triallate), selective herbicides for use on the faba bean crop do not yet exist. Nevertheless, selectivity can be achieved with herbicides of low solubility used after sowing and before germination (methabenzthiazouron, simazine, dinoterbe, neburon and linuron associated with nitrofene or trifluralin). Their efficiency depends on the tilth and moisture of the land. They need deep sowing and can be toxic when washed down in too light soils. If these are efficient, later post-emergence herbicides such as dinoterbe or carbetamide can be used on winter seedlings and dinoseb on spring ones. The successful use of the latter requires a precise temperature and stage of plant growth.

The chemical control of *Botrytis* can be realised through systemic fungicides such as methylthiophanate or benomyl. However, their persistence is not high and it is often necessary to spray several times. Spraying is nost efficient when the disease reaches the virulent stage, but then the plants are in full flower and it is difficult to go through the crop because of the height of the plants (one meter or more). An earlier spraying at the beginning of the flowering period, when the plants are less than 45 cm tall, protects the plant during the first half of flowering. This needs to be followed by a second spraying when the fungus becomes virulent.

The black bean aphids are also controlled by chemicals, but, because of the low persistence of the aphicides, spraying must be done during flowering of spring faba beans with the resultant difficulties. In this case it is important to use only pesticides that are not toxic for pollinating bees, such as pirimicarb, phozalon or bromophos. Primicarb has a very strong efficacity and preserves the predatory fauna (*Coccinellidae*, *Syrphae* etc.). Nevertheless, in areas where the risk of infestation is very high it is necessary to spray just before flowering with a more persistent aphicide such as oxydemeton methyl. Knowledge of the number of eggs on the secondary winter host (*Evomynous*) (one egg per 200 buds) or, in the shorter term, of the number of infested plants at the end of the migration flight would allow suitable spraying predictions and the preservation of the predators. In wetter areas a parasitic fungus (*Entomophtora*) can also control the pest.

Irrigation can be undertaken in the particularly dry areas where rainfall is the limiting factor for the crop. This should be done during the first part of flowering, beginning with the swelling of the first flowering buds, and ending when the pods of the fifth node are a good size. The weekly amount of water is calculated to fill the water deficit (ETP x 1.25 - rainfall) during this period. Later irrigations lengthen the growing period and increase the vegetative mass but not the seed yield. Moreover, they favour the spreading of *Botrytis fabae* which must be efficiently controlled. Early sowing is advisable in any case, to reduce the water requirement and also to avoid too high temperatures during flowering and pod setting.

A good matching of the factors of management of faba beans with the agroclimatic conditions is indispensible in obtaining yields high enough to be competitive, and stable enough to secure a regular supply to users.

In the near future, use of cultivation techniques more adapted to each location should allow farmers to obtain good profits from this species, with its advantages as a break from cereals.

In the long run, improvements may be made through genetic improvements, ideally through making the best use of hybrid vigour, either by hybrid combinations obtained with the aid of male sterility, or by synthetic varieties arising from recurrent selections for yield. The stability of the crop's growth and production should also be improved by obtaining new ideotypes through mutagenesis and/or the recombination of fundamental morphological and physiological characteristics.

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* AFPP - (Association Francaise des Producteurs de Plantes a Proteines. Legumineuses a graines, Paris). French Association of Protein Crop Producers - Pulses.

AMSOL - (Association des Etablissements Multiplicateurs de Plantes Legumeineuses a grosses graines) Association of Seed Producers of Protein Plant - Pulses.

UNIP - (Union Nationale Interproffeccionnelle des Proteagineux) Interprofessional National Union for Protein Crops.

**FORMA - (Fonds d'Orientation et de Regularisation des Marches Agricoles) Fund for Orientation and Regularisation of Agricultural Markets.

Faba beans in Japan: a history of research

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It was in 1888 that the Scientific Agricultural Society was established following the foundation of the Society of Botany and Zoology. Since then, many pioneers have made efforts to promote the science of agriculture in Japan through agricultural education, experimental research and the compilation of agricultural statistics. Accompanying the development of scientific agricultural research, many specialised societies were established between 1910 and 1930 in the areas of genetics, breeding, crop science, horticultural crop science, soil and manure, phytopathology, and applied entomology.

Although the history of faba bean cultivation in Japan goes back over 1200 years, cultural practices used by farmers were not clarified until 1697 by Miyazaki's book 'Nogyo-Zensho'. Farmers followed these practices up to the end of the First World War following which agricultural research began to have a considerable effect in improving the old practices (Kogure,1979). Fig. 1 shows the statistics of faba beans which were first officially recorded in 1905. Though the yield was maintained at about 1400 kg/ha it fell to 1000 to 1100 kg/ha after the end of the Second World War. Production has decreased rapidly together with the area planted since 1933 and the imported quantity of faba beans has been higher than the home-produced quantity since 1960, so that today's situation in Japan is similar to that in all developed countries (FAO, 1977).

History of faba bean research

There have been 236 reports concerning agricultural research on faba beans. The first study was carried out on the relationship between growth and soil reaction in 1912 (Table 1). The research histories of each section can be summarised as follows:

1. Research in subject areas of genetics, crop husbandry, soils and fertilization, and insect damage began during the period 1912 to 1930. This included studies of the confirmation of chromosome number and its behaviour (a), problems in practices of winter cropping (j), soil reaction(m), inoculation of root nodule bacteria (n), and broadbean weevils (q).
2. In the next two decades, research developed in all subject areas except for germination, virus disease, and seed quality and processing. During this period, there were many results of analyses about the characteristics of flowering and maturing habit, including pollen germination (b), photoperiodism (h), vernalisation (h), and adaptibilities for the environmental factors, especially the wet-injury (e) and the implications for agriculture. Of the diseases, however, stem wilt began to result in severe damage of the crop, this being closely related to winter cropping in wet conditions (p).
3. The efforts of researchers have produced a lot of reports in the following ten years (1951-1960) and contributed to progress being made on the importance of phosphorus fertilizer (o), herbicides (k), mixed cropping (k), and the relationship between germination and colour of seed-coat (d). Moreover, there were some valuable reports about the ecological analyses of seeds,

Table 1. Research history of faba beans in Japan.

Section / subject		Number of reports and publications 1911-1920	1921-1930	1931-1940	1941-1950	1951-1960	1961-1970	1971-1979	Total
breeding and genetics		3[a]*	2	1[b]	-	4	1[c]	4	15
physiology & ecology	germination	-	-	-	-	9[d]	-	2	11
	growing process	-	-	2[e]	3	15[f]	7	18[g]	45
	flowering & maturing	-	-	2[h]	3	17[i]	7	-	29
crop husbandry		-	2[j]	5	7	22[k]	3	1[l]	40
soil & fertilizer		1[m]	1[n]	4	2	7[o]	2	1	18
disease damage	virus	-	-	-	-	7	8	7	22
	others	-	-	3	4[p]	8	1	2	18
insect damage		-	3[q]	4	-	7	4	1	19
seed quality & processing		-	-	-	-	9	3	7[r]	19
		4	8	21	19	105	36	43	236

*The letters a to r refer to the specific subject areas mentioned in the text.

more specifically with reference to different production regions or growing locations (i), and the physiological analyses of the growing process (f) which was the start of the author's studies.

4. Within the last 20 years, research on faba beans decreased steadily together with the decline in home-grown production. But studies on the karotype (c) (Yamamoto, 1973), photosynthesis and respiration, dry matter production, and matter translocation (g) morphology and physiology of roots (g) (Tanaka, 1971), and virus diseases (Tanaka, 1973) have been carried out in studying the characteristics of this bean crop. Studies of the after-ripening practices (l) (Kogure, 1974), feed value of seed (r) (Totsuka, 1977), and the maintenance of quality for green seed (r) (Iwata, 1971) have also been made in line with changing national needs.

The future of faba bean cultivation in Japan is not good because of the overlap between faba bean harvesting and the subsequent rice transplanting time, which has now been pushed forward by the propagation of young seedlings. However, there is the new and the hopeful development of the crop for use as green seed, and use of plants for animal feed. Consequently, we have to reassess our varieties (Kogure, 1979) and to introduce foreign ones very soon.

Fig.1. Faba beans in Japan.

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Short Communications

All faba bean researchers are invited to contribute Short Communications for FABIS Newsletter No.3. These should be not longer than 600 words with one Table and/or Figure and should be submitted before December 1st for inclusion in the March 1981 issue.

General

A note on the use of the term "1000 kernel weight" in faba beans

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It is usual to use 1000 kernel weight as the measure for seed size in faba beans (*Vicia faba*), and on this basis samples are classed as *minor*, *equina* or *major*. However, the 1000 kernel weight is not an accurate measure of seed size, which depends more on the shape of the bean - whether or not it is short, round, flat, shrivelled, filled or not filled.

Would it not be better to indicate the seed size by a sieve measurement in mm, as is commonly done with potatoes?

Plot technique studies on faba beans I: row length and border effects

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In 1979 a study was initiated to obtain information on the effect of number of rows and length of row in experimental yield trials with faba beans (*Vicia faba*).

Two experiments were conducted at Aleppo: one with small seeded and one with large seeded local beans. Each trial consisted of eight replications in a randomised block design. The experimental units were 5-row plots planted on a 50 cm spacing between rows with a one meter alley around each plot. Treatments consisted of various row lengths.

1. 0.5 meters (0.25 m^2) 4. 2.0 meters (1.00 m^2)
2. 1.0 meters (0.50 m^2) 5. 2.5 meters (1.25 m^2)
3. 1.5 meters (0.75 m^2) 6. 5.0 meters (2.50 m^2)

Table 1. Mean yields of small and large seeded faba beans grown in different row lengths.

	Row No.	Mean Yield (g/10m^2) row length (g): 0.5	1.0	1.5	2.0	2.5	5.0	Mean
Small seeded	1	4675	3372	3716	3565	3790	3207	3721
	2	3930	3128	3062	2900	3412	2725	3193
	3	3810	3300	2716	3132	2962	2606	3088
	4	4186	2880	3379	2980	2928	2638	2537
	5	4800	4120	3972	3755	3457	2985	3848
Large seeded	1	7690	5195	4735	4692	4133	4433	5146
	2	5260	3980	3979	3512	3445	3310	3914
	3	5970	3800	4022	3580	2946	3295	3936
	4	6590	3650	3472	3488	3222	3380	3967
	5	6420	4725	4789	4382	4142	4172	4772

At maturity each row was harvested seperately, and the yields were converted to a comparable yield per unit area basis (g/10 m^2). Mean yield was much higher for the two outside rows (1 and 5) than for the inside rows (2,3 and 4). This is undoubtedly an edge, or border, effect. A similar effect is evident with the shorter rows (0.5 and 1.0 meters), which produced higher per unit area yield than did the longer rows.

To examine these results in greater detail, combined mean yields for the outside rows (1 and 5), the next to outside rows (2 and 4) and the inside row (3) were subjected to an analysis of variance. These analyses are given in Table 2.

There was a highly significant effect of row length and of the position of the row within the plot. There was no indication, however, that the effect of row length is dependent on position. Further analysis of the positional effect revealed that there was no significant difference in yield among the three inside rows (2, 3 and 4). The outside rows (1 and 5), however, differed significantly from the inside rows. Clearly, in faba bean yield trials it is necessary to provide and outside unharvested row on either side of the plot to guard against border effects. The data presented here, however, indicate that no more than one guard row on either side is needed.

Table 2. Analysis of variance of faba bean yields.

Source	df	Small MS	Small F	Large MS	Large F
Block	7	12,487,947	20.78*	3,524,650	7.09*
Row length	5	4,766,954	7.93*	25,336,890	50.99*
Position	2	9,075,763	15.10*	15,813,732	31.82*
3 vs. 2+4	1	10,251	.02	24,225	.05
out vs. in	1	18,141,276	30.19*	31,603,238	63.60*
Length x Position	10	147,718	.25	77,172	.16
Error	119	600,970		496,883	
cv		22.8%		16.2%	

* Significant at the 1% level.

Further analysis of the effect of row length indicated that there was no significant difference in yield among the rows one meter long or longer. However, rows 0.5 meters long had a significantly higher yield than did longer rows. This almost certainly reflects an edge effect on short rows.

In summary, the results of this trial indicate that for yield experiments with faba beans a border row is required on each side of the plot. Further the row length should be at least one meter. It should be noted, however, that in the trials an alley of one meter was left around each plot. This practice is used primarily to reduce the effects of differential inter-cultivar competition. It may be, however, that when such competition is of small effect, alley size can be reduced and some alleys eliminated. This could in turn affect the optimum configuration of the plot.

Plot technique studies on faba beans II: length of row, number of rows, and number of replications

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In 1979 a study of small plot techniques for yield trials with faba beans (*Vicia faba*) was conducted at the ICARDA research station near Aleppo, Syria. A description of the study and some of the results are presented in another short communication (Petersen, Omar and Hawtin, 1980). This paper reports the findings as regards the effect of length of row, number of harvested rows, and number of replications on the accuracy of the trial.

The accuracy of the trial is reflected in the standard error of the treatment means which, in turn, is affected by row length, number of rows, and number of replications. The effect of row length, to a large extent, is determined by soil heterogeneity. H.F. Smith (1938) showed that the relationship between the variance, V_x, of plots x units in size and the variance, V_1, of plots one unit in size is given by the expression

$$V_x = V_1/x^b$$

In the context of this paper

V_x = variance of a plot with rows x meters long.

V_1 = variance of a plot with rows one meter long.

b = Smith's coefficient of heterogeneity

Smith's b is an objective measure of soil heterrogeneity. It can vary between zero, complete uniformity, and one, high heterogeneity. Using the data from these trials, Smith's b was computed for both the small seeded and the large seeded experiments. For the small seeded trial b = 0.7307, indicating a high degree of heterogeneity For the large seeded trial b = 0.3553, indicating a fair degree of uniformity. The implication is that length of row had a greater effect in the small seeded trial than in the large seeded trial, an effect which was probably due to different soil heterogeneity rather than differential genotypic responses.

The question now arises about the number of rows to be harvested. Some insight into this can be obtained by estimating the variance between rows within plots. Using only the center three rows estimates of the components of variance between rows and between plots were obtained. For the small seeded trial the between row component, S_r^2, was 1,009,196 and the between plot component, Sp^2, was 154,805. Variance component estimates for the large seeded trial were S_r^2 = 553,368 and S_p^2 = 65,160.

Combining the information on variance components with the information on heterogeneity it is found that the variance of a treatment mean, $V_{\bar{y}}$, can be expressed as

$$V_{\bar{y}} = \frac{S_r^2 + nS_p^2}{rnl^b}$$

where

Sr^2 = variance between rows
S_p^2 = variance between plots
r = number of replications
n = number of harvested rows
l = number of 0.5 meter row lengths
b = Smith's coefficient of heterogeneity

The effect of changing the number of replications, number of rows, and length of row may be seen by substituting for Sr^2, Sp^2, r, n, l and b in the above equation. Further, since the 5% least significant difference (L.S.D.) is given, approximately, by

$$\text{L.S.D. } (.05) = 2\sqrt{2V_{\bar{y}}}$$

the effect of changes in row length, number of rows, and number of replicates may be obtained. Estimates of the L.S.D. for these trials under various conditions are given in Tables 1 and 2.

Note that in either trial there is little decrease in the L.S.D. as the number of rows is increased beyond 3. Note, also, that there is little change in the L.S.D. for row lengths greater than 5 meters.

Table 1. 5% L.S.D. for various row lengths, numbers of harvested rows, and numbers of replications in the small seeded trial.

No. of reps	No. of rows	Row Length: (m)	5% L.S.D. ($g/10m^2$) 1.0	2.5	5.0	10.0
2	1		1675	1199	931	723
	3		1088	779	605	470
	5		927	664	515	400
4	1		1185	848	638	511
	3		770	551	428	332
	5		656	469	364	283
6	1		967	692	538	417
	3		628	450	349	271
	5		535	383	298	231

Table 2. 5% L.S.D. for various row lengths, numbers of harvested rows, and numbers of replications in the large seeded trial.

No. of reps	No. of rows	Row Length: (m)	5% L.S.D. ($g/10m^2$) 1.0	2.5	5.0	10.0
2	1		1573	1177	1039	917
	3		999	748	660	583
	5		839	628	554	489
4	1		1112	832	735	648
	3		706	529	467	412
	5		593	444	392	346
6	1		908	680	600	530
	3		577	432	381	336
	5		484	362	320	282

Tables 1 and 2 may be used to estimate the number of replications, number of rows, and length of row required to attain a given accuracy. For example, suppose it is desired to have an L.S.D. no greater than $500g/10m^2$ in a trial with four replications. Based on data from the small seeded trial, this level of accuracy could be attained with one row 10 meters long, three rows 3 meters long, or five rows 2 meters long.

Plot technique studies on faba beans III: border effects for different plot designs

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An experiment was conducted in the 1978/79 season to study the effects of different field plot designs on the yield of the border and the next two inner rows when the adjacent plot was of the same or a contrasting genotype. Two genotypes were used in the trial: (A) a local Syrian, high yielding and highly branched *V. faba major* cultivar (ILB 1814) and (B) a shorter, lower yielding and less branched *V. faba minor* cultivar from Sudan (Hudeiba 72). Three designs were compared:

a. a single row was left unplanted between plots.
b. the plots were planted contiguously, without an empty row.

c. a single row of a third cultivar (ILB 1812; of intermediate growth habit and vigour) was planted between adjacent plots.

The length of the rows in the plots was 5 m and rows were planted 65 cm apart. At maturity the three rows under test (numbered 1,2 and 3 from the border) were harvested separately and the yield recorded (g/row). The trial layout is more fully explained in Table 1.

The trial was randomised in four replicates. In order to compare the yields of the different rows within each treatment, a split-plot analysis was used in which the 12 treatment combinations were assigned to main plots and the row positions were considered as sub-plot units.

Results and discussion

From the analysis of variance, the main plot effects, sub-plot effects and the interaction between them were all highly significant.

Table 1. Yield (g/row) of first, second and third rows in plots adjacent to the same or a contrasting genotype under different plot designs.

Main Plot Treatment*		Yield (g/row) Row No.1 (border row)	Row No. 2	Row No. 3
1	A-A	626	577	607
2	A-B	910	736	690
3	B-A	448	345	358
4	B-B	342	284	314
5	AA	642	674	685
6	AB	750	742	629
7	BA	351	347	309
8	BB	331	334	326
9	ACA	657	630	659
10	ACB	629	630	649
11	BCA	324	351	315
12	BCB	343	332	364

5% LSD for row positions within the same main plot treatment = 78.9 g.
*A = ILB 1814; B = Hudeiba '72; C = ILB 1812. The first letter indicates the genotype evaluated. The last letter indicates the adjacent genotype. A dash (-) indicates than an empty row was left between plots and the letter C indicates that a single row of a common entry (ILB 1812) was planted between adjacent plots.

The results, summarised in Table 1, indicated that when an empty row was left between plots (treatments 1 to 4) there were large differences between the yield of the row adjacent to the empty row and the second row. The differences were greatest when the adjacent plot was of a contrasting genotype. There were no significant differences, however, between the yields of the second and third rows. This result is consistent with the findings of Petersen *et. al.* (1980), and indicates that a single border row should be discarded from both sides of plots in yield trials in which there are gaps between the plots.

When no empty row was left between plots (treatments 5 to 8) there were no significant differences between the first and second row. However in the case where the vigorous genotype (ILB 1814) was directly adjacent to the weaker one (Hudeiba 72), there was a significantly higher yield in the first two rows of the former compared to the third row, (treatment 6). In all other treatments there were no significant differences between any of the rows. This trial design might thus be useful for comparing similar genotypes. When comparing contrasting genotypes, however, it may be necessary to discard more than one border row from both sides of each plot, a situation which would be impractical if seed supply were limiting.

In the plot design in which a single border row of a common cultivar of intermediate vigour was used to separate plots (treatments 9 to 12), there were no significant differences between the first second and third rows of either genotype tested. In trials in which contrasting genotypes are to be compared and in which seed or land are limiting factors, it may thus be best to plant a single row of a cultivar of 'average' growth habit between each plot. In this situation it should even be possible to get reasonably accurate data on single-row plots.

Reference:

Petersen, R.G., M.A. Omar and Geoff Hawtin (1980).'Plot technique studies on faba beans I. row length and border effects'. FABIS 2, 14.

Training of food legume researchers in the Near East and North Africa

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As noted in the last issue of FABIS (Hawtin and Stewart, 1979) there are many specific problems faced by faba beans trying to grow in the Near East and North Africa region. These include *Ascochyta* and *Botrytis* diseases, *Orobanche* infestations, insect pests(esp. aphids, *Sitona* weevil), weeds, drought, high temperatures, winter frosts and salinity. Added to these problems is the fact that in many countries of the Region there are insufficient numbers of research staff working among the relevant disciplines to enable the crop to achieve a greater success.

Manpower problems.

Table 1 shows the low number of researchers working with faba beans in several of the countries where large areas of the crop are grown. This is most clearly the case in Ethiopia, Morocco and Tunisia, and to a lesser extent in Algeria, Iraq and Syria. These countries appear to have the most urgent manpower needs of the region. Table 1 also shows that the number of research workers would be much lower were it not for three training courses concerned with faba beans which have taken place to date.

Past training for the Region.

As can be seen from Table 1, training in the Near East and North Africa region has in the past, apart from university courses, been largely organised and sponsored by outside organisations. To date, only three courses in the Region have attempted to satisfy the demand, or need, for trained faba bean researchers. The first was sponsored by the Arid Lands Agricultural Development program (ALAD) and began in 1974. The course was entitled 'Food Legume Training', and ran for two years. A total of 26 trainees from 13 countries in the region participated in the course, which was held in Lebanon and dealt primarily with the breeding of faba beans, chickpeas and lentils.

The second course was organised by FAO, and

Table 1. The number of participants attending recent food legume training courses in the Near East and North Africa.

Country	Area of faba beans[1] (ha)	ALAD[2] 1974	ALAD[2] 1975	DANIDA[2] /FAO	ICARDA[2] 1978/79/80
Ethiopia	220,300	1	1	(no data for individual countries)	1
Morocco	200,000	-	-		1
Egypt	104,700	2	2		2
Tunisia	62,700	-	-		4
Algeria	33,300	2	2		4
Turkey	32,000	2	1		10
Iraq	22,300	2	1		1
Sudan	15,300	2	1		4
Syria	7,000	-	-		11
Libya	5,000	-	-		1
Cyprus	2,300	1	-		-
Lebanon	1,000	-	-		3
TOTALS		12	8	16	42

[1] values are means of 1975, 1976 and 1977 figures in the FAO Production Yearbook, 1977.
[2] details of the three training courses are given in the text.

was supported financially by the Danish International Development Agency (DANIDA). The course was held over four months in 1975, and of the 10 countries represented by the course participants, four are major faba bean producing countries of the Region.

ICARDA's Food Legume Training Course is now in its third year. The course has concentrated on the three legume species faba beans, chickpeas and lentils. Of the 53 trainees who have attended the course, 30 came from the countries listed in Table 1, 17 concentrated on faba bean improvement, and all studied faba beans to some extent. The course has been organised in three main subject areas: crop improvement/breeding, agronomy and physiology, and field experimentation. Supporting subjects have included mechanisation, crop protection and communication and extension. During the course trainees have had discussions with the staff of the Farming Systems Research Program on the different approaches to agricultural research, the importance of studying individual crops as one component of a farming system, and the possible deficiencies in the existing structure and organisation of agricultural research in the Region.

Apart from these three courses, graduate training and research on faba beans has been held at some of the Region's universities, principally at the Universities of Cairo, Alexandria, Jordan and the American University of Beirut (AUB). Graduate training has also taken place elsewhere in the world for research workers based in the region. For example, scientists from the Sudan, Egypt, Ethiopia, Iraq and the Lebanon have studied at the Universities of Reading, Oxford, London and at PBI (Cambridge) in the UK, at INRA, Dijon in France, at the Universities of Wisconsin in the U.S.A. and Manitoba in Canada. There are several other institutes not mentioned here, and there are several researchers now working with faba beans in Region who completed higher degrees elsewhere in the world on other crops.

Major needs for training in faba bean research.

Faba bean research in the Near East and North Africa region is based on the traditional approach of studying one or two factors at a time. Often the researcher does not integrate his results and knowledge with all the other factors affecting the crop e.g. other crops in the farmer's rotation, economic and social advantages of one cultural practice versus another, the variability of climate, the effect of conducting research away from farmers' fields etc. We think, therefore, that major needs for training in the region are to give an appreciation of the importance of i) a well balanced approach to research ii) understanding the cropping systems and practices that farmers employ iii) recognising the limitations of research station studies. Within these areas the role of the national level communicator, extension officer and information officer is crucial. A holistic approach to research should be the basis on which the specific subject areas covered by training courses are built.

The specific subject areas where deficiencies in training are most acute in the Region are weed control, pathology and pest (including *Orobanche*) control. These are followed by breeding, seed technology and communication studies. In faba bean breeding there are needs for training in methodology, hybridisation techniques and breeding for resistance to insects and diseases. In many countries of the region there are marked deficiences in communication studies. Future training programs may do well to recognise this deficiency and incorporate discussions on the ways researchers can strengthen their links with other agriculturalists concerned with the crop. Links with scientists in other disciplines who are working on the same crop are often weak and need to be strengthened e.g. through FABIS.

There are other areas where there is clearly a need for training but where this is not as urgent as for those outlined above. These include microbiology, soil studies, genetics for breeders and anti-nutritional factors.

Future training.

Training in the future needs to be provided for the technical staff in all countries of the region, for research staff in most countries, and for communicators and seed production specialists in all countries of the region.

Training needs to concentrate on the specific subject areas outlined above. We think that training courses should:

i) emphasise the need for an integrated approach to agricultural research, so that the trainees are aware of the long term benefits of a multi-disciplinary approach to development.

ii) reflect the importance of communications between the researcher, the farmer, the extension worker and the information officer. If such communication is non-existant or clouded then not only can the results of research be doomed to get no further than the researcher's immediate sphere of collaborators, but the very assumptions on which that research is based can be inapplicable or can be over-simplications of farmers problems.

iii) be conducted increasingly at the national level so that they can address more directly the problems encountered in one country or in a small group of countries.

iv) deal increasingly with trials carried out on farmers' fields.

v) result in a network of ex-trainees throughout the Region who are aware of their own countries' problems in the perspective of those in the Region as a whole.

If anyone has any further information on training in the Near East and North Africa relevant to faba bean research, we would be pleased to hear from them.

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Faba bean wine

Recipe for a traditional Old English country wine:

Shelled green faba beans, too old and "black in the eye" for normal use	2 kg (4½ lb)
Chopped sultanas	250 g (9 oz)
Lemon	1
White sugar	1 kg (2¼ lb)
Water	4 litres (7 pts)

Cereal yeast and yeast nutrient (ammonium phosphate + vitamin B_1)

1. Boil the beans and the thinly pared lemon rind in the water for one hour, then leave to cool.
2. Strain the liquor on the chopped sultanas, add the lemon juice, nutrient and active yeast.
3. Ferment in a large covered vessel for five days, pressing the fruit down daily.
4. Strain out and press the sultanas, stir in the sugar, pour the mixture into a fermentation jar, fit an air-lock and ferment out.
5. Decant or syphon into a clear jar, add one crushed Campden tablet and when clear decant again.
6. Mature the wine for nine months before bottling and serve it cool and dry.

Based on a recipe in 'The Compleat Home Winemaker and Brewer' by Ben Turner, Emblem Books, 1976.

The divided world of V. faba

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It is by now well known that there are two big groups of varieties in *V. faba*: those well adapted to climates characterised by mild winters, short springs and long and hot summers, and those adapted to cold winters, rather long springs and short and fresh summers (we will not consider horticultural faba beans here). We will refer to the former as 'Mediterranean' and the latter as 'European' varieties. The border line crosses northern Spain, northern Italy and probably southern France with northwestern Greece and Yugoslavia lying north of this imaginary line. Good varieties from one group generally do not perform well when tested in the other region. To ignore this fact has produced some serious results such as the case of varieties registered in Cordoba in 1971 following direct importation probably from England or Germany.

To get more precise knowledge about the gap separating both groups, we conducted two trials using four Spanish selections (INIA 03,04,05 and 06), three 'European' popular varieties including two winter types (Maris Beagle and Cote d'Or) and one spring type (Maris Blaze), and also two *paucijuga* populations that can be classed in a third group ('Indian') because of their many primitive and special features (accession numbers VF 171 and 172).

In the first trial we tested the material at two dates of sowing, mid-autumn and mid-winter, and at two densities: low (5 plants/m^2) and medium (15 plants/m^2). Table 1 summarises the results. The two winter varieties did not yield when sown in February and one of them (Cote d'Or) did not even flower. Maris Blaze, when sown in November, did not yield badly at all. It is worth mentioning the big difference between densities in the February sowings in both the Medditerranean and Indian groups. The reason is probably an interplant 'protection', much stronger under harsh conditions than following autumn sowings.

Table 1. The effect of sowing date and plant density on the yield of different *Vicia faba* types.

Type	Sowing date: Plant density:	Yield (t/ha) November low	November medium	February low	February medium
Spanish		4.9	5.8	1.1	2.2
M. Blaze		3.0	3.8	0.1	0.3
Winter types		0.6	0.6	-	-
Indian		1.0	2.2	0.2	1.2

The second trial was, unfortunately, sown on only one date, in the second half of December. As a result, the yield of the European types was lower than that expected from the results of the first trial particularly for Maris Blaze. Nevertheless, the results are interesting because to combat *Orobanche crenata* we need to sow as late as possible. Fig. 1 shows the big differences in yield obtained. Just one month's delay in the date of sowing produced a drop in yield for Maris Blaze from 3-4 t/ha to 0.5-1 t/ha.

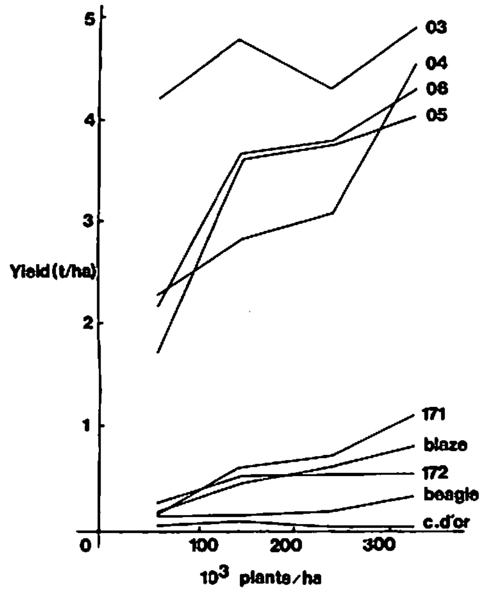

Fig.1. The effect of plant density on yield for nine *Vicia faba* selections.

Perhaps this dramatic dependance on early sowings could be the best characterisation of the 'spring wing' of the European group, that of the 'winter wing' being the complete lack of adaptation to the Mediterranean conditions.

Requirement of both cold and day length have to be present in these responses. The Indian group is better defined by its primitive characteristics rather than by its response to both date and density of sowing. However, it is interesting to mention that it is a really miserable looking plant at low sowing densities.

All these factors are important when breeding under our conditions. European varieties have more flowers per node, less branches per plant, a more suitable architecture for mechanical harvesting and a high yield potential, among their most useful characteristics. But the strict dependance on the date of sowing, the height and the broad leaflets, not to mention the long period required to reach full maturity, make them inconvenient. Indian types are very self-fertile but useless for agronomic purposes. Mediterranean varieties have convenient height and leaflet shape, indehiscence and most important, they are well adapted. Plant breeding will work.

The genetics of the resistance of faba bean to *Orobanche crenata*

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The genetics of the resistance of faba beans (*Vicia faba*) to broomrape was studied by means of a 6 x 6 diallel cross following the analysis of Hayman (1954 ; 1954a). The lines used in these studies included two resistant/less susceptible *paucijunga* lines (accession Nos 171 and 172) and four clearly susceptible lines, two *equina* (Nos 168 and 169), one *minor* (No. 166) and one *major* (No. 165).

Observations were made on F_2 plants, the 30 crosses (maintaining reciprocals differentiated) and the six parental lines being randomised in four replications. Twenty plants of each F_2 were sown and the number of broomrapes per host plant was recorded on each of the 10 central plants of each row. Previous studies have shown that for this character mean and variance are correlated. The transformation giving the best non-correlation between these statistics is log (x + ½), so each result was transformed in this way.

The W/V plots for each of the four replicates showed a large environmental effect, a result in agreement with earlier data (Cubero, 1973; Cubero and Moreno, 1979). The parental lines were scattered in the graphs and in general the regressions were not significant. However, when the results of the four replications were pooled a clearer picture emerged; the slope of the W/V regression line was significant and was not different from unity. (Fig. 1). The two *paucijunga* lines were in the zone of the recessives and the susceptible parents in the zone of the dominants. The analysis of variance showed strong additive effects, with dominance effects being almost non-significant. No maternal affects were detected.

These results, together with the degree of dominance (0.62) and the heritability in the broad sense (0.76), suggest that the genetic system controlling the number of broomrapes per plant (with the data transformed as indicated above) gives a rather low partial dominance, with resistance being recessive.

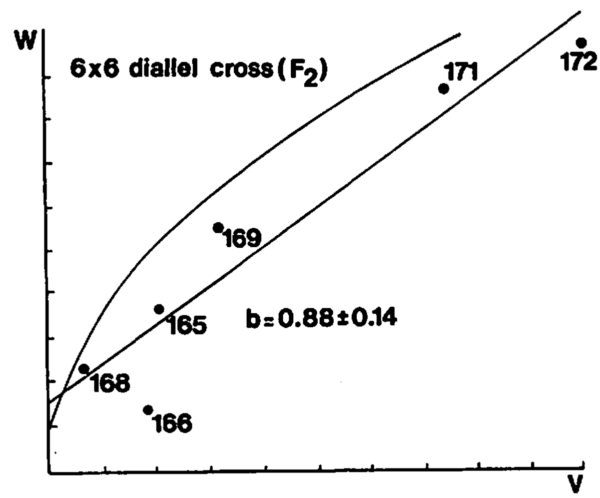

Fig.1. W/V regression line for six *Vicia faba* lines.

Good agreement with these results has been reported by Suso (1980) who used a 8 x 8 F_1 diallel cross including six *major* and two *equina/major* lines. The heritability, however, was lower (0.10), probably due to the narrower genetic base of the material. Large additive and environmental effects, dominance which was almost non-significant (degree of dominance 0.59) and lack of reciprocal differences were also recorded.

It is interesting to consider the effects of scaling on the genetic interpretation of the data. When non-transformed data were analysed, both additive and dominance effects were detected, the degree of dominance being close to one. More importantly, the W/V plot suggested dominance of resistance, this being reported in a previous paper (Cubero and Moreno, 1979). Different conclusions were reached after the logarithmic transformation which was carried out because of the observed mean-variance correlation. This can be explained by the scaling effect itself (Mather and Jinks, 1971), the removal in the transformed analysis of one of the parents from the original 7 x 7 diallel (reported by Cubero and Moreno, 1979) because of its abnormal behaviour, and/or by the fact that the order of dominance can be more apparent than real when the genetic system is one of almost intermediate inheritance. The order of dominance, in any case, is very dependent on the scale of measurement on the one hand and on the presence or absence of one parental line on the other. The scale of measurement needs to be very clearly defined.

It is clearly important to use as many replications as possible, this being the most practical way of controlling, or rather pooling, the large environmental effect. This gives us one more difficulty when breeding for resistance to *Orobanche*.

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A brief note on yield stability and 1000 grain weight in Vicia faba

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Results have been collected during 15 years out of 21 for three faba bean varieties on the French list, grown in the same trials at the same location (Rennes Plant Breeding Station). Table 1 shows the grain yields (15% humidity) and 1000 grain weight for these varieties (Ascott, Columba and Strube). The correlation between the two sets of data have been studied (Fig. 1) and the results show that the three varieties fall into two groups:

Ascott and Columba: r values 0.79 and 0.83 (significant at the 0.001 level) respectively. About two-thirds of the yield varience can be explained by the variation in 1000 grain weight.

Strube: r = 0.58 (significant at the 0.5 level). Only a third of the yield variance can be explained by the variation in 1000 grain weight.

1000 grain weight is easier to estimate than yield (requiring a smaller amount of seed, less space, less work, less time), so if the 'Ascott and Columba group is sufficiently common, then the breeder can in one year hope to have initial information about yield stability through measurement of 1000 grain weight at a number of very different locations, and using a minimum number of seeds. Perhaps there are results already available at different institutions which can confirm or refute this correlation between yield and 1000 grain weight for a given genotype.

Table 1. Yields and 1000 grain weights of three varieties of *V. faba* from 1957 to 1977.

Year	Columba		Ascott		Strube	
	Yield (q/ha)*	1000 grain weight	Yield (q/ha)	1000 grain wt.(g)	Yield (q/ha)	1000 grain wt.(g)
1957	12.6	264	10.4	268	26.5	414
1958	28.1	383	32.4	445	37.6	673
1959	28.5	426	34.6	467	37.6	681
1961	37.4	408	43.7	464	48.3	774
1964	45.1	442	50.4	545	59.6	762
1966	50.3	390	57.0	458	64.5	578
1967	25.9	356	39.2	418	36.5	527
1968	44.0	424	47.1	508	50.9	672
1971	27.7	319	36.7	355	41.5	470
1972	27.5	368	33.5	408	38.4	562
1973	50.9	478	47.6	503	49.5	726
1974	21.8	282	37.5	394	28.6	473
1975	34.5	344	39.4	439	35.3	613
1976	6.7	276	10.7	365	11.7	525
1977	37.9	358	44.8	461	47.1	616
Mean	31.9	368	37.7	434	40.9	604

*q = quintal = 100 kg.

International faba bean germplasm collections at ICARDA

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Base collection

The international faba bean germplasm collection maintained at ICARDA currently comprises 1931 accessions from 50 countries (Table 1). The collection includes both material collected in the field, primarily from the West Asia and North Africa regions, and certain entries from germplasm collections maintained elsewhere including:

Manitoba Collection; University of Manitoba, Winnipeg, Canada
ICA Collection; Bogota, Colombia
INIAP Collection; Quito, Ecuador
ARC Collection; Giza, Egypt
National Collection; Holetta, Ethiopia
Hohenheim Collection; Stuttgart, Germany
N.C.R. Collection; Germplasm Laboratory, Bari, Italy
National Collection; Cordoba, Spain
PIC Collection; Menemen, Izmir, Turkey
PBI Collection; Cambridge, U.K.
USDA Collection; Pullman, Washington State, USA

As can be seen in Table 1, material from most faba bean producing countries is represented in the collection. The most notable exception is China which has by far the largest production but is represented by only nine accessions. Latin America is also poorly represented with no accessions from Brazil, Dominican Republic, Guatemala or Paraguay and only a few from Argentina, Bolivia and Peru.

Table 1. Origins of accessions in ICARDA faba bean germplasm collection and area under production in various countries.

Country	No. of accessions	Area* under faba beans 1977 (1000 ha)	Country	No. of accessions	Area* under faba beans 1977 (1000 ha)
Afghanistan	98	n.d.+	Lebanon	30	1
Algeria	21	35	Libya	-	5
Argentina	1	1	Malta	-	1
Australia	2	n.d.	Mexico	1	50
Austria	1	n.d.	Morocco	15	190
Bangladesh	2	n.d.	Nepal	1	n.d.
Bolivia	1	11	Pakistan	7	n.d.
Brazil	-	195	Palestine	7	n.d.
Canada	2	n.d.	Paraguay	-	10
China	9	4000	Peru	2	20
Colombia	14	n.d.	Poland	12	n.d.
Cyprus	-	3	Portugal	5	38
Czechoslovakia	-	23	Spain	77	96
Dominican Republic	-	7	South Africa	1	n.d.
Ecuador	13	14	Sri Lanka	2	n.d.
Egypt	57	102	Sudan	35	16
Ethiopia	370	271	Sweden	10	n.d.
Finland	11	n.d.	Switzerland	1	n.d.
France	9	19	Syria	62	9
Germany D.R.	-	6	Tunisia	49	64
Germany FED	257	8	Turkey	120	30
Greece	25	11	U.K.	88	40
Guatemala	-	18	Uruguay	1	n.d.
Holland	33	n.d.	USA	2	n.d.
Hungary	10	n.d.	USSR	21	n.d.
India	9	n.d.	Yemen	6	n.d.
Iran	13	n.d.	Yugoslavia	14	n.d.
Iraq	57	29	N. Europe	82	-
Italy	48	163	Unknown	192	-
Japan	5	2			
Jordan	18	n.d.			
			TOTAL	1931	

* From FAO Production Yearbook, 1977.
\+ n.d. = no data available.

There are two main problems in handling germplasm of faba beans: the large seed size of many accessions (up to nearly 2 kg per 1,000 seeds) and the high level of out-crossing. In view of the small number of accessions in the collection, compared to many other crops, the problem of seed size is not so acute, although it is clearly impractical to maintain a base collection of 12,000 seeds per entry as recommended by Hawkes (1976) for highly heterogeneous samples. ICARDA currently maintains 1½ - 2 kg of seed of each entry. At present no long-term storage facilities are available but it is planned to develop these in the near future. A duplicate set of most of the accessions have been sent to Bari, Italy for storage.

Out-crossing poses a number of problems. Many of the accessions received from collections elsewhere have not been maintained under strict selfing conditions and are highly heterogeneous. In many cases samples of the same cultivar sent from different sources are clearly different as a result of out-crossing and are maintained at ICARDA as separate accessions in the collection. It is seldom possible to eliminate duplicates within the collection by combining material from different sources.

Another problem which arises as a result of the high level of out-crossing is the maintenance of the collection. After a few generations of seed increase under open field conditions the seperate identity of each line would be lost, and thus increase has to be carried out in isolation plots, in insect-proof screen cages or through bagging individual plants.

In view of these problems, ICARDA's strategy on handling the faba bean germplasm is to increase all new accessions under controlled pollination and to store up to 2 kg of seed of each accession. This forms the base collection, referred to in ICARDA as the ILB collection (ILB = International Legume Bean collection). Frequent seed increases are avoided to reduce genetic drift.

Working collection

From one to four single plants are selected in each accession, depending on the heterogeneity, and their progenies grown in seperate rows the following season in the screen house. These are subsequently maintained in a second collection which forms the breeders' working collection (the BPL collection) and is used as the basis of all germplasm evaluation work. The entries in this collection are increased each year from a single representative plant selected the previous season. Thus after several generations the lines can be regarded as essentially pure. Although the genetic variation within each line is limited, which greatly facilitates the identification of desirable characters, the variation between lines selected from a single ILB accession is maintained. The total range of genetic variation within the pure-line collection, however, will be less than in the base collection. It may sometimes be necessary to return to the base collection if the desired characteristics are not found in the pure-line collection.

The pure line collection now contains 2466 entries, but this number is expected to increase substantially in the future.

Small samples (10 - 20 seeds) are available from both collections on request, but in view of the problem of genetic drift and the need to maintain large samples in the base collection, we prefer to distribute seeds only from the pure-line collection.

Lists of the germplasm at ICARDA are being prepared and will be available soon. ICARDA would also be very pleased to receive new material from any reader, particularly from those countries which are not currently well represented in the collection.

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Faba bean breeding in Manitoba

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Interest in faba beans in Manitoba, Canada, began with the introduction and observation of two European cultivars in 1969. Their obvious potential coupled with the dramatic increase in vegetable protein prices in the early 1970s led to the commercial production of fababeans in 1972. Although production has declined somewhat from the 6000 ha in 1973 there is still considerable interest in the crop both for grain and for silage.

During the period 1970-73 a large number of cultivars and accessions were introduced and tested. The most promising were evaluated in a National Fababean Co-operative Trial co-ordinated by the Department of Plant Science at the University of Manitoba and conducted at approximately twenty locations each year. On the basis of the results, four European cultivars - Ackerperle, Diana, Erfordia, and Herz Freya - were licensed in 1973 and 1974. With the exception of Erfordia, which was found to be susceptible to disease, these cultivars are currently recommended for production in western Canada. These cultivars are all protected by breeders' rights and the distribution rights have been granted to Canadian agents by the originating institutions.

Although these cultivars have enabled us to produce and utilise a faba bean crop, drawbacks such as late maturity, shattering, and disease susceptibility, when coupled with the inherent hazards of importing seed, illustrate the necessity of developing Canadian cultivars.

A breeding program, supported by Agriculture Canada through the New Crop Development Fund, was initiated at Manitoba in 1973 with the aim of developing cultivars better suited to local conditions which could be an economic "home-grown" protein source. The major objectives of this breeding program have been to improve maturity, reduce shattering, decrease seed size, and improve disease resistance while improving or at least retaining yield and protein levels. Recently the deleterious effects of condensed tannins in the seed of this crop have been verified and their elimination is now an additional major objective.

Varietal Introduction and Selection.

A major prerequisite for a breeding program is genetic variability. To provide this a collection of 468 strains of fababeans was introduced, quarantined, purified, and evaluated for the characters previously outlined as desirable in a new cultivar. In addition to the already licensed cultivars many other selections from these introductions are currently being evaluated for possible release as cultivars. This material has also served as the basis for hybridisation.

Co-operative Testing.

A national testing program was initiated in 1971 and expanded to include up to twenty-four locations per year from 1973 to 1977. Prior to 1975 the co-operative tests included only introduced material but by 1976 all entries were derived from the local breeding program. In 1977 a selection from an introduction, designated as UMFB-9, was supported for licensing on the basis of data similar to that of Table 1 as summarised from co-operative tests. Although this selection may be the first Canadian fababean cultivar, varietal hybridisation is expected to be the source of future improved cultivars.

Table 1. Comparison of the performance of four *Vicia faba* varieties*.

	Variety:			
	UMFB-9	Ackerperle	Diana	Herz Freya
Yield (kg/ha)	2961	2587	2475	2651
1000 seed wt. (g)	346	343	376	373
Protein content (%)	29.5	29.4	30.6	29.0
Avge. days to maturity	93	97	93	92
Lodging range (0 to 9)	2.8-6.0	1.5-4.6	1.8-2.6	1.8-4.0
Height (cm)	87.1	85.9	84.4	92.5

*data taken over 20 station years, 1973-76, at Manitoba and Saskatchewan.

Varietal Hybridisation.

Hybridisation began in 1972 and to date in excess of 100 crosses have been made with the following objectives: increased yield, reduced time to maturity, reduced shattering, reduced seed size, improved disease resistance, reduced tannin levels, and higher protein content. The ultimate objective would be to combine an optimum level of each characteristic in a single "super cultivar" although such a utopian situation is unlikely to occur. Tables 2 and 3 indicate the improvements already obtained.

Table 2. Comparison of five F_4 lines with Diana.

	Agronomic characters in ± units relative to Diana					
Line	Yield as % Diana	1000 seed weight (g)	Height (cm)	Lodging	Days to Maturity	Protein (%)
514063	128	-44	±0	-1	-8	-0.4
515083	102	-35	-10	+1	-12	+1.4
515086	122	-60	-15	+2	-7	-2.6
515191	88	+29	-10	-2	-1	-4.0
515143	77	-133	-25	+3	-12	+1.8

It is clear from Tables 2 and 3 that the desired improvements are possible but the incorporation of all the attributes into a single line will require considerable time and effort.

Table 3. Comparison of five F_5 lines with Diana.

Line	Yield as % Diana	Agronomic characters in ± units relative to Diana: 1000 seed weight (g)	Height (cm)	Lodging	Days to Maturity	Protein (%)
515063	124	-62	+2	±0	-4	-2.4
515068	137	-15	+16	+1.6	+5	-0.2
515165	86	-68	+17	+2.5	-5	-1.2
515024	93	-94	±0	-1.0	-1	-2.4
515139	100	+99	+3	±0	+3	+1.6

Breeding Methodology.

In dealing with a new crop it is necessary to establish breeding procedures best suited to that crop. This section briefly describes some of the numerous aspects that have been or are being investigated.

The seed, larger than all cereals or legumes previously grown and requiring a greater depth of seeding, necessitated the design and construction of specialised seeding equipment. Plot design and handling in terms of harvest, drying, and storage had to be developed and tailored to fit this crop.

Hybridisation techniques are similar for most crops; however, each technique is unique. Methods including both hand manipulation and controlled insect pollination under isolation cages have been developed, permitting efficient production of segregating material. Simultaneously, greenhouse and growth room conditions that would facilitate adequate growth and seed production have had to be elucidated. Once the hybrid seed is produced, the segregating generations are evaluated. In Canada, this means one field generation per year. To advance segregating material rapidly, winter nurseries are usually employed. Several locations, including Southern California, Mexico and Hawaii have been examined. Hawaii produces the best quality and quantity of seed in time for spring planting in Manitoba.

Other areas being investigated include the development of pure line genetic stocks for inheritance studies; screening methods for characters such as disease resistance, seed coat thickness, and tannin levels; establishing useful selection criteria such as pod density and distribution indices; yield testing of early generation material.

In terms of a breeding program, ten years is a very short time even with an established crop. With a new crop it is obviously just the first chapter.

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Faba bean breeding in the Netherlands

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Faba beans (*Vica faba*) could be an important crop in the Netherlands for several reasons:-

a. the high protein content of the seed - if faba beans were grown on a large area the importation of protein in the form of soya beans could be reduced.
b. energy can be saved by the N fixing *Rhizobia*.
c. the crop can improve the usual narrow crop rotation system.
d. the faba bean stubble can be important for the following crop.
e. the crop can be easily grown by the farmers; planting, weed control, harvesting can all be done using the machinery already available on the farm.

Farmers' interest in the crop is at the moment low. The most important reason is the instability of yield, which can vary from 2500 to 6000 kg/ha. In years when there is a shortage of imported protein, legumes are used as a substitute crop, but the farmer must then be protected against low yields and a low price for the product. The first character may be overcome by plant breeding; the second is a question of politics. An increase in the breeding effort is one of the most important ways of increasing the value of faba beans.

In the Netherlands the following characters are important in a breeding program:

a. tolerance to early sowing.
b. rapid early growth.
c. two stems per plant developing at the same time.
d. stems strong enough to avoid lodging.
e. early flowering.
f. early pod setting.
g. first pod setting at a height of 20 to 25 cm above the soil surface, to avoid losses during mechanical harvesting.
h. concentrated pod setting - a limited number of fertile internodes with a high number of pods per node and sufficient seeds per pod.
i. pods parallel to the stem.
j. limited stem length.
k. high percentage of selfing.
l. tolerance to various environmental characters.
m. resistance to diseases and pests.
n. non-shattering pods which still can be easily threshed.
o. seed size giving 1000 kernel weight of around 800 g.
p. low tannin content.

It is not clear what the reasons are for the fluctuation in yield, and more research is needed in this field. Due to the small amount of research in the last 10 years no new genetic material has found its way into the agricultural sector. Little attention has been paid to resistance to pests and diseases. More intensive studies should also be made into *Rhizobia*, and their optimum N fixing ability. More fundamental work should be done through close co-operation between microbiologists and plant breeders.

Of all the legumes tested in the growing conditions of Western Europe, faba beans (*Vicia faba*) appears to be the most promising source of protein for animal feed. Yields of around 6 to 7 ton/ha have already been realised with existing varieties. Increasing the level and stability of the yield seems to be the best ways of securing the future of the crop. It is necessary to combine the efforts in both plant and bacteria breeding. Results from such programs cannot be realised rapidly. Long-term research and international co-operation in this field are therefore of great importance.

A cross breeding program for faba bean (Vicia faba)

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In order to enrich the useful variability in faba bean, crosses were made among stocks from the following parents:

1. Subspecies *paucijunga*
2. Subspecies *eu-faba*
   - minor sorts; the varieties Diana, Herra, Kristall and Nixe from West Germany and the line C5 from Egypt (of Ethiopia origin).
   - *equina* stocks: the variety Giza 2 and line C (both from Egypt).
   - *major* varieties: Hedosa, Staygreen, Trio and Tuinbonen from West Germany and the Netherlands.

In this program selections are made under different environments and two generations are grown each year. A winter generation is grown in Egypt, a summer one in West Germany. Selections at different locations and in different environments may contribute to better yield stability by the development of 'stocks' minimally affected by environmental fluctuations.

So far, different F_2, F_3 and F_4 populations have been raised during the 1977/78 and 1978/79 seasons (and later generations are being tested at present). Selections have been made on different faba bean populations, some of which were grown both on one side and on both sides of the ridge. Yield data were obtained from individual plants as well as from bulk material on a plot basis.

The yields per plant sown on one side and those sown on both sides of the ridge showed a significant positive correlation (r = 0.59). This suggests that both methods of sowing can be used in experimental work. However, a 'plant' on both sides of the ridge produced an average 80% of the yield of a plant grown on one side only. Some of the populations produced equal yields per plant when grown either on one or on two sides of the ridge. However, with other populations growing plants on two sides of the ridge reduced yields by half compared to plants grown on one side only.

The association between the yield character per plant from samples picked individually at random and the plot yields themselves was relatively strong. This was noted with both sowing methods. The correlation coefficient values of individuals and plot yields ranged from 0.40 to 0.61 throughout the experiments.

Selecting the selectors

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It has often been said that plant breeding is a 'numbers game', and from purely genetic considerations it would appear important to grow large populations of as many crosses as possible in segregating generations in order to maximise the chances of obtaining the desired recombinants. This is particularly true when trying to improve a composite character such as yield which may be controlled by genes at a very large number of different loci. The main problem which arises in attempting to handle large numbers in a breeding program is the ability of the breeder to identify the desired types. Many scientists, working with various crops, have attempted to find characters which are closely correlated with yield, but which are more easily used as the basis of selection. In many legumes the character 'pods per plant' is the one most closely correlated with yield, but using this as the basis of a single plant selection is almost as difficult as selecting for yield itself.

A trial was conducted at the ICARDA farm at Tel Hadya in the 1978/79 season to determine how accurately different people could select single plants in F_3 bulk populations on the basis of a quick visual yield assessment. Nine people, including the authors, who were familiar with faba beans to varying degrees, were each assigned two different F_3 populations of about 450 plants each and asked to choose the 20 highest yielding plants from within each population. This 'eye ball' selection was to be only for yield per plant, as a visual estimation taking into account pods/plant, pod size etc.

A time limit of 5 min. per population was allowed, the selected plants being tagged. A prize of a bottle of whisky was offered to the best selector. Each plant was then harvested and threshed individually and the seed yield recorded. The mean yield of each population, the mean yield of the 20 selected plants and the standardised difference between the two means were then calculated.

The latter figure was used to determine the winning selector as it reduced the effects of differential population variances. A further measure of the accuracy of visual selection for single plant yield was determined by the percentage of the plants selected which were within the top 15% of the whole population. The results are given in Table 1.

Table 1. Accuracy of visual selection of single plants for yield in F_3 populations by different selectors. Mean of 2 populations per selector.

Selector	A Pop. Mean Yield (g/plant)	B Selected Plants Mean yield	Stand. diff.* between A and B	% selected plants in top 15% of pop.
1	24.6	43.9	1.97	78
2	26.0	42.8	1.86	66
3	24.6	40.1	1.48	64
4	20.1	37.2	1.40	61
5	28.6	46.8	1.39	49
6	24.9	41.5	1.28	64
7	19.7	28.2	0.76	40
8	26.6	34.2	0.60	27
9	19.2	23.8	0.53	32

*Calculated as:

$$\frac{\text{Selected plants mean yield - population mean yield}}{\text{standard deviation of whole population}}$$

It can be seen that several of the selectors were able to select single plants on the basis of a visual estimate of yield with reasonable accuracy. Those who were most familiar with the crop were the more accurate, although it appeared that relatively little exposure to the crop might be necessary in order to become a good selector. The prize was retained by one of the authors!

Tetraploid plants from Vicia faba and Vicia narbonensis using colchicine treatments

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The aim of this work was to obtain hybrids from *V. faba* and *V. narbonensis* for use in a breeding program to give resistance against *Botrytis fabae*.

Mature seeds were used throughout, and treated seeds (50 per treatment) were rinsed in tap water and sown in a mixture of sand and mould in the glasshouse. The first trial was carried out with the spring *V. faba* cultivar 'Herra' and the *Vicia narbonensis* cultivar 'France'. The two treatments were as follows:

- seeds were soaked for 48 hours in 2.5, 5 and 10% aq solution of colchicine.
- seeds were soaked in water, dehulled then soaked for 24 hours in 1.25, 2.5 and 5% aq solution of colchicine.

These conditions are similar to those used successfully for other species, but here there was no germination.

. In the second and third trials the field bean cultivars 'Herra' and 'Ascott' and the *V. narbonensis* selections 'France' and 'Palerme' were used respectively. After 24 hours in water seeds were soaked from 12 to 24 hours in aq solution of colchicine at various concentrations. The results are presented in Table 1.

The results of the second trial are as follows:

- colchicine delays and reduces germination. *V. faba* was particularly susceptible, this being confirmed by the third trial.
- it was not useful to check chromosome number on root tips of plants whose seeds had been treated, as the plants can be chimerae (some tetraploid plants were obtained with plants whose controlled roots were diploid). Observations must be made on the first generation (after selfing) plants as well as at each generation because aneuploids may appear (e.g. *V. narbonensis* with 4n = 27 and *V. faba* with 4n = 25).
- not all the flowered nodes of a single 'treated' plant gave tetraploid seeds.
- the pollen of the nodes which gave tetraploid plants, was mostly triangular ans larger than the pollen of diploid *V. faba* or *V. narbonensis*. This has also been observed by Rybin (1939) and Poulsen (1977). Such pollen was not very fertile particularly with the vetch, although selfing could be achieved. It was also observed that the tetraploidy was generally associated with a high number of chloroplasts in substomatal cells in the lower epidermis of leaves (about 35 as opposed to 20). This phenomenom was also observed in another species (*Beta vulgaris*).
- the only tetraploid faba bean obtained was male sterile. By chance we had seed of the tetraploid Po. 1 found by Poulsen (1977) in the 'Primus' mutant, and we crossed the two tetraploid plants. The F_1 was fertile. The agronomic effect of polyploidy on these plants was not studied because they were hybrids.

Table 1. Effect of colchicine treatments on *Vicia faba* and *Vicia narbonensis*.

	Colchicine concn. (% aq soln)	2nd Trial *V. faba* cv. 'Herra'		2nd Trial *V. narbonensis* cv. 'France'		3rd Trial *V. faba* cv. 'Ascott'		3rd Trial *V. narbonensis* cv. 'Palerme'	
		a*	b*	a	b	a	c*	a	c
12 hr	0.75	1	0	2	0				
	0.50	0	-	11	3	0	-	26	3
	0.25	0	-	30	1	0	-		
	0.125	17	1	43	1	2	0		
	Control	31	0	48	0	43	0	47	0
24 hr	0.75	0	-	2	0				
	0.50	0	-	4	1	0	-		
	0.25	0	-	16	0	0	-		
	0.125	6	0	37	1	4	0		
	Control	30	0	47	0	36	0		

*a = number of germinated seeds (out of 50).
b = number of plants giving tetraploid offspring.
c = number of plants showing indications of tetraploidy.

The third trial sought to confirm these results. Only three plants of *V. narbonensis* showed triangular pollen and a high number of chloroplasts. The offspring have not yet been sown.

Interspecific crosses have been made with all combinations between tetraploid and diploid *V. faba* and *V. narbonensis* without any success. Howbever, it must be noted that even after self-pollination the tetraploids are not very fertile and there is not much pollen available for cross pollination, particularly in the case of the narbon vetch.

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Hybridisation techniques for crossing in faba beans

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Studies were conducted in the 1978/79 season at the ICARDA site near Aleppo, Northern Syria, to determine the best time of day for making crosses. Other aspects of crossing technique were also investigated in an initial attempt to develop methods to maximise crossing efficiency.

Crosses were made under open field conditions by hand. The female flowers were emasculated in the late bud stage, prior to dehiscence of the anthers, by slitting the dorsal surface of the flower with fine forceps, holding the slit open and removing the anthers with the forceps. The emasculated flowers were then pollinated immediately by transferring pollen from freshly dehisced anthers of the male flower to the stigma. No petals were removed from the female flower and they were returned back to their normal position following pollination to protect the stigma. No efforts were made to prevent further uncontrolled crossing by insects. However, in crosses where marker genes were present there was evidence that the level of both selfing and natural out-crossing was very low following hand crossing and for the purpose of these studies was disregarded. The percentage of pods set per emasculation and pollination was used as the criterion for estimating crossing success.

Time of day

A study was made on 12 crosses in which a total of 2,245 flowers were pollinated. Crosses were made during three time period: early morning (8.00-10.00 hrs), late morning (10.00-12.00 hrs) and afternoon (13.00-15.00 hrs). The results are summarised in Table 1. The time of day significantly affected the success in crossing, with the greatest success rate (61.8%) occuring in the afternoon and the lowest (44.5%) in the early morning. Crosses made during the late morning (10.00 to 12.00 hrs) were intermediate (55.8% success). Of the 12 crosses studied, 9 had the highest success in the afternoon period and the remaining 3 were most successful in the late morning. In no cross was the greatest success recorded in the early morning period.

Table 1. The effect of time of day on the percentage success of hand crossing.

Time of day	Total pollns* made	Mean pollns per cross	Mean pods set per cross	% Success**
08.00-10.00 hrs	695	58	25.8	44.5
10.00-12.00 hrs	775	65	36.3	55.8
13.00-15.00 hrs	775	65	40.2	61.8

*pollns = pollinations
** measured as $\frac{\text{pods set per cross}}{\text{number of pollns per cross}} \times 100$

Methods of emasculation

Of a total of 572 emasculations and pollinations, in four crosses, half were carried out using the method described above, and in the other half the petals of the female flower were all removed prior to emasculation. Over all crosses, the method in which petals were not removed resulted in a 24% increase in a success compared to the method in which petals were removed. In one cross out of the four, however, a higher success was achieved by the second method.

Effect of seed size

A total of 1698 pollinations were made in 12 crosses. Parents having different seed size (var. *major* and var. *minor*) were included and the reciprocal crosses were also made. Of the 24 cross combinations (including reciprocals) six were *major* x *major*, five *major* x *minor*, five *minor* x *major* and eight *minor* x *minor*.

Over all crosses, those in which the females were small seeded (13 crosses) were 15% more successful (45.1%) than those (11 crosses) in which the females were large seeded (39.2% success). Considering only the five crosses between large and small types and their reciprocals, however, the opposite picture emerged and those in which the large-seeded parents were the females were on average 17.4% more successful. Thus it is not possible to draw any firm conclusions from this trial as to the relationship, if any, between the seed size of the female parent and success of crossing.

The contributions of M. Foleh, M. Saleh and A. Abu Zeid to these studies is acknowledged.

Breeding for many small seeds per pod in Vicia faba

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It has been shown earlier (Poulsen, 1977) that within the small seeded botanical variety of field beans (*Vicia faba minor*) an increased number of seeds per pod showed a strong negative correlation with the duration of the post anthesis growth phase, and in particular that part of the phase relating to the indeterminate growth habit of the plant. At the same time the number of seeds per pod was found to be slightly positively correlated to seed yield. Similar relationships are known from work on cowpeas (IITA, 1974). These findings indicate that the characteristic number of seeds per pod may provide a tool for breaking the negative relationship between seed yield and earliness in ripening generally found in field beans.

It is well known that the variation in number of seeds per pod available for selection is much smaller in field beans than in broad beans (*Vicia faba major*). In field beans the maximum number of ovules per pod is four to five, whereas in broad beans, genotypes exist with up to nine ovules (seeds) per pod. Thus within the species as a whole there is a strange positive correlation between the two yield components, number of seeds per pod and weight per seed. The work described here was initiated with the aim of increasing the number of seeds per pod while maintaining the low seed weight of the field bean type. This first report deals with the variations in, and the relationships between, ten characters in a F_2 population after intercrossing broad beans and field beans.

Materials and methods.

In 1976 approximately 200 broad beans (c.v. 'Gillets Imperial Longpod'), with a generally determined high number (seven to nine) of ovules per pod, were used as guard plants in a field experiment with field beans. The offspring of the broad beans were sown and open pollinated in 1977. In this population a large number of F_1 hybrids from broad and field beans originating from 1976 pollination appeared. These hybrids were distinctive, with pod and seed characters intermediate between those of the broad bean and field bean respectively. They were harvested separately, bulked and yielded approximately 15 kg F_2 seeds (approx. 20,000 seeds). In 1978 these seeds were sown in rows 50 cm apart with approximately five plants per meter row. To assess the variation, 50 one meter rows containing 245 plants were chosen at random in which the following characters were examined:-

- number of nodes before first podded node
- length of pod (cm)
- number of ovules
- number of seeds
- weight of seeds (g)
- weight of pod walls (husks) (g)
- pod length per ovule
- pod length per seed
- pod wall weight per seed
- seed weight (g)

The fruit characters were measured on the longest pod only. All weights are based on dry matter. The variation in, and the phenotypic correlation between, the characters were calculated.

Results and discussion.

The means and variations in the characters measured are shown in Table 1. These data show that the population is characterised by a very wide variation in all morphological fruit characters. The population covers the full range of the species, from the small seeded tick bean to the large seeded broad bean.

Table 1. Range, mean and standard error (S.E.) of mean for characters measured on 245 F_2 *Vicia faba* plants from crosses between *Vicia faba major* and *Vicia faba minor*.

Character	Range	Mean	S.E.
No. nodes before first podded node.	2-10	4.6	±0.08
Pod length (cm).	8.3-22.7	14.2	±0.19
No. ovules per pod.	4-9	6.1	±0.06
No. seeds per pod.	2-9	5.7	±0.07
Yield per pod (g).	1.9-14.1	5.2	±0.12
Pod length per ovule (cm).	1.4-3.8	2.3	±0.02
Pod length per seed (cm).	1.4-6.0	2.5	±0.04
Pod wall weight.	0.13-3.93	1.34	±0.037
Pod wall weight per seed.	0.02-0.54	0.24.	±0.006
Seed weight.	0.37-1.77	0.91	±0.016

Phenotypic correlation coefficients between the studied character are given in Table 2, which shows that the number of nodes before the first podded inflorescence was not correlated to any of the fruit characters. Of the fruit characters the length of the pod was positively correlated to all other characters. The number of the ovules per pod was correlated to the number of seeds per pod, and both of these characters were correlated to the weight of seeds per pod and to the weight of the pod walls.

In addition, the number of ovules per pod was additionally positively correlated to the seed weight. However, no significant correlation was found between the number of seeds per pod and seed weight.

Clearly the close positive relationship between number of ovules and seeds per pod and seed weight existing in the parental types, had been broken by the hybridization and subsequent recombination of genes for these characters. The total distribution is shown in Figure 1. The majority of plants had an intermediate number (5,6 or 7) of ovules in the largest pod, this group of plants covering an extremely wide and continuous variation in seed weight.

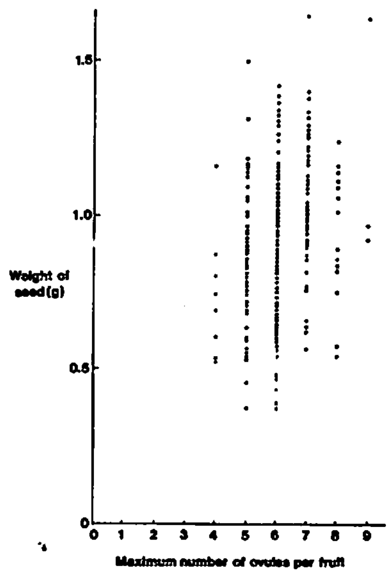

Fig.1. Relationship between seed weight and maximum number of ovules per fruit in F_2 plants from *V. faba major* and *V. faba minor* crosses.

Table 2. Phenotypic correlation coefficients between characters measured on 245 F_2 *Vicia Faba* plants from crosses between *Vicia faba major* and *Vicia faba minor*.

Character	Correlation coefficients (r)* 1	2	3	4	5	6	7	8	9	10
1. No. of nodes to first podded node.	1.00									
2. Length of pod.	-0.05	1.00								
3. No. of ovules per pod.	0.01	0.67	1.00							
4. No. of seeds per pod.	0.08	0.56	0.77	1.00						
5. Weight of seeds per pod.	0.08	0.88	0.64	0.62	1.00					
6. Pod length per ovule.	-0.00	0.81	0.47	0.35	0.84	1.00				
7. Pod length per ovule.	-0.07	0.62	-0.15	-0.07	0.40	0.56	1.00			
8. Pod length per seed.	-0.14	0.46	0.00	-0.44	0.25	0.44	0.62	1.00		
9. Pod wall weight per seed.	-0.05	0.59	0.15	-0.14	0.54	0.85	0.61	0.77	1.00	
10. Seed weight.	0.04	0.74	0.30	0.10	0.82	0.80	0.66	0.63	0.81	1.00

*For r $\geqslant$ 0.127 and 0.166, P = 0.05 and 0.01.

Earlier work has shown that number of seeds per pod and seed weight are highly heritable characteristics (Bond, 1966; Poulsen, 1977). If this is generally so, the present data support the hypothesis that the small seed weight of field bean may, by breeding, be combined with the larger number of seeds per pod of the broad bean. This conclusion is further supported by similar findings at PBI, Cambridge (D.A. Bond, personal communication).

The following fruit characters were positively correlated to one another:-

- weight of pod walls
- pod length per ovule
- pod length per seed
- pod wall weight per seed
- seed weight

This shows that the pod characteristics are more or less strongly correlated to the weight of the seed.

The work described here began at the Plant Breeding Institute, Cambridge, U.K., in 1976, and was from 1978 continued at the Royal Veterinary and Agricultural University, Copenhagen. Financial support by the British Council and the Danish Agricultural Research Council is gratefully acknowledged.

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Estimation of out-crossing between isolation plots of faba beans

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Faba beans are a partially autogamous species and under favourable environmental conditions (e.g. high levels of pollinating insects) out-crossing can exceed 40%. In plant improvement programs this can impose a severe restriction on the size and scope of the work, for instance when it is desired to bulk a large number of advanced lines for multi-location testing and yet retain adequate seed purity. The best method to ensure self-fertilization is to raise the plants under insect-free conditions in screen cages. This, however can be very expensive and few programs have the resources to bulk a large number of lines in this manner. An alternative method is to grow the material in isolation plots. In order to ensure complete purity, large isolation distances are required and this too becomes impractical if many lines are involved.

Very few studies on out-crossing in faba beans have been undertaken in the Middle East; Kambal (1969) reported that in Khartoum the level of out-crossing ranged from 35.8% to 42.1% while El-Sherbeeni (1970) reported between 57% and 71% at Giza, Egypt. El-Sherbeeni also reported that out-crossing between lines 125 metres apart was very low and that there was no out-crossing between lines planted at a distance of 175 metres, provided there was no apiary nearby.

The trials reported here were carried out to investigate isolation-plot techniques which would provide an acceptable control of out-crossing, under Syrian conditions, while at the same time minimising expense.

Out-crossing was determined using the genetic marker black hilum colour, controlled by a single gene which is dominant to the recessive white hilum gene (Sirks, 1920). The test plots were planted with pure white hilum seed selected from locally adapted stocks (the flower colour is normal) and the marker plots were planted with a local black-hilum cultivar (ILB 1814). Seeds harvested from the test plots were planted in the summer and each plant scored separately at the end of the season for hilum colour. The percentage of black hilum plants was used as the measure of out-crossing the previous season. This value was not adjusted and thus is indicative of crossing between the marker plot (or other faba beans in the area, which normally have black hila) and the test plot only. Crossing between or within test plots was not estimated

In the 1977/78 season a trial was conducted at the ICARDA site in Northern Syria to estimate out-crossing between small test plots of faba beans (2.5m x 2.5m) and a restricted marker source (a single 10m x 10m plot).

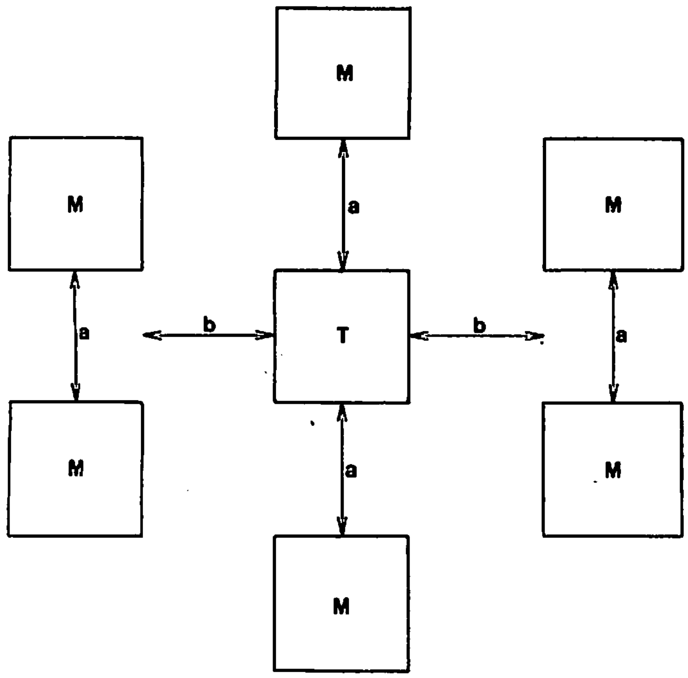
The test plots were planted at distances of 10, 20,30,40,65,90 and 130 metres in a line east and a line south of the marker plot. A further line of test plots were planted at 50,100,150 and 200 metres north of the marker plot. The trial was conducted at a distance of at least 1.5km from any other faba beans. No clear effect of direction of test plot from the marker source was observed and the mean figures for the various test plots, grouped according to the distance from the marker plot, are given in Table 1. The percentage of out-crossing clearly decreased with increasing distance from the marker plot, however even at the closest distances the level was small.

Table 1. The effect of isolation distance on out-crossing between small plots of faba beans.

Distance of test plot from marker gene source (m)	No. of plots	Mean % outcrossing
10-40	7	6.8
40-80	3	4.1
80-120	3	4.1
120-160	3	2.5
200	1	1.6

In the 1978/79 season a second trial was conducted to determine the effects of plot size and the distance between plots on out-crossing in the centre of the plot and the borders. A border of 1.3m around each plot was harvested separately from the centre of the plot. In this trial the test plots were of two sizes: 7.8m x 4m and 3.9m x 4m. Each test plot was surrounded by 6 marker plots of the same size, planted on hexagonal grids of dimensions: 9.75m x 6.5m and 19.5m x 6.5m between plots (see Fig.1). The trial was not replicated and was conducted only 50m from a 2 ha block of faba beans (black hilum).

The results are summarised in Table 2. The effect of inter-plot distance appears to be slight but was consistent in that the wider distances resulted in a slightly lower percentage of out-crossing. Plot size had a clear effect, however, with



T = test plot (white hilum)

M = marker plot (black hilum)

a = 9.75m or 19.5m

b = 6.5m

Fig.1 Trial layout.

on average 37% less out-crossing between the larger plots. There was also a clear trend (which was also observed in a separate trial not reported here) that out-crossing in the borders was higher than in the central part of the plot. In both the large and small plots approximately 30% less out-crossing occurred in the central part of the plot compared to the border.

Table 2. The effect of plot size and distance between plots on percentage of out-crossing.

Plot size	Distance between adjacent plots	Out-crossing % plot border	Out-crossing % plot center	Out-crossing % whole plot
7.8m x 4m	9.75m - 6.5m	9.6	8.9	9.4
	19.5m - 6.5m	9.4	4.5	8.3
	- mean:	9.5	6.7	8.9
3.9m x 4m	9.7m - 6.5m	15.1	12.5	14.8
	19.5m - 6.5m	14.2	7.7	13.6
	- mean:	14.7	10.1	14.2

Based on the above trials over 100 isolation plots of approximately 5m x 15m size, have been planted this season at 50m intervals adjacent to the roads at the edge of other crops. Only the central part of each plot will be retained and a single row of each is also being grown in an insect-proof cage to provide a pure seed source for future needs.

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Effect of environment on the instability of two sources of cytoplasmic male sterility in faba beans

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Faba bean hybrids with higher and more stable yields can be produced using ctyoplasmic male sterility (CMS). Both the 447 cytoplasm (D.A. Bond, PBI, Cambridge, England) and the 350 cytoplasm (P. Berthelem, INRA, Rennes, France),which are sources of CMS in faba bean, lead to an unstable phenotype of male sterility and are therefore at present unsuitable for hybrid breeding. Inter- and intra-plant phenotypic variations in pollen fertility appear in the progenies of crosses between male sterile plants and different maintainer lines, leading to partial or complete restoration of the fertility.

Pollen staining by Alexander's technique was used to measure the fertility of pollen in the following two studies:

a) Effect of environment on variation in pollen phenotype.

This study was made through growth chamber experiments. When plants of a 447 male sterile line were heat treated at different temperatures and at different stages, we observed that constant temperatures of 10°C and 20°C maintain a good male sterile phenotype, whereas thermal shocks (12 to 20°C, 12 to 27°C, 20 to 27°C, 20 to 12°C, 10 to 32°C and 20 to 32°C), when applied at the anthesis stage of the first floral node, led to up to F = 32% (= percentage of pollen grains stained purple) in the male fertility of flowers which were at the stage of male meiosis at the moment of thermal shock.

A stronger effect was obtained when a luminous shock with or without a thermal shock was applied to plants of a 350 male sterile line. This treatment consisted of transferring plants from 8000 lux (9 hours) to 25,000 lux (16 hours) at the stage of ten vegetative nodes on the main stem. In 66% of the plants studied, a male fertility of up to F = 80% was observed in flowers which were at the stage of male meiosis at the moment of the luminous shock, while all others remained completely sterile.

b) Heritability of environment-induced phenotypic variations.

In the case of the 350 male sterile line treated by a luminous shock, on the same plant we self-pollinated the flowers which were induced to a male fertile state, and pollinated some male sterile flowers with this induced pollen. The average fertility of the progeny of male fertile flowers was higher than that of the progeny of male sterile flowers, but not significantly so.

In June 1978, backcrosses of four maintainer lines were carried out by hand crossing in two different environments: in the open field, and in the greenhouse where the maximum day temperature was 38 to 40°C. For the four lines, a higher proportion of fertile plants appeared in the progeny of the open field backcross, this difference being significant fpr three of the lines:

line	% fertile plants from progeny of open field backcross	% fertile plants from progeny of greenhouse backcross	No.of plants studied
1	5.9	0	259
2	9.5	0	88
3	10.0	0	276

Conclusion.

The environment-induced phenotypic variations in pollen phenotype not only represent a change in the physiology of the male gametogenesis; they are also linked to a modification in the geno-cytoplasmic information transmitted to the progeny. This modification can occur in the ovules or in the embryo, and can explain some of the instabilities of the cytoplasmic male sterility in faba bean. The observed variability between different lines in the level of susceptibility of the male sterile phenotype to these environmental shocks suggests the possibility of selecting maternal geno-cytoplasmic information, which could lead to a more stable cytoplasmic male sterility.

Studies on quantitative inheritance in Vicia faba major

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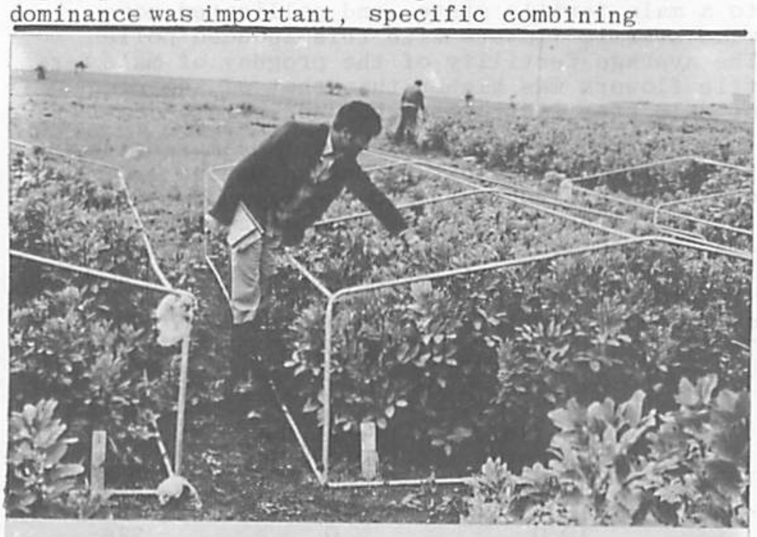
The quantitative inheritance of several traits of *Vicia faba* has been studied by Cubero (1970, 1976), Martin (1976) and Martin and Cubero (1979). These authors have employed 7 x 7 F_1 diallel crosses including parental lines belonging to the four botanical groups that are currently recognised in the species. It was apparent from this work that for some characters the genetic system inferred from the analysis was a 'pooled' system i.e. the result of partial genetic systems shown by different groups of lines. One example is seed size, where European lines show a different system.

This suggests that different botanical and/or geographic groups can be characterised by different genetic systems. A systematic study of the quantitative inheritance within several such groups was made. The first group to be analysed was a Mediterranean one (see Moreno and Martinez, 1980) formed by six *major* and two *equina/major* lines obtained from Spanish populations by means of a 8 x 8 diallel cross. Thirteen characters have been analysed to date and are reported here. The analysis of Hayman (1954 and 1954a) has been followed, and the number of broomrapes per host plant has been transformed to log $(x+\frac{1}{2})$ (see Cubero and Martinez, 1980).

Additive effects were important in all twelve characters. Dominance was not significant in two (pod length and width/length of pod) and not very important in five (seeds per pod, leaflet width, width/length of leaflet, seed width and broomrapes per host plant). Among those cases in which dominance was important, specific combining ability effects were significant in two (time to flower and ovules/ovary, in the second case only significant at the 5% level). Maternal effects were significant in four cases (ovules/ovary - the only case of high significance, leaflet width, width/length of leaflet, and thickness/length of seed). Significant differences between replicates were obtained mainly for vegetative characters.



There is a good agreement with the studies mentioned above for leaflet length (+ve sense), width/length of leaflet (-ve), number of flowers per node (+ve), ovules/ovary (+ve), seed length (-ve) and thickness/length of seed (-ve dominance i.e. *major* dominant over *equina* type).

A different genetic system is indicated for width/thickness of seed (W/V plot indicating probable partial negative dominance) and for number of leaflets per leaf (-ve sense in the present work). Time to flower has been as difficult to interpret as with previous studies. The new characters here were seed width (-ve sense), pod length (intermediate, the W/V plot indicating perhaps a partial dominance of -ve sense) and number of broomrapes per host plant (transformed to logarithm; partial dominance to intermediate inheritance; resistance recessive).

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Intergenotypic competition in field plots of faba beans

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Selected plants of faba beans at Saskatoon generally produce progeny rows that only yield enough seed to be placed in the following generation, in yield tests consisting of two-row plots 4.87 meters long and replicated three times. Intergenotypic competition has been noted in soybeans (Gedge *et al.*, 1977) and it was felt that this may be differentially affecting our two-row preliminary yield tests. Consequently, a competition experiment was begun at Saskatoon in 1975 in which the cultivar 'Erfordia' (tall, late and high yielding) was compared with the USDA Plant Introduction 317500 (a short, intermediate maturing line

of moderate yield). Herz Freya, another high yielding, tall and late maturing cultivar, was added to the experiments in 1978. The experiments were sown in eight row plots in which one cultivar made up the center 2, 4 or 6 rows with the other cultivar providing the appropriate number of border rows. The row spacing was 30 cm and the experiment was a randomised complete block, replicated four times.

Although the treatment effects were not always significant, results consistently and clearly indicated that the four row plot, with the middle two rows harvested for yield measurement, gave a greater yield. Furthermore, this increase in yield tended to be greater in the high yielding 'Erfordia'. Thus, lower yielding material may be retained more often when grown in two-row compared to four-row yield tests.

Table 1. Center two-row plot yields in 1975, 1976 and 1978.

Year	Cultivar	Yield (kg/ha) BBBAABBB*	BBAAAABB	BAAAAAAB	Mean
1975	Erfordia	1471	2046	1799	1772
	PI31750	1291	1326	1450	1356
	Mean	1381	1686	1625	
1976	Erfordia	1860	2339	1775	1991
	PI317500	1549	2305	1433	1762
	Mean	1705	2322	1604	
1978a	Erfordia	1762	1828	1814	1801
	PI317500	1263	1223	1304	1263
	Mean	1512	1526	1559	
1978b	Herz Freya	1458	1403	1527	1463
	PI317500	940	1053	1203	1065
	Mean	1199	1228	1365	
1978c	Erfordia	1449	1602	1595	1549
	Herz Freya	1339	1324	1341	1335
	Mean	1394	1463	1468	
	Grand Mean	1438	1645	1524	

*The letter A represents the row of the cultivar listed in the table, and the letter B to the other cultivars in the particular experiment.
Border treatment effects were significant at the 10% level in 1975 and 1976, and at the 5% level in 1978b.
Cultivar differences were significant at the 1% level in all trials except 1976.

Significant differences were also noted in height in 1975 and 1976 with the 4-row and 6-row plots averaging 6 cm taller than the 2-row plots in 1975 and the 4-row plots averaging 10 cm taller than the other two treatments in 1976. No consistent differences in other characters such as protein, maturity or 1000 seed weight were noted.

It is possible that the rows adjacent to the center two rows in the four-row plots may be shorter due to competition effects from the outer two border rows. If this had occurred, it could have provided a yield advantage to the center two rows. Measurements were taken on these adjacent rows in all the 1978 experiments, but no differences were found.

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Gedge, D.l., Fehr, W.R. and Walker, A.K. (1977). 'Intergenotypic competition between rows and within blends of soybeans'. Crop Sci. 17, 787-790.

A note on pod size

The largest faba bean (*Vicia faba*) pod ever recorded in the U.K. was 59.35 cm long and was grown by T. Currie of Jedburgh in Roxburghshire in 1963.

Reference:

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Physiology and Microbiology

A fertilizer response study on faba beans in Northern Syria

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Faba beans in West Asia are generally grown either as a rainfed crop in high rainfall coastal areas or as an irrigated crop in low rainfall inland areas. Efforts are being made to develop genotypes suitable for rainfed farming even in areas receiving annual rainfall of 300 to 400 mm. Little information exists on the agronomic requirements of faba beans under such conditions. Since the fertility status of the soil in these areas, particularly the available phosphorus and organic matter content, is generally low, it was thought worthwhile to study the response of local faba beans to the application of phosphatic and nitrogenous fertilizers at ICARDA's site at Tel Hadya in Northern Syria in the 1977/78 season.

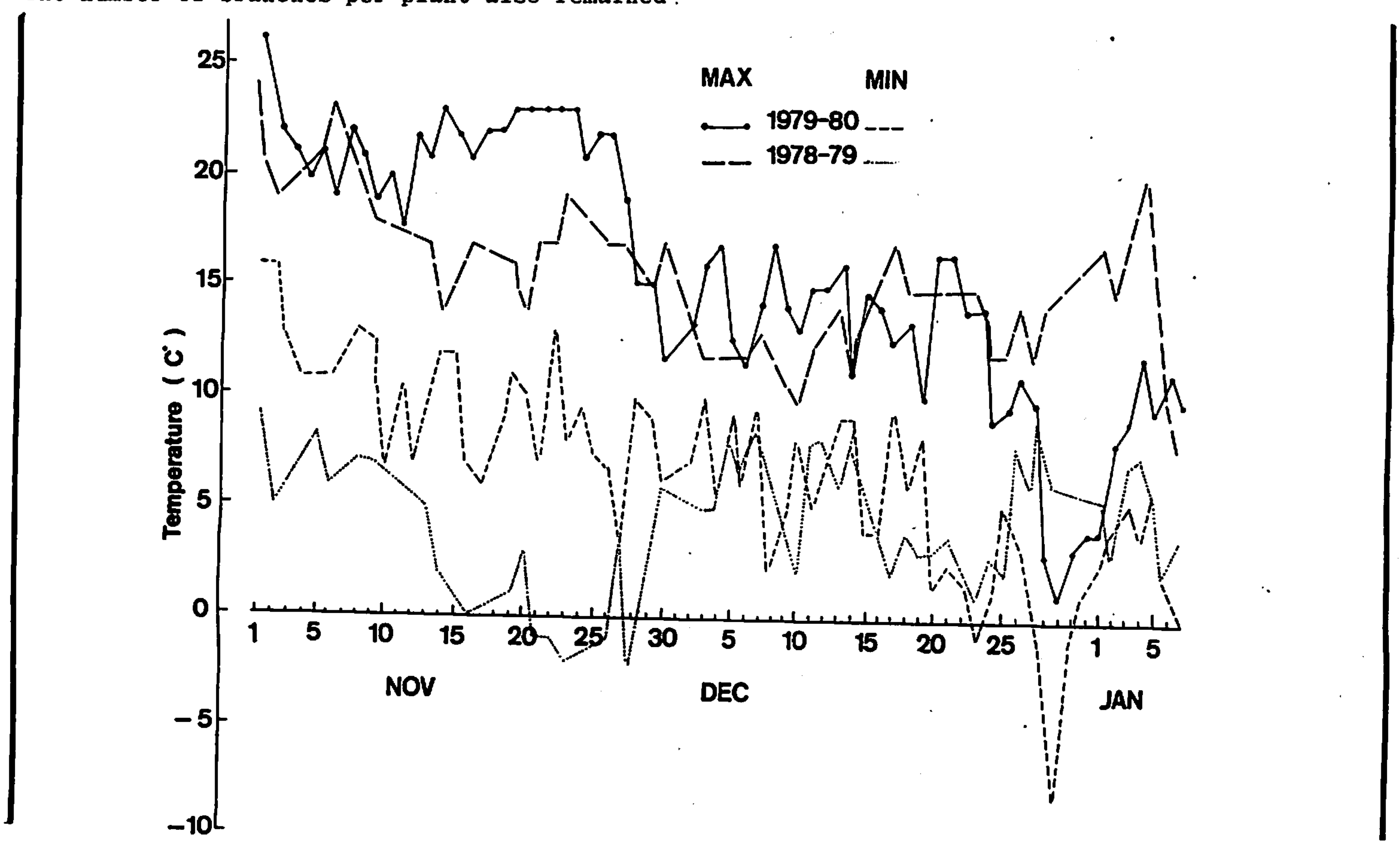
The soil of the experimental field was clay-loam with pH 8.5, 1.11% organic matter, 8.0 ppm available (Olsen's extractable) phosphorous and 1.208 meq of exchangeable K^+ per 100 g soil. 'Syrian local large' (ILB 1814) and 'Syrian local small' (ILB 1813) cultivars of faba bean were grown with six different fertilizer rate combinations (Table 1). The 12 treatment combinations were tested in a randomised complete block design with four replications. The crop was planted on December 1st, 1977, in rows 50 cm apart with a plant to plant distance of 10 cm. Nitrogen was applied as urea. An amount in excess of 20 kgN/ha was applied in two equal doses at 30 and 60 days after emergence. Phosphorus was applied as triple-super-phosphate. The crop was raised under rainfed conditions and the total seasonal rainfall was about 360 mm.

Table 1. Effect of nitrogen and phosphate application on the yield and some yield attributes of ILB-1814 (V_1) and ILB-1813 (V_2) faba beans.

Treatment	Grain yield (kg/ha) V_1	Grain yield (kg/ha) V_2	Grain yield (kg/ha) Mean	No. of Pods/plant V_1	No. of Pods/plant V_2	No. of Pods/plant Mean	100 grain weight (g) V_1	100 grain weight (g) V_2	100 grain weight (g) Mean
Control	1655	1219	1437	3.48	2.36	2.92	159.0	122.3	140.7
20 kgN/ha	1701	1356	1529	3.70	2.95	3.32	160.0	121.3	140.6
20 kgN + 50 kg P_2O_5/ha	1942	1782	1862	4.28	3.08	3.69	154.8	126.8	140.8
60 kgN + 50 kg P_2O_5/ha	2136	1799	1967	4.45	3.33	3.89	163.7	122.5	143.1
120 kgN + 50 kg P_2O_5/ha	2097	1890	1994	3.83	3.98	3.91	169.4	118.7	144.0
180 kgN + 50 kg P_2O_5/ha	1872	1829	1850	4.08	3.10	3.59	166.0	124.6	145.3
Mean	1901	1646		3.97	3.10		161.1	122.7	
L.S.D. 5%:									
Fertilizer treat	236.6			0.58			not sig.		
Variety	136.6			0.34			4.95		
Interaction	not sig.			not sig.			not sig.		
c.v.	13.1%			16.30%			5.91%		

The grain yield was significantly affected by the fertilizer application and the varieties, but their interaction was not significant (Table 1). ILB 1814 out-yielded ILB 1813 by a margin of 15% because of significantly higher number of branches per plant, pods per plant, and 100-grain weight, although the number of grains per pod was significantly lower. The starter N dose of 20 kgN/ha resulted in a small but non-significant increase in the yield (Table 1). Phosphate application (50 kg P_2O_5/ha) resulted in about a 35% increase in the yield, because of increased pods per plant. The number of grains per pod and 100 grain weight were only marginally improved by phosphate fertilization, but the effect was statistically non-significant, at the 5% level. The number of branches per plant also remained unaffected, so that increase in pod number per plant should have resulted from improved pod set on the existing branches.

Nitrogen at higher rates was of little advantage. Apparently, the symbiotic N fixation in the presence of 50 kg P_2O_5/ha was adequate to meet the N needs of the crop. Thus, the study revealed that application of phosphatic fertilizer was essential for realising good yields from rainfed faba bean when the available phosphorus status of the soil was 8 ppm P or below. Since only one rate of phosphate application was tested in this study, it would be necessary to carry out a phosphate response surface study so that economic optimum levels can be determined. Such studies are now in progress.



Influence of topping of faba beans (Vicia faba L.) on their growth and on the supply of the flowers with ^{14}C

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Competition between the vegetative and reproductive parts, irrespective of water supply, appears to be one of the main reasons for the rather low and unstable yield of faba beans. Accordingly, trials were conducted both under controlled conditions and in the field to study vegetative development. This was done in a randomised block trial with three replicates by measuring plant height, length and weight of the internodes, leaf area, leaf and root quality. At each of six harvests eighteen plants were analysed for each of three topping dates and compared to controls. These measurements were considered in connection with reproductive development. The most important results were as follows.

Effect of topping on flower drop and pod development

Topping reduced flower drop to a very great extent. However, the large number of young pods had, as a result, great difficulty in developing themselves fully. The number of stunted and fallen pods was greater than the control. The greater number of mature pods on the lower nodes of the topped plants did not compensate for the higher total number of pods on the control plants. The more rapid development of the pods on the topped plants lasted only up to one month before maturity; an evident retardation followed because the stems, as well as the roots, had already used up their retranslocatable substances.

Effect of topping on the supply of flowers with ^{14}C

Using ^{14}C labelling we were able to establish that the flowers near the decapitated apex were better nourished. Flowers more than 12 days old retained an amount of labelled assimilates in proportion to their weight. The fruits of topped plants later obtained fewer assimilates in proportion to their weight. The distribution of fruit in the areas of flowering, the retardation of growth of the young fruit and flower drop (Jaquiery, 1977) were also analysed in our trials. The model described by Jaquiery appears to be equally valid for the fruit of topped plants. The area of retardation of growth of the young fruits must be placed in relation to the lower 'sink' ability of the fruit itself.

Effect of topping on the vegetative growth and the yield of faba bean.

The development of side shoots as a result of topping was very much dependent upon climatic conditions. However, when the number of flowers removed by topping was not too great (i.e. when this interference took place in the middle of the flowering period) the side shoots do not develop under any conditions. The length of the internodes was greatly reduced with the appearance of the flowers. The stem and roots act as a buffer between supply and demand of assimilates.

A significant correlation was found to exist between the leaf area duration (LAD) and the yield of the various trials. The single leaves of the topped plants had a greater area and a higher specific weight than the control plants. This was by no means sufficient to compensate for total leaf area loss.

It was shown at harvest that topping increased the number of pods, depending upon the amount of vegetative growth. The number of seeds per pod and the mean seed weight were, however, lower for the topped plants so that the harvest index was identical for all trials. The harvest index proved to be, in general, the most stable factor of faba bean culture in our trials. The yield of the topped plants was less than that of the controlled plants.

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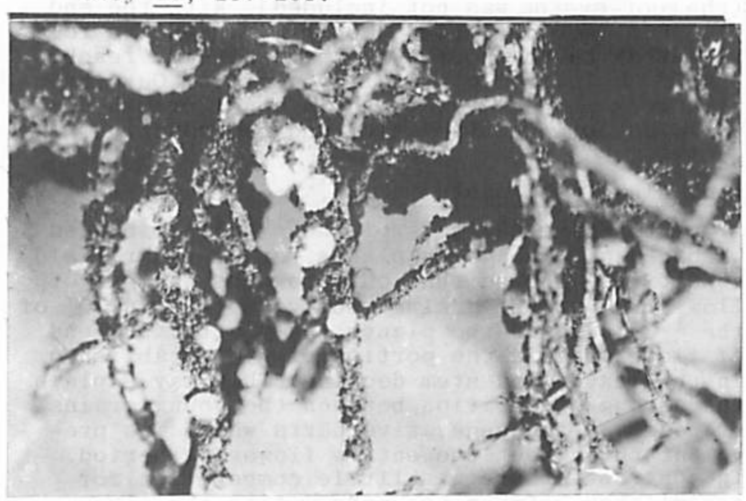

Rhizobia nodules

Influence of the distribution of assimilates on pod set in faba beans (Vicia faba L.)

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The yield of faba beans is dependent on, among other factors, seeding date, seeding density and seeding depth, and on water supply and the development of diseases and pests. Yield is also influenced by the extent of flower- and pod-drop which can reach 70 - 80%. The phenomenon of the dropping of flowers is known to exist for many cultivated plants. In this respect, a favourable distribution of the assimilates within a plant is of great importance for yield information.

A field trial was carried out to evaluate the yield structure. Six harvests of 5 x 10 plants each were made. The number of leaves, the number of pods and seeds, the leaf area, the height as well as the dry weight of the stems, leaf, pod and grain portions were recorded or calculated on a per plant basis. The course of flowering and flower drop were studied in a greenhouse and in a field experiment. The qualitative distribution of the assimilates of a leaf which had assimilated $^{14}CO_2$ was determined at 4 dates during the growing period (4 plants each time) by means of autoradiography.

Throughout the flowering period, the stems as well as the new leaves accumulated nearly all the dry matter produced. The increase in the dry weight of the flowers was only small. The correlation coefficients for the leaf area of the plants and the number of pods and their kernels as well as their dry mass were very high. The same correlation existed between the dry weight of the stems, the number of leaves and the height of the plants with their reproductive organs.

The chance as to whether of not a flower was able to develop into a pod after fertilisation, was dependent on the position of each flower on the plant (the situation of the inflorescence on the main shoot and the position of the flower within the inflorescence). The inflorescence on the upper part of the plant did not have the same good flower/pod relationship as did those on the lower parts. Flowers at the apical position of an inflorescence developed fewer pods than flowers at the base of the inflorescence.

Radiographic studies made it possible to show the attraction of the apex for assimilates up to the end of the flowering period. The apex imports assimilates from all the leaves up to this phase; the same occurs in the lower part of the stem (the root-system was not included). With the end of the flowering period the apex passes its role as a sink to the pods which have already reached 4 to 6 cm in the lower inflorescences. Our investigations showed that there is considerable competition between vegetative and reproductive growth.

Analysis of ^{14}C distribution.

Quantitative analysis of the ^{14}C distribution within whole faba bean plants, grown under field conditions, showed that only towards the end of flowering did the grains receive more than 10% of the ^{14}C found in the plants; only after the end of flowering did the portion of ^{14}C established in the leaves and stem decline. This may explain the strong competition between the young grains or pods and the vegetative parts which was prevalent throughout the entire flowering period. In contrast, there was little competition for assimilates between the pods within the same inflorescence up until the middle of the flowering period.

Carbon 14 distribution among the grains was very irregular. The amount of ^{14}C which a grain receives was affected by its stage of development (or age) and position. The pods which dropped contained the smallest amount of ^{14}C assimilates and came from the uppermost inflorescences. It is, however, difficult to ascertain the real reason for grain drop: whether this is due to their lack of assimilation or if it is the result of other occurrences which induce pod drop. Gehriger(1978) was able, nevertheless, to reduce flower drop, or rather increase the number of pods, by topping the plants. This, however, did not result in an increase in grain yield at full maturity. An attempt will be made, therefore, to influence the number of grains by using growth regulators at the Institute of Crop Science at the ETH.

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Preliminary studies on faba bean plant type

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In order to develop appropriate plant ideotypes for different environmental conditions, it is necessary that the relative significance of various morphological characters and growth habit is evaluated under field conditions. The degree of branching and the determinancy of growth are characters of importance in this respect in the case of faba beans.

Evaluation of the significance of different degrees of branching and determinate growth habit can be made by developing a series of isogenic lines in the background of a locally well-adapted genotype. This is, however, time consuming. Although not quite as satisfactory, an alternative approach is to create variations in the degree of branching by removing the branches as they appear on the plant, and in the case of determinacy by detopping the shoots at the appropriate stage of growth. Using this approach, a preliminary study was carried out at the ICARDA site in Tel Hadya in Northern Syria, during the 1977 to '78 season, to evaluate the significance of branching and determinate growth habit for local large faba beans (ILB-1814) planted at a population level of six plants/m^2 and grown without irrigation (with seasonal rainfall about 360 mm). Three treatments were tested: (i) 'control'; (ii) 'detopping' - the apical shoot containing three nodes was removed from each of the primary branches and main stem at the appearance of the first pod; (iii) 'debranching' - all the branches were periodically removed, as they appeared, to maintain one main stalk per plant. The results are summarised in Table 1.

Debranching caused a conspicuous reduction in the yield, whereas detopping tended to improve the yield. The leaf area index and total shoot dry weight at an advanced podding stage followed a similar trend to the yield. About a quarter of the pod bearing nodes and pods per plant was contributed by the main stem, and the remainder by the branches, in the case of the 'control' and 'detopping' treatments. 'Debranching' encouraged the main stem to develop about 2.5 times as many pod bearing nodes and 3 times as many pods compared to 'control' and 'detopped' plants. However, this increase did not compensate for the loss of pod bearing nodes (and thus pods) per plant; the 'debranching' therefore resulted in reduced yield. The study thus emphasised the importance of branching under the conditions of the present experiment, which permitted only a limited realisation of the full growth and yield potential of the local faba bean cultivar.

A somewhat more expanded study was carried out during the 1978/79 season involving four population levels (8, 16, 24 and 32 plants/m^2) and four 'plant types' ('control', debranching to maintain 'one main stalk', debranching to maintain 'three main stalks' and 'detopping') obtained with ILB-1814 faba beans. The crop was given supplementary irrigation and showed relatively better growth as a result. However, the experimental plot was adversely affected by *Orabanche* infestation and the coefficient of variability for data on various yield attributes and yield was high. As a result, the effect of 'plant type' variable failed to reach the 5% level of significance, although there was a trend for the yield (Table 2) to be the highest under the treatment '3 main stalks' per plant. The treatments 'one main stalk' per plant and 'detopping' resulted in reduced yield particularly at the lowest population level (8 plants/m^2). There is a need for further studies to give more conclusive results.

Table 2. Effect of 'plant-type' and plant population levels on the yield of ILB-1814 faba beans at Tel Hadya, Northern Syria.

Treatment	Yield (kg/ha), No. of plants/m^2: 8	16	24	32	Mean
Control	2906	2990	3281	3531	3177
One main stalk	1848	3073	3031	3406	2840
Three main stalks	2948	3448	2657	3990	3261
Detopping	2073	2698	3365	3073	2802
Mean	2444	3052	3084	3500	

	Plant type	Population	Interaction
S.E.	298	196	392
L.S.D. 5%	Not Sig.	572	Not Sig.
C.V.	34%		23%

Table 1. Yield, yield attributes and other characters of Syrian Local Large (ILB-1814) faba beans as affected by de-topping and debranching treatments. (1977/78 season).

Treatment	Grain Yield (kg/ha)	Single plant dry weight (g): stem	leaves	pods	total shoot	Leaf area index*	No. of pods per 3 plants: main stem	branch	total	No. of pod bearing nodes per 3 plants: main stem	branch	total
Control	1068	14.6	15.0	13.0	42.6	2.47	6.0	18.6	24.6	5.7	18.0	23.7
Detopping	1262	15.8	18.0	13.8	47.6	2.53	6.3	18.6	24.9	5.7	17.3	23.0
Debranching	809	9.6	12.3	11.3	33.2	1.7	19.0	-	19.0	15.7	-	157

*at advanced podding stage.

Effect of growth regulators on faba bean (Vicia faba L.) development

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In 1977 a 'screening' trial to test ten growth regulators was carried out in the field on 270 plots each of 3 m^2. Three different concentrations of the chemicals were applied at three different stages of development - five days before the onset of flowering, at full flowering and at the beginning of pod formation.

The best results with this initial screening were obtained with GA_3 when applied at the first development stage, at a concentration of 10^{-4}M and as a run-off treatment. With this chemical there was an accelerated elongation of plants at the beginning of flowering with a retardation one month later. There was a significantly higher pod set with an increase in the number of grains per plant, and an increase in grain yield per plant of about 20%, although this was not significant. Harvest index was calculated for all three application dates - suprisingly this was the same for the controls and the GA_3 treated plants, although the total dry matter produced was quite different.

These results led us to concentrate our efforts in 1978 on the application of GA_3. Treatments of GA_3 applied at the six leaf stage and at a concentration of 10^{-4}M gave the most promising results. Special attention was paid to the effect of the chemical on the length of internodes, on pods per node, on the leaf surface, on specific leaf weight and on grain yield. ^{14}C labelling showed that pods from plants treated with GA_3 developed more rapidly and with less pod drop than pods from the control plants, this confirming the findings of Jaquiery (1977) and Gehriger (1978), that adequate supply of assimilates during the lag phase of seed development is of outstanding importance.

Although it was possible to reproduce the yield increases due to GA_3 treatments in two successive seasons, these results should be considered as preliminary. Experiments done in the third season (1979) were at 12 different locations and will show the effect of different environmental conditions. This series of experiments will be concluded in the summer of 1980.

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Effect of several herbicides on the nodulation and yield of faba bean (Vicia faba)

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Faba beans are normally grown in the West Asia region as a winter crop. The presence of adequate moisture in the soil profile during the winter encourages the growth of many weeds, which can limit both N_2-fixation and grain yield in faba beans. In recent years hand-weeding has become less economic in some areas and chemical weed control has become more popular. Several promising herbicides for weed control in faba bean fields have been identified, but there is very little information on the effect of these chemicals on nodulation and N_2-fixation.

An experiment was conducted on the ICARDA farm at Tel Hadya to study the effect of a pre-planting herbicide (Treflan, one litre P*/ha) and several pre-emergence herbicides (Gesagard 2 kg P/ha; Alachlor, 3 l. P/ha; Tribunil 4 kg P/ha; and Metribuzin 1 kg P/ha) on nodulation and growth of uninoculated and inoculated faba beans (cv. Syrian Local Large, ILB 1814). A mixture of three strains of *Rhizobium* (BB 10c, BB 21b, and IC 9253) was used for inoculation. Each treatment had four replications. Planting was in late November; there was approximately 240 mm rainfall during the growth period and no supplementary irrigation was provided.

Visual observations were made regularly; plants were harvested at the early vegetative and mid pod-filling stages for nodulation studies. A minimum of 32 plants from each treatment were assayed for nodule number and weight. Weeds were removed at a very late stage of growth and their dry weights recorded. A final harvest gave the grain yield data.

Results and Discussion

Of the five herbicides tested, two (Gesagard and Metribuzin) were found to be phytotoxic under the conditions of the trial and were not included in the analysis. A summary of the results are given in Table 1. Only Tribunil gave very good control of the weeds and did not significantly reduce the yield compared to the hand weeded control. Alchlor gave better weed control than Treflan, but reduced the yield by 54%. Treflan provided reasonable weed control and resulted in only a slight reduction in the yield.

In general, inoculation resulted in higher nodule production per plant and a greater total weight of the nodules, although neither the effects of inoculation on yield, nor the inoculation x herbicide interaction were significant. Inoculation with the *Rhizobia* in the Alachlor treated plots produced a greater percentage increase in both nodule number and nodule weight compared to the corresponding increase in the hand weeded plots, indicating that the introduced *Rhizobia* may have tolerated the effects of

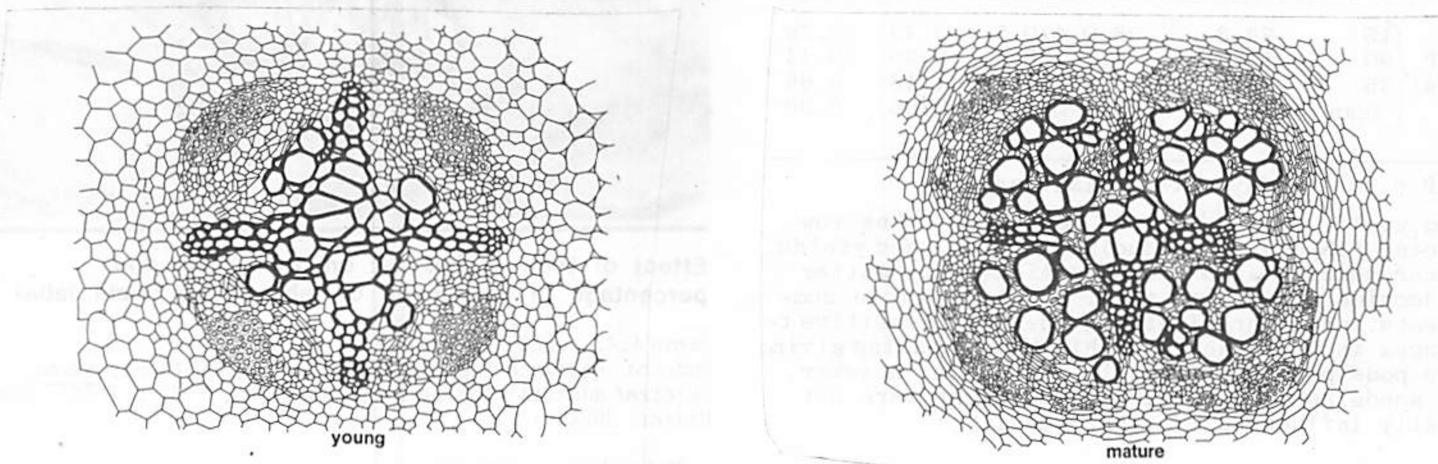
Table 1. Production of nodules, nodule dry matter and grain by faba beans, and the development of weeds under different herbicidal treatments.

Treatment	Nodule No./plant			Nodule D. wt. (mg/plant)			Weed Biomass (kg/ha)	Yield (kg/ha)		
	Uninoc.	Inoc.	Mean	Uninoc.	Inoc.	Mean		Uninoc.	Inoc.	Mean
Unweeded control	41.9	74.1	58.0	52.4	104.3	78.4	2950	1276	1111	1193
Weeded control	51.8	70.9	61.4	68.1	120.6	94.4	-	1590	1861	1726
Treflan	35.8	32.7	34.3	66.4	47.5	56.9	1357	1386	1471	1429
Alachlor	22.9	45.4	34.2	26.5	47.2	36.9	2032	840	743	792
Tribunil	57.1	46.1	51.6	42.6	64.0	53.3	82	1795	1541	1668
Mean	41.9	53.8		51.2	76.7			1377	1345	
L.S.D. 5%										
Inoc.	10.4			16.1				not sig.		
Herbicide	15.2			22.4				241		
Inoc. x herbicide	21.5			31.6				not sig.		

Alachlor better than the native *Rhizobia*.

The results thus indicated that herbicides might have different effects on nodulation, and larger number of *Rhizobia* strains may have to be screened to identify those which might tolerate the herbicide and result in good nodulation.

*P = Product.



Cross-section of Vicia faba roots

Agronomy and Mechanisation

Growth and yield potential of faba beans (Vicia faba) in sub-tropical environment

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Introduction

Faba beans are grown as a crop on a small scale in India. However, the crop is widespread in some parts of the country, particularly in Uttar Pradesh, Bihar, Punjab, Kashmir, Madhya Pradesh, Rajasthan and Karnataka. It has many vernacular names, such as 'Bakla' and 'Anhuri' in Hindi, 'Naikshan' and 'Nakhthan' in Ladaki, and 'Kaivn' in Kashmiri. The crop appears to have been introduced into India in recent times as there is no mention of a Sanskrit name in the literature. It probably arrived in India from the Near East, and was first grown in the North Plain, Kashmir, in Ladak, in Punjab and in the North West Plains (Kogure, 1979). Faba beans are commonly cultivated at 5000 ft. in Kashmir and from 8000 to 12000 ft. in Kanawar Spiti and Tibet, and appear to be fairly tolerant to low temperatures (Watt, 1972).

The crop is grown in kitchen gardens and on marginal land for green pods, and is also harvested at maturity for dry seed. Dry seeds are used in either the split form as 'dhal' and flour for human consumption, or as animal feed. The existing ecotypes used as vegetables have long and broad pods and are fairly resistant to pests and diseases, although *Ascochyta* blight (*Ascochyta fabae*) and wilt (*Rhizoctonia spp.*) can occur.

Local varieties are planted in the middle of November and fit very well in the 'rabi' (November to April) cropping system. The crop is normally grown on conserved moisture without any fertilizer application, as the soils contain *Rhizobia* which can nodulate the crop very well. Because faba bean is not a major crop in India there has not been any serious effort made to collect the local ecotypes and to evaluate their production potential on a large scale. However, with the growing demand for high protein food both for humans and animals, faba bean has a great potential on marginal lands outside existing cropping systems.

Growth and yield potential trial

The plant type, pod setting and yield potential prompted a systematic trial designed to evaluate the growth and yield potential of two local cultivars under three plant densities. A randomised block design with four replications was used and seeding was done by hand in rows. After emergence, plants were thinned to 10 cm spacings. The crop was grown on a fertile silty loam without added fertilizer, and was irrigated 45 days after planting. Weeds were removed by hand and the plants were harvested at different intervals for measurement of dry weights and yield components. The net plot was harvested for final seed yield.

The data presented in Tables 1 and 2 shows that Bihar Local performed better than U.P. Local in dry matter production (g/m^2), crop growth rate and

Table 1. The effect of row spacing on dry matter production and growth rate of two faba bean cultivars.

	Row Spacing (cm)	Dry matter production (g/m^2) DAP*: 38	58	85	Crop growth rate (g/m^2/day) 38-58	58-85
Bihar Local	15	43.3	113.7	653.1	3.52	19.97
	30	19.5	61.5	312.6	2.10	9.30
	45	13.0	42.2	210.4	1.40	6.22
	Mean	25.3	72.5	392.0	2.34	11.83
U.P. Local	15	29.3	98.0	470.5	3.43	13.79
	30	12.4	56.4	338.4	2.20	10.44
	45	8.7	32.0	184.9	1.16	5.66
	Mean	16.8	62.1	331.2	2.96	9.96

*DAP = No. of days after planting.

seed yield. Both genotypes responded to narrow spacing (15 cm) by producing maximum seed yields. Closer spacing also promoted higher dry matter production and growth rate. Among the yield components, pods per plant was the most sensitive to changes in row spacing within 45 cm spacing giving more pods per plant than 15 and 30 cm. However, the seeds per pod and 100 seed weight were not greatly influenced by plant density.

Table 2. The effect of row spacing on yield and yield components of two faba bean cultivars.

	Row Spacing (cm)	Yield components: pods/plant	seeds/pod	100 seed weight (g)	Yield (kg/ha)
Bihar Local	15	22.5	2.22	22.7	4881
	30	53.5	2.51	26.7	4118
	45	67.9	2.65	19.8	2257
	Mean	48.0	2.46	20.5	3752
U.P. Local	15	25.4	2.60	23.1	4343
	30	43.1	2.50	23.3	2975
	45	57.7	2.50	20.3	1940
	Mean	42.1	2.53	22.2	3086

The results of this preliminary study demonstrated beyond doubt that faba bean has a high yield potential for high seed production in the Indian cropping system. The seed yields compared well with chickpea (2.5 to 2.8 t/ha), lentil (1.5-2.0 t/ha) and pea (1.8 to 2.0 t/ha) when grown in the same field under similar agronomic conditions (Pandey, 1979).

However, in order to realise the full production potential of this crop, improved cultivars need to be evaluated under varied planting dates, seeding rates, moisture supply and nutrients. Future research work will study these factors.

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Effect of time of harvest on grain yield and percentage of hard seed of faba beans (Vicia faba)

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Faba beans are grown on small-holdings as a winter crop along the Nile and in the Northern Province of the Sudan. They are an important cash crop in the area and constitute the number one grain legume in the Sudan. Farmers tend to harvest the crop before full maturity in order to benefit from the relatively high prices at the time of lowest supply. The trials described here were designed to assess the yield losses encountered by farmers employing such a practice, to determine the best time for harvest and to find out if the percentage of hard seed is affected by time of harvest.

Materials and Methods

The effect of the time of harvest, at 90, 100, 110, 120, 130 and 140 days after sowing, on the grain yield and percentage hard seed of faba bean cultivar H.72 (selection from Rebaya 29) was studied. The field trial was carried out in the 1976/77 winter season at Hudeiba Research Farm, and treatments were made in randomised blocks with four replicates. Plot size was 8 x 2.4 m^2, of which 7 x 1.8 m^2 was harvested for yield. The crop was sown on 30th October, 1976 on ridges 60 cm apart and at a plant spacing of 20 cm with two plants per hole. Plots were watered weekly. The soil was a heavy clay vertisol. The percentage hard seed was calculated after soaking for 24 hours in water.

Results and discussion

Grain yield increased significantly, and at a linear rate, with delay in harvest from 90 to 110 days after sowing; it almost levelled off between 110 and 120, then decreased significantly at later harvests (Table 1). There was little increase in the number of pods between 90 and 110 days, after which there was a noticeable drop with delay in harvest due to shedding. On the other hand there was a significant and marked increase in grain size between 90 and 110 days after which grain size was stable - a sure sign of full maturity. The percentage of hard seed decreased by 50% between 90 and 110 days, reaching a value of 10% at full maturity.

Table 1. The effect of time of harvest of faba beans on grain yield and other characteristics.

Time of harvest (No. of days after sowing)	Grain yield (kg/ha)	Total No. of pods/ plant	100 seed weight (g)	Seed hardiness (%)
90	559	29	20	19
100	1377	30	29	15
110	2186	28	33	10
120	2149	25	34	11
130	1793	24	34	6
140	1627	20	35	8
S.E.	±94.4	±3.0	±0.7	±1.4

This showed clearly that the best harvest time for faba beans under the conditions of the trial H.72 is between 110 and 120 days after sowing. Delays or advancement in the harvest time could result in appreciable losses in grain yield, which may not be offset by the increased price a farmer gets by harvesting before full maturity. The percentage of hard seed is also affected by time of harvest, and is lowest when the crop is harvested after full maturity.

Time of sowing - a major factor influencing the yields of Vicia faba in South Australia

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A research program was initiated at Waite Agricultural Research Institute in 1973 to evaluate several winter cropping legume species and cultivars. Faba beans (*Vicia faba*) produced the highest yields of all the crops tested (Laurence, 1979) but there was a wide range of yields within this species. The highest yields were obtained from cultivars of Mediterranean origin.

In 1977, a field experiment was conducted at Roseworthy College to study the effects of time of seeding and plant density on the productivity of some of Laurence's highest yielding lines of *V. faba equina* and *V. faba minor*. A split-plot design was used with times of sowing (June 4th, July 1st and July 29th) as the main treatments and 4 genotypes as sub-treatments. Each genotype was planted by hand in a fan design as described by Bleasdale (1967) to produce 12 different densities ranging from 8 to 80 plants m^{-2}. All treatments were replicated four times in a randomised block design. Only 216mm of rainfall was recorded during the growing season (April - October), 33% below average and plants from the first time of sowing started to wilt during August as a result of moisture stress. Seed yields increased with increasing plant density over the range 8 to 60 plants/m^2, before peak yields were achieved. This optimum density appeared to be the same for each time of seeding and each genotype. Time of sowing had a large effect on yield (Table 1), with a yield reduction of about 50% occurring with each 4 weeks delay in sowing. The earliest flowering genotype, line 72, produced the highest yields at all seeding dates.

The following year an experiment was conducted to study the effects of time of seeding in greater detail. A split-plot design was used with dates of sowing (May 22nd, June 30th and August 1st) as the main treatments and five genotypes as the sub-treatments. Each genotype was sown at a density of 50 to 60 plants/m^2, in 20cm rows using a Walter and Wintersteiger seeder. The growing season was very favourable, with 462mm of rainfall recorded in April-October. Much higher yields were obtained in this wetter season. Once again, there was a pronounced decline in yield with delay in date of sowing for all genotypes (Table 1). This yield reduction was associated with fewer pods per plant and a reduction in mean seed weights. The number of seeds per pod was unaffected.

Table 1. The effect of time of sowing on the mean yields (kg/ha) of faba beans.

	Sowing date	Yield (kg/ha)	Pods per Plant	Mean 100 seed wt. (g)
1977 (dry)	June 4	990	-	-
	July 1	510	-	-
	July 29	270	-	-
1978 (wet)	May 22	5531	11.5	41.3
	June 30	4201	8.8	39.0
	Aug. 1	2829	5.8	34.3
	L.S.D. (p = 0.01)	1021	1.6	1.4

These experiments suggest that field beans are not well adapted to withstand dry conditions, but with favourable rainfall can produce relatively high yields. Early sowing appears to be very important for dryland production in the Mediterranean climate of South Australia.

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Vicia faba water requirement in the Sudan

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The high temperatures prevailing during the Sudanese growing season produce appreciable water stress at certain growth stages of faba beans. Research has shown that the frequency of irrigation is important in minimising this stress. The watering treatment also affects plant vigour and the susceptibility of roots to attack by wilt.

Watering regime.

Watering regimes have been studied by several workers in the past. Ali *et al* (1965;1966;1977) found that watering every week increased seed yield by 42% compared to watering every two weeks. Ayoub (1971;1972;1973) found that 8 day watering treatments gave yield increases of 22%,63% and 108% over 13, 18 and 23 day treatments respectively. Babiker (1975) reported that watering at weekly intervals increased grain yields by 92% over watering every two weeks. El Nadi (1970) has also studied the effect of differential irrigation on faba bean yields, as has Ageeb (1974). These two authors found that the reproductive growth phase was more sensitive to water stress than the vegetative phase. Ageeb (1976) also found that the interaction of sowing date and watering interval had a slightly significant effect on grain yield.

Water closure.

Recent work has shown that grain yields decreased with increases in the period of water closure. Highest yields have been obtained from plots which were irrigated until maturity. Two seasons' results indicated that the variety H.72 required 110 days from planting to the time of the last irrigation to produce high yields, and that shortening the periods of water availability would be likely to result in lower yields (Salih, 1977; 1978).

Future research.

Studies of water closure and its interaction with sowing date will be made. It is important that irrigation water be used economically so that any extra can be used for other crops. The response of faba beans to irrigation in relation to different plant growth phases will also be made. It is intended to determine the water requirements of the crop at different growth stages for water stress, in order to find the most economic method of irrigation.

Another project will study the yield performance of plants at four different plant densities and at two periods of water application (10 and 20 days). A multi-purpose experiment conducted at Hudeiba will have the following objectives: a. to determine the consumptive use of water by the crop (four water regimes on different soil types), b. to study the effect of soil temperature (i.e. differences between east and west sides of the ridge) on seed germination, crop life cycle and crop yield, and c. to study the effect of seed placement (i.e. top, east side and west side of the ridge) on yield as related to salt accumulation zones.

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Response of faba beans (*Vicia faba*) to N, P and K

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A national study was made to assess the response of faba beans to N, P and K to determine the optimum rate of fertilizer application. Two series of experiments were carried out. The first was a preliminary study to identify the major nutrient elements important for faba bean production which are at a low level in Egyptian soils. Fifteen field trials were conducted. The data obtained from the first series provided the base for the second series, the aim of which was to find the response of faba beans to different rates of N and P, and the interaction between the two elements when applied in different combinations. The relationship between the soil test values and the response of faba beans to N and P was also examined. Thiry-one field trials were conducted throughout the major faba bean producing regions of Egypt. Soil samples were assessed for fertility status and correlation coefficients were used to study the relationship between soil test values and percentage of yields.

The main findings of the two series can be summarised as follows:-

1. Faba beans responded significantly to N application at 18 and 36 kg N/ha, with yield increases from 9.4 to 10.5% above check treatments. However, there was no significant difference between the 18 and 36 kg N/ha treatments.
2. There was a high response by faba beans to P application with yields increasing steadily and significantly as the rate of application increased up to 72 kg P_2O_5/ha. Yield increase over controls were 9.8 and 15.7% *for the 36* and 72 kg P_2O_5/ha treatments respectively.
3. The maximum economic yield was obtained from 36 kg N/ha and 72 kg P_2O_5/ha. Under this treatment 1 kg N/ha was estimated to give an increase in yield of 8.1 kg bean seeds. Such increases in yield would secure a good return for farmers, based on local fertilizer prices.
4. No significant effect due to K application was detected, indicating that most Egyptian soils are rich in this element.
5. N- and P-index studies showed that about 80% of the field trials responded positively to N and P. There was no response in the remainder
6. The responses of faba bean plants to N and P applications were not well correlated to the soil test values. There is a need for a concentrated research effort on soil testing methods.

Irrigating faba beans

Effect of sowing date and watering interval on the incidence of wilt and root rot diseases in faba bean

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Faba bean (*Vicia faba*) is one of the most important food crops in the Sudan. It is mainly grown in the northern part of the country where the environmental conditions are most suitable for its production. In recent years wilt and root rot diseases have become the major factors affecting crop yield through their effect on the main component, plant population. The diseases are attributed to *Fusarium oxysprum* and *F. solani* f.sp. *fabae* respectively (Ibrahim and Hussein 1975, Freigoun 1975). Recent research has shown that all varieties grown are susceptible to the disease. Trials to test the application of fungicidal seed dressings as a control measure gave no satisfactory results - the tested chemicals gave no significant reduction in disease level. Research has therefore been directed towards breeding for disease resistance and studies of cultural practices which may reduce the adverse effects of the disease by providing conditions less favourable for disease development and more favourable for plant growth.

For three consecutive seasons an experiment was conducted to study the effect of sowing date and watering interval on disease incidence in three varieties under Hudeiba's natural conditions. Eight sowing dates at ten day intervals and three watering intervals (7,14 and 21 days) were combined in a factorial experiment with four replicates. Disease counts were taken at weekly intervals to study disease development and to assess the effect of the treatments on disease incidence throughout the season.

The results have consistently shown a highly significant effect of sowing and watering interval, and their interaction, on disease incidence, but differences between varieties were non-significant. The percent infection increased significantly with early sowing and decreased with short watering intervals (Table 1). The effect of watering interval was more pronounced in the early sowings where there was a greater demand for water by the plant. This was due to the high temperatures which were also more conducive to disease development. It has been generally observed that symptom development is quicker in treatments subjected to long watering intervals. These findings suggest that water stress predisposes the plant to infection.

Table 1. Effect of sowing date and watering interval on the incidence of wilt and root rot diseases of faba beans.

Sowing date	Mean % infection*		
	1 week	2 week	3 week watering interval
3 Oct.	39.5	46.4	53.0
13 Oct.	31.4	37.7	46.3
23 Oct.	26.8	38.0	41.0
2 Nov.	25.7	26.5	34.0
12 Nov.	17.6	20.2	24.8
22 Nov.	12.5	19.5	18.7
2 Dec.	7.0	12.3	10.6
12 Dec.	9.7	10.0	10.5

*SE ±3.1

It has been generally recommended that the optimum sowing date for faba beans is around mid-October. The results suggest that this should be shifted to late October or the first week of November. This is of particular importance as the watering interval practiced by farmers is between two to three weeks. Under such conditions the grain yield should be at its maximum (Salih 1977). Delaying the sowing date beyond this will expose the crop to other diseases, particularly broad bean mosaic virus and powdery mildew which are known to significantly reduce grain yields in late sown crops (Hussein and Freigoun, 1978).

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Scoring cold damage

Pests and Diseases

Botrytis pod rot of Vicia faba in England

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Botrytis cinerea is well known as one of the causes of non-aggressive chocolate spot on leaves of *Vicia faba* (Leach 1955) and of pod rot of *Phaseolus vulgaris* (Gane, King, and Gent 1975), but it has not been reported as a common or serious disease of pods of *Vicia faba*. However, in August 1979 severe pod rotting was observed in spring-sown breeding material at the Plant Breeding Institute, Cambridge, and on some crops in Essex. Pods were girdled with black lesions mostly originating at the end distal to the stem, and seeds in the affected parts of the pods had rotted or were discoloured (Plate 1). Many of the lesions were covered with a mass of conidiophores and conidia of *B. cinerea*.

The disease was more widespread on large-seeded cultivars (*V. faba major*) and infection on tick beans (*V. faba minor*) was confined to the tip of the pod. In a trial which included cultivars of *major*, *equina* and *minor*, the mean lesion length was significantly greater on Threefold White (*V. faba major*) than on Maris Bead and Blaze (*V. faba minor*). *Equina* types Beryl (Ite), Polar and BTW, which had been derived from *major* x *equina* or *minor* crosses, had lesions of intermediate length. Lesion length as % of pod length and frequency of infected pods were also less in the *minor* cultivars than in others.

Pod rotting was also observed in a 0.2 ha plot of F_2 and F_3 plants derived from a *V. faba major* x *minor* cross. A random sample of 316 plants from this F_2 showed that 58% of the plants were infected. Frequently only one pod per plant was infected although up to four rotted pods per plant were recorded. The majority of plants within the F_2 had fleshy pods of intermediate size, and so no association between thickness of pod wall and infection was apparent. However, thickness of pod wall and length of pod were positively correlated, and it was clear from the trial that longer-podded varieties were more severely infected than short-podded varieties.

The incidence of *Botrytis* diseases is greatest during cool moist conditions (Baker 1946), and chocolate spot of *V. faba* becomes aggressive only at high humidity, but the lesions of *Botrytis* pod rot in *V. faba* at Cambridge were observed towards the end of a long dry spell of weather (only 3 mm rain fell from 1 to 27 July). Moreover, in another trial, which included only *equina* and *minor* cultivars, irrigation decreased the incidence of pod rot.

Primary infection must have occurred during humid conditions which prevailed at flowering time during June; the fungus then probably remained latent in moribund tissues of the flowers and style until a change in the physiology of the pods, as a result of drought stress or senescence, allowed it to become aggressive.

There would be two important consequences if this previously unreported disease were to appear again. First, the value of commercial crops of *V. faba major* intended for direct human consumption or for preserving by canning or freezing could be considerably reduced. Secondly, as our observations on *V. faba* confirm the general description of *B. cinerea* as favouring fleshy tissues (Ellis and Waller 1974), it is possible that field bean breeding programs involving crosses with *V. faba major* (most of which have large fleshy pods) could introduce susceptibility to pod rot if selection for resistance is not practised. Segregates in the F_2 with short pods and small seeds all had thin pod-walls but the sample was small and it is not yet clear whether the thick, fleshy pod-wall and dense tomentum are closely linked with the long pod and large seed-size characteristic of *V. faba major*. If long pods and thick pod walls are not closely linked there is the possibility that some short podded, i.e. *minor* or *equina* derivatives of *major* x *minor* or *equina* crosses will be fleshy podded and very susceptible to *Botrytis* pod rot.

Amparo Martinez of INIA, Cordoba, Spain, brought some of the infected pods to our attention whilst working at Cambridge. M. Pope managed the field trials.

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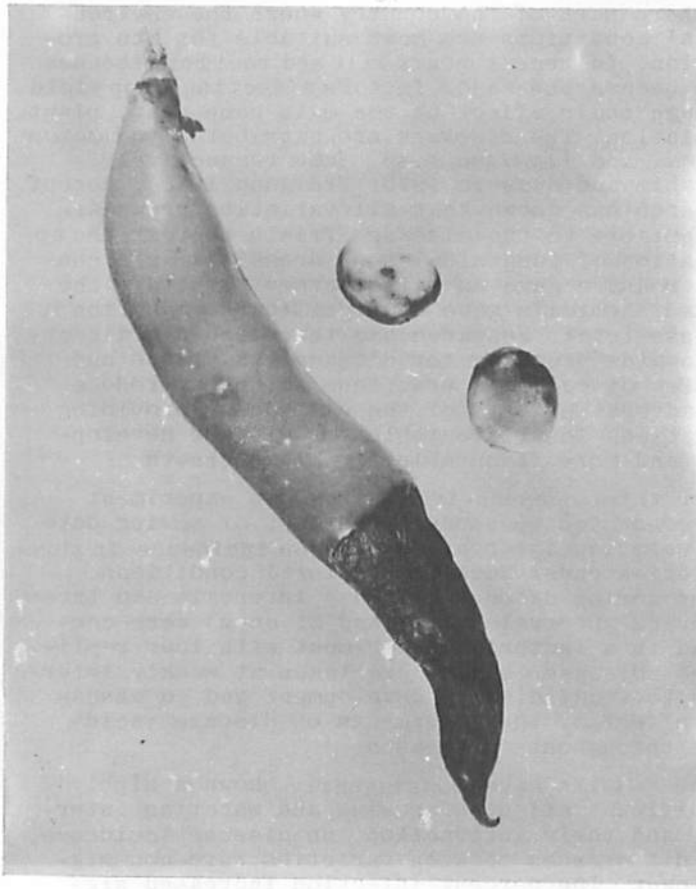

Fig. 1 Symptoms of *Botrytis cinerea* on a pod and seeds of *Vicia faba*.

A note on bean yellow mosaic and other viruses in Egypt

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Faba bean (*Vicia faba* L.) is an important and widely cultivated field crop in Egypt, and constitutes a cheap source of protein for a large proportion of the population. However, the crop is subject to periodic infection and attack by several viruses and insects.

The most widespread of all the viruses infecting faba bean is bean yellow mosaic virus. Broadbean true mosaic virus, broadbean stain virus, alfalfa mosaic virus, pea mosaic virus and several bean yellow mosaic virus strains have also been isolated from faba bean.

A strain of bean yellow mosaic virus, isolated from naturally infected faba bean, was used in a trial to test the susceptibility of 90 faba bean lines and cultivars. Five of these lines were considered resistant on the basis of percentage infection and on the time from inoculation when symptoms first appeared.

Fungicidal control of Ascochyta blight of faba beans

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Ascochyta blight caused by *Ascochyta fabae* has been the most destructive disease to date in Manitoba. It was observed in several fields in 1973 and caused severe defoliation and pod spotting in some fields. Use of laboratory-tested disease-free seed has since reduced the incidence to low levels. However, the disease can build up rapidly and the production of disease-free seed might prove difficult in years of above-average precipitation. Consequently, several systemic and non-systemic fungicides were evaluated as seed treatments.

In laboratory assays, all seed treatments containing the systemic fungicides benomyl or thiabendazole effectively controlled seed-borne *Ascochyta* but only soaking seeds in benomyl-thiram (0.2% a.i.) for 8 hours effected complete eradication. In field tests, however, none of the treatments significantly reduced seedling infection.

In an attempt to improve the effectiveness of the seed treatment, the fungicide carbendazim (trade name Delsene) which contains the active ingredient of benomyl in a form immediately available was used instead of benomyl. The fungicide was used in water or dichloromethane for seed soaking or as a slurry for treating faba bean seed containing 65% seed infected with *A. fabae*.

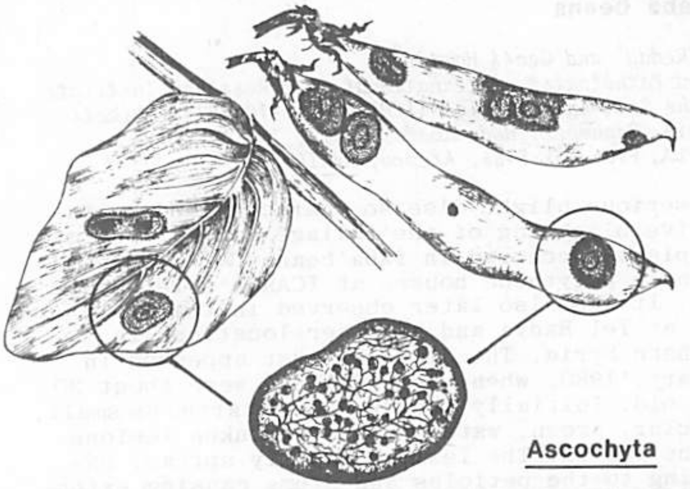
Pre-emergence and seedling rot (*Rhizoctonia* spp; *Fusarium* spp.) was quite severe. Delsene slurry significantly improved emergence (Table 1). As usual, not all *Ascochyta* infected seeds gave rise to *Ascochyta* infected seedlings. Effective control of seed-borne *Ascochyta* by Delsene-water soak or Delsene slurry was demonstrated in both laboratory and field tests. However, although a seed soak in Delsene significantly reduced the number of infected seedlings, complete eradication was again not achieved. Dichloromethane which is reported to enhance uptake of chemicals into dry seeds was no better than water as a carrier and caused stunting in about 25% of the seedlings as well as variegated leaves.

Table 1. Control of *Ascochyta* blight of fababeans by seed treatments.

Seed treatments at a rate of 0.2% a.i.	Field: Mean emergence	Field: %*Ascochyta* infected seedlings	Laboratory: %*Ascochyta* colonies on PDA
Mertect-160 60 W in DCM-24 hr soaking	102.7 a	2.1 b	9
Delsene 40F in DCM*-24	109.0 a	3.7 c	15
Delsene 40F in water - 12 hr soaking	113.8 a	0.1 a	0
Delsene 40F - slurry	153.5 b	1.1 b	0
Control (no treatment)	99.0 a	5.9 d	65

Column means followed by same letter do not differ significantly (P = 0.05) according to Duncan's Multiple Range Test. *DCM = Dichlormethane.

The ability of *Ascochyta* blight to build up rapidly is demonstrated in the results of a field experiment where, under moderately good conditions for disease development, 1% infected seedlings (foci) in the test plots gave rise to 27% infected seed in the harvested seed. This clearly indicates the seriousness of the disease and the need to use seed stocks that are disease-free.



The inability of dry seed treatments to eradicate the fungus prompted us to assess the effectiveness of foliar applications of fungicides in preventing the spread of the disease in the field and in reducing the amount of seed infection. In field tests, two sprays of 0.1 percent chlorothalonil, a non-systemic fungicide, applied at three-week intervals significantly reduced disease severity and to some extent protected the seeds from infection in such a suceptible cultivar as Erfordia.

All cultivars recommended for Manitoba are susceptible to *Ascochyta* blight. However, Ackerperle was found to be less susceptible than cvs Erfordia, Diana, or Hertz Freya. A comparison was made between Ackerperle and Erfordia for their ability to restrict the spread of the disease in the field. The two cultivars were seeded in individual 6m x 6m blocks and replicated six times. In a corner of each plot, four plants were inoculated with a highly virulent isolate of *A. fabae* to create a focus of infection. The number of plants infected during the next seven weeks and the percentage of infected seeds in the harvest were significantly higher in Erfordia than in Ackerperle. We also investigated the influence of cultivar on the control of this disease by fungicidal sprays. Two sprays of 0.1 percent chlorothalonil as described above gave significantly better control in Ackerperle than in Erfordia and completely prevented seed infection in Ackerperle.

Our studies thus indicate that seed soaking in benomyl-thiram or Delsene (0.2% a.i. for 8-12 h) can be effectively utilized to produce *A. fabae*-free seed in small lots of breeder's seed. On a large scale, where seed soaking may not be practical, seed treatment with Delsene coupled with two to four sprays of chlorothalonil (0.1% a.i.) seems to be promising.

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Occurrence of a bacterial blight disease in faba beans

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A serious blight disease characterised by extensive blighting of the foliage and killing of the plants occurred in faba beans (*Vicia faba* L.) grown in polythene houses at ICARDA's Tel Hadya farm. It was also later observed in the field both at Tel Hadya and at other locations in Northern Syria. The disease first appeared in January, 1980, when the seedlings were about 30 days old. Initially the symptoms started as small, circular, brown, water soaked shrunken lesions on the leaves. The lesions rapidly spread, extending to the petioles and stems causing extensive blighting and killing of the plants (Fig.1). However, the root system of the affected plants remained apparently normal.

The blighted plants did not show any external visible structures of fungi. Incubation of the blighted tissues in moist petri plates overnight also did not result in any visible fungal growth. Microscopic examination of the blighted tissues failed to reveal any fungal structure. However, fresh cuts through blighted tissues of leaves and stems in a drop of water showed extensive oozing, characteristic of bacterial cells. Isolations on potato dextrose agar plates gave pure culture of a bacterium. The colonies in the beginning were translucent but later turned to yellowish. The bacterium was found to be a rod and gram negative. Pathogenicity tests on susceptible cultivars resulted in the development of typical symptoms. The bacterium is suspected to be a species of *Xanthomonas* and has been sent to the Commonwealth Mycological Institute, Surrey, U.K., for a confirmation and identification.

From a search of over 4,000 references on *Vicia faba* (from 1973) only two, one from Russia and one from Germany, mentioned bacterial diseases (*X. phaseoli*). These are given below.

Fig. 1. Symptoms of a bacterial blight disease on a faba bean seedling.

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Detached leaf technique for infection of faba bean plants (*Vicia faba* L.) with *Botrytis fabae*

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Introduction

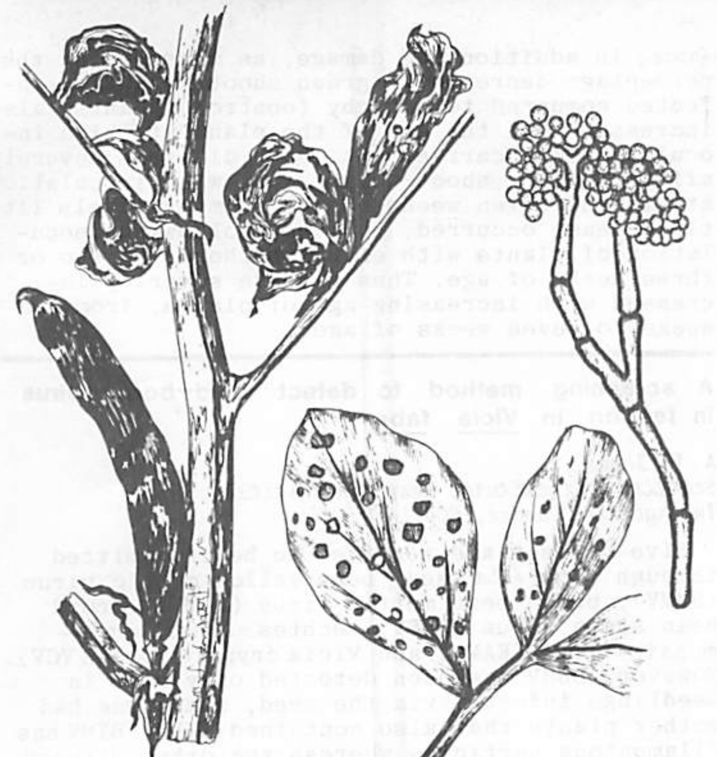
Faba beans in Egypt are subject to serious losses due to diseases, particularly in the northern parts of the Nile Delta where the climatic conditions lead to high leaf spot infection. Chocolate spot (*Botrytis fabae* Sard.) is responsible for most of the damage, especially with early sowing dates. Low temperatures and high humidity are known to be conductive to severe infection by this pathogen, so varietal evaluation under normal field conditions may be of limited use. We decided therefore to test lines and cultivars by artificial inoculation. We thought that the detached leaf test would facilitate the screening of lines and populations before the standard testing in the glasshouse or under field conditions.

Method

Trays (48x 30 cm) were filled with washed sand, 3 to 5 cm in depth. Sand was moistened, but there was no free water in the tray. Detached leaflets, from the same position on the stems, were placed on the moistened sand with upper surface above, after being washed with distilled water. Leaflets were sprayed with standard volumes of spore suspensions (prepared from cultures 10 to 15 days old) of known concentrations using an atomiser. Trays were then covered with polyetheleyne sheets to maintain high relative humidity (90-95%). Trays were kept in the glass-house at an average temperature of 20°C.

Four tests were carried out during the 1978 and 1979 growing seasons. The first (Test A) was conducted on March 22nd 1978 using leaflets from plants of the commercial cultivar Giza 2 grown in the field. Plants were in the pod filling stage. The second test (Test B) was conducted on April 9th 1978 using leaflets from plants grown inside and outside the glasshouse, which represented different growth stages as follows: six week-old plants, plants in the pod filling stage and plants approaching maturity. Two concentrations of the spore suspension (75,000 and 150,000 spores/ml) were used, and each treatment was replicated four times. Notes were recorded when symptoms started to appear (12 hours after inoculation) and daily for three days.

The third test (Test C) was conducted on April 30th 1978 using five cultivars and one concentration of the spore suspension (75,000 spores/ml). Treatments were completely randomised and replicated four times. Notes were recorded two days after inoculation. The fourth test (Test D) was conducted during February 1979 to examine a number of parents and their F_1's, comparing them with the susceptible cultivar Fam. 402. Treat-



Botrytis fabae

ments were randomised and replicated five times in one tray. Leaflets were sprayed with 75,000 spores/ml on February 11th and final notes were recorded three days after inoculation.

Results

In Test A, disease symptoms appeared 12 hours after inoculation, as very minute spots crowded on the leaflet surface (due to the high concentration of 470,000 spores/ml). After 24 hours the number and size of the lesions increased. Lesions continued to enlarge and coalesce and five days after inoculation large areas of the leaflets were discoloured. Test B showed that leaflets from plants grown in the glasshouse were more readily and severely infected than those grown in the open field. Symptoms appeared within six hours on leaflets of plants grown in the glasshouse. Lesions were many, and developed very quickly to the extent that all the leaflets were covered, and some completely discoloured, within four days. Leaflets from plants approaching maturity were more easily infected than those from younger plants. Increasing the number of spores/ml increased the number of lesions. The increased infectivities of larger inoculum densities were of the same order on the oldest and most susceptible as on the youngest and most resistant leaves.

The results of Tests C and D are presented in Tables 1 and 2 respectively.

Table 1. Reaction of detached leaflets of five faba bean cultivars to infection with *Botrytis fabae*.

Cultivar	% infection	Remarks
NEB 519	14	–
Giza 1	20	–
Giza 3	25	lesions large, some coalescence
Giza 2	28	lesions small, numerous, but no coalescence
Rebaya 40	92	leaves black due to severe infection.

Table 2. Reaction of some *Vicia faba* cultivars and F_1 plants to infection with *Botrytis fabae*.

Cultivar or F_1	Replicates: I	II	III	IV	V
Fam.40	MS-S	MS-VS	S-VS	MR-MS	MS
139 A/77	MS-S	MS	R	MS-S	MR-MS
F_1NEB 938x139 A/77	VR	VR	R	R	MR
NEB 938	R	VR	VR	VR	R
F_1NEB 938xGiza3	R	R	R	MR	MR
Giza 3	MS	R	MS	MR	MR

VR: highly resistant - no lesions.
R: resistant, very few lesions, resistant type.
MR: moderately resistant, few lesions, moderately resistant type.
MS: moderately susceptible - lesions larger in size (2-3 mm) and covering the leaflet.
S: susceptible- lesions larger and starting to coalesce and cover leaflet.
VS: very susceptible - lesions large and coalesced and covering the leaflet; part of the leaflet black in color.

The results of these four tests clearly indicate the efficiency of the detached leaf technique in testing lines for their reaction to chocolate spot (*Botrytis fabae* Sard.). Results can be determined within a few days using only a few leaflets of the plants. The same plant can be tested with several pathogens and isolates in the same growing season. The same technique has also been used to study the infection of detached leaves of faba bean plants with the rust caused by *Uromyces fabae*; the results are promising.

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Susceptibility of faba beans of different ages to infection by Botrytis fabae and Ascochyta fabae

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The susceptibility of *Vicia faba* bean plants of different growth stages, to chocolate spot (*Botrytis fabae*) and *Ascochyta* blight (*A. fabae*) was investigated. Plants of 6 different age categories (two, three, four, five, six and seven weeks from planting) were grown in 30 cm diameter plastic pots containing methyl bromide-treated soil. Five plants were raised per pot. Isolates of *B. fabae* and *A. fabae*, obtained from naturally infected faba bean leaves in the Lattakia coastal region of Northern Syria, were grown on faba bean dextrose agar in an incubator at 22°C. After three days the plates were exposed to an alternating cycle of 12 hours white light and 12 hours dark for a period of two weeks to induce sporulation. A spore suspension containing 300,000 spores per ml of water was prepared for both *A. fabae* and *B. fabae*, by homogenizing the contents of the plates in a blender, straining through a cheese cloth and diluting with tap water to the desired spore density. Each treatment was replicated four times.

The plants at the various growth stages were inoculated by spraying the leaves with 25ml per plant of either *B. fabae* or *A. fabae* spore suspensions. A further set of plants of each age category were sprayed with only water as a control. The pots were then placed in individual polythene-covered moist chambers for 5 days. The relative humidity and temperature inside the chambers were 98% and 20°C respectively.

At the end of the 5 day period the plants were removed from the chambers and after a further nine days in the open were rated for disease reaction on a 1 to 9 scale as follows:

Rating	Reaction
1	No disease symptoms
3	Few small discrete lesions
5	Lesions common; some coalesced lesions
7	Large coalesced lesions with some defoliation
9	Extensive lesions with severe defoliation

In addition to the disease rating the fresh weight of the above soil plant parts was measured in each treatment.

The results given in Table 1, clearly indicate that as the plant age increased from two to seven weeks, there was a corresponding increase in disease severity of both *Botrytis fabae* and *Ascochyta fabae*. In addition the damage, as measured by the percentage decrease in green shoot weight of infected compared to healthy (control) plants, also increased with the age of the plant at which inoculation was carried out. Both diseases severely affected green shoot weight following inoculation at six and seven weeks of age. Comparatively little disease occurred, however, following inoculation of plants with either pathogen at two or three weeks of age. Thus disease severity increased with increasing age of plants, from two weeks to seven weeks of age.

Table 1. Disease severity and plant damage caused by *Botrytis fabae* and *Ascochyta fabae* on faba bean at different growth stages.

Plant Age (wks. from sowing)	Disease Rating			%decrease (c.f. control) in green shoot wt. following infection	
	Control	*Botrytis fabae*	*Ascochyta fabae*	*Botrytis fabae*	*Ascochyta fabae*
2	1.0	2.3	2.3	0.7	1.3
3	1.0	2.3	2.3	1.0	1.7
4	1.0	6.0	5.0	4.6	3.5
5	1.0	6.0	5.6	29.8	44.2
6	1.0	8.0	6.7	54.8	52.6
7	1.0	8.3	8.0	59.6	54.1

A screening method to detect seed-borne virus in fection in Vicia faba

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Five viruses are reported to be transmitted through *Vicia faba* seed: bean yellow mosaic virus (BYMV), broad bean mottle virus (BBMV), broad bean stain virus (BBSV), echtes ackerbohnen-mosaik-Virus (EAMV) and Vicia cryptic virus (VCV). However, BBMV has been detected only once in seedlings infected via the seed, and these had mother plants that also contained BYMV. BYMV has filamentous particles whereas the other viruses have isometric particles about 30 nm in diameter. VCV infects plants symptomlessly and the other four viruses induce a chlorotic mottle or mosaic of varying intensity in *V. faba* plants.

In Scotland, to detect infection with these viruses in *V. faba* seed, samples of seed (100-200) are sown in spring in shallow seed trays. Symptoms may not become obvious in warm conditions, so the seedlings are kept in cool, frost-free glasshouses. If possible, seed is also sown in the field. The seedlings are examined regularly for virus-like symptoms for up to two months after emergence. Sap from symptom-bearing plants is examined in the electrom microscope to search for the filamentous particles of BYMV and is tested by the agar gel-diffusion method for its ability to react with antisera to BBMV, BBSV, and EAMV. Where facilities for these tests are not available, the four viruses can be distiguished by their differential reactions in *Chenopodium amaranticolor*, *Phaseolus vulgaris* and *Pisum sativum* (Table 1).

Table 1. Reactions of *Chenopodium amaranticolor*, pea and French bean to infection with BBMV, BBSV, BYMV and EAMV.

Plant species	Reaction to infection with:			
	BBMV	BBSV	BYMV	EAMV
C. amaranticolor	CLL, not S	immune	CLL, S S veinal chlorosis	immune
Pisum sativum	S, lethal wilt	SM, some N	SM	severe SM, occasional SN
*Phaseolus vulgaris** cv. 'The Prince'	S, interveinal M	diffuse CLL, SM	CLL or NLL, SM	discrete NLL, not S

C = chlorotic, LL = local lesions, S = systemic, M = mottle or mosaic, N = necrosis.
* Other cultivars of *P. vulgaris* may react differently.

The presence of VCV cannot be determined by symptomatology or serology at present. Instead, sap from about 20 symptomless seedlings is extracted in 0.5 m phosphate buffer containing 1% asorbic acid (final pH 8) in the ratio 1 g leaf: 2 ml buffer. After squeezing through muslin, the extract is stirred with an equal volume of a 1:1 mixture of n-butanol and chloroform overnight at room temperature. After low speed centrifugation the aqueous phase is centtrifuged for 2 hours at 80,000 g and the pellets resuspended in very dilute NaOH (pH 8). Preparations are then examined in the electron microscope for the presence of isometric virus-like particles. Most of such preparations contain only a few VSV particles but their attachment to electron microscope grids can be enhanced by floating the grids on the preparations for 1 to 2 hours (Jones, 1980). Infectivity tests to the species in Table 1, or serological tests, are then made to confirm that any isometric particles seen in such preparations are not associated with latent infections with BBMV, BBSV or EAMV.

Recent tests in Scotland on European *V. faba* seed stocks detected VCV in 7 of 14 stocks and BBSV, EAMV and BYMV in 5, 4 and 1 respectively of 49 stocks.

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Effect of gamma radiation on development stage of the pulse beetle (Callosobruchus chinensis L.)

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To avoid the problems associated with the use of insecticides, studies have been made to develop other suitable methods of pest control. The work described here was on the use of gamma radiation in controlling the pulse beetle, a serious pest of faba bean (*Vicia faba*) in Egypt.

All insects used in the study were progeny of insects reared on faba bean at 30°C and 65± 5% humidity. The development stages used were 1 day and 3 day old eggs, 7 day and 15 day old larvae, 3 day old pupae and 2 day old adults. The stages were irradiated with Co^{60} radiation, larvae and pupae being irradiated when they were inside the seeds.

The results given in Table 1 show that 3 day old eggs were more tolerant to radiation than the 1 day old ones. One day and 3 day old eggs treated with a dose of 1 Kr or more produced larvae which could not complete their life cycles. Radiosensitivity of larvae depended on age; 7 day old larvae were more sensitive than 15 day old ones. Females produced by irradiated larvae gave fewer eggs with increased dose intensity. Eggs laid by adult females produced from treated 7 day old and 15 day old larvae (at certain doses) did not hatch.

Pupal mortality increased as dose increased, with LD_{50} of 5.6 Kr. The mean number of eggs laid by females which emerged from treated pupae decreased as the dose increased. Eggs laid by females which emerged from pupae treated with 6 Kr. or more did not hatch. The LD_{50} of 2 day old adults was 162 Kr. Females exposed to 140 Kr. or more did not lay eggs; eggs laid from females exposed to 100 Kr. or more did not hatch.

The results suggested that the use of gamma radiation could be an effective method for controlling the pulse beetle and possibly other pests of stored grain.

Table 1. Effect of gamma radiation on the development stages of C. *chinensis*.

Stage	Radiation dose and % mortality (%M)							LD_{50}
1 day old eggs	Dose (Kr.)	0.5	1.0	1.5	2.0	2.5		
	%M	35	70	78	89	100		0.72
3 day old eggs	Dose (Kr.)	0.5	1.0	1.5	2.0	2.5	3.0	
	%M	17	27	32	34	46	76	3.00
7 day old larvae	Dose (Kr.)	0.4	0.8	1.2	1.6	2.0		
	%M	13	22	55	66	100		1.2
15 day old larvae	Dose (Kr.)	1	2	3	4	5		
	%M	14	23	35	41	54		4.8
3 day old pupae	Dose (Kr.)	3	6	9	12			
	%M	31	46	64	80			5.6
2 day old adults	Dose (Kr.)	100	120	140	160	180	220	
	%M	37	43	57	64	75	86	162

Chemical control of Orobanche crenata in Vicia faba

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Broomrape (*Orobanche crenata* Forsk.) is a great obstacle to faba bean (*Vicia faba* L.) production. In Egypt the area allotted to faba beans has decreased remarkably. The reduction in terms of area and production during the ten year period 1969 to 1978 amounted to some 41,440 ha (29.2%) and 63,850 tons (22.2%) respectively, largely due to broomrape infestation. Although investigations into broomrape control have progressed, no acceptable measure has yet been adopted. As a continuation of earlier work, a series of pot and field trials were undertaken over the six seasons 1974 to 1979.

The two herbicides glyphosate (360 g a.i./l) and pronamide (50% w.p.) were studied in detail. Glyphosate may be effective against broomrape through its action as a phloem mobile herbicide

Orobanche and Vicia faba

(Rioux *et al*, 1974; Lundi-Hoie, 1976). Glyphosate is applied to the host and becomes concentrated in the parasite. The chemical moves into the underground organs more readily than 2,4-D (Lange *et al*,1973; Wyrill and Burnside, 1976). Pronamide (propyzamide) is a pre- and post- emergence selective herbicide used for new and established small-seeded legumes. Previous studies have been made by Dawson (1969) and Kasasian (1973).

Glyphosate.

Past work has indicated that glyphosate is effective when applied as a post-emergence foliar spray at low rates (72 to 108 g a.i./ha) once, or repeatedly at two to three week intervals, starting five to eight weeks after sowing (Kasasian, 1973; Zahran, 1974; Basler, 1979 and Schluter and Aber, 1979).

Table 1. Effect of glyphosate at different rates applied as four sequential foliar sprays on *Orobanche crenata* (Giza, 1977, pot trial)

Rate (ml/ha)	% reduction, *O. crenata* No. of spikes	Fresh wt. of spikes	Dry weight of spikes
120	46c	67c	74c
180	71b	89b	88b
240	95a	98a	98a

Table 2. Effect of application of 240 ml glyphosate/ha at three week intervals on *O. crenata* and *V. faba*.

Site	Year	*O. crenata* % reduction in spikes	Check (1000 spikes/ha)	*V. faba* seed yield % of check	Check (ton/ha)
Ashmoon	1976	71	36	150	0.6
	1977	88	85	218	1.1
	1978	53	4	114	1.4
	1979	70	18	143	2.3
Sakha	1978	97	42	475	0.4
	1979	84	23	153	1.7

The results are summarised in Tables 1 and 2 and show the glyphosate could be effective when applied accurately. The most appropriate application was that of four sequential sprays each of 0.240 l/ha at three week intervals, beginning at the onset of flowering of the host plant. The volume rate with the knapsack sprayer used did not exceed 500 l/ha.

Glyphosate may be effective against broomrape through its action as a translocated phloem-mobile herbicide (Rioux *et al*, 1974). Whitney (1973) showed that there was a rapid transport of a wide range of materials across the fusion region between the *V. faba* root and *O. crenata*.

Pronamide.

Pronamide (propyzamide) is a pre- and early post-emergence selective herbicide for small-seeded legumes. Dawson (1969) showed that pronamide controlled dodder. Kasasian (1973) noted that pronamide applied either as PPI or pre-emergence failed to control *O. crenata* in *V. faba*, but did not injure the host plant.

Results from present work are given in Table 3 where they can be compared to those for glyphosate. The effectiveness of the herbicide was most pronounced when the solution was sprayed onto the soil and the host plants four weeks after sowing, with application rates of 7.5 to 10.0 kg/ha and a volume rate of not less than 1500 l/ha.

Table 3. Effect of different rates of pronamide (one spray) and glyphosate (three sprays) on *O. crenata* (Sakha, 1979, field trial).

Herbicide	Rate of application (kg/ha)	*O. crenata* % reduction in No. of spikes	Wt. of spikes
pronamide	5	45b	51b
	7.5	93a	87a
	10	96a	96a
glyphosate	0.24 (3 times)	87a	83ab
Check values:	—	$273/m^2$	$460g/m^2$

In a demonstration field at Sakha in 1979, pronamide was superior to glyphosate in performance. However, both herbicides will be studied further in extended trials in the coming season.

Acknowledgement:

This work was partly financed by the USA Department of Agriculture Research Service (PL 480).

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Stem nematode (Ditylenchus dipsaci) a seed and soil-borne pathogen of Vicia faba

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The stem nematode, *Ditylenchus dipsaci*, occurs in several biological races, some of which are known to attack broad beans (*Vicia faba major*) and field beans (*Vicia faba minor/equina*) (Sturhan, 1975). This nematode, particularly the fourth stage juvenile, can withstand desiccation and consequently can be dispersed in dried plant debris and especially on seed.

The stems of infested *V. faba* plants show a reddish-brown discolouration that blackens with age. It usually begins at the base of the plant but may extend to the pod bearing region. Symptoms are most easily seen when pods are formed but still green; however the brown/black stems are easily confused with early senescence.

The oat race of *D. dipsaci* was first recorded on field beans in England by Ritzema Bos (1892) and the giant race on broad beans in North Africa by Debray and Maupas (1896). The giant race is very devastating on field and broad beans and often causes severe distortion of stems, leaf petioles and pods; seeds from infested pods may be blackened with cracked testas, individual seeds can be infested with up to 10,000 *D. dipsaci*.

Both the oat race and the giant race are known to be seed borne (Hooper, 1971) and although the first crop from infested seed may not be much harmed, large soil populations produced can cause severe losses in subsequent *V. faba* crops. Both races of *D. dipsaci* can survive in soil for several years without a host crop and the oat race can attack several other important crops in addition to oats.

The giant race is known to be a serious pest of broad beans in the Mediterranean region and especially in Portugal (Goodey, 1941); also severe local infestations of oat race and giant race are known in England (Hooper, 1971) and Germany (Diercks and Klewitz, 1962).

There is a very real danger of the introduction and dispersal of *D. dipsaci* with *V. faba* seed but stocks can easily be checked for this pest by soaking seeds in water for about 12 hours and examining the extract with a stereoscopic microscope (30-50X magnification).

Infested seed stocks can be fumigated with methyl bromide to control *D. dipsaci* but the concentration of fumigant required may decrease the germination of *V. faba* seed and might not eradicate the nematodes from heavily infested seeds (Powell, 1974).

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Report of stem nematode (Ditylenchus dipsaci) on faba bean in Syria

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[2] *Institute fuer Pflanzenkrakheiten, Nussallee 9 5300 Bonn 1, WEST GERMANY.*

The stem nematode *Ditylenchus dipsaci* (Kühn, 1857) Filipjev 1936 was detected on *Vicia faba* in farmers' fields near Jenderia, Berjan, Ashrafia, El-Bassa, Jable, and Lattakia near the Mediterranean coast of Northern Syria. The number of diseased plants at three locations exceeded 80 percent. Seed produced in Homs, collected at the Lattakia market, was also heavily infested with the nematode.

Symptoms of damage were similar to those described for *D. dipsaci* on this crop in other countries bordering the Mediterranean, e.g. Morocco (Schreiber 1977). The stem nematode has also been reported in Jordan by W. Abu Gharbiah at the University of Jordan, Amman.

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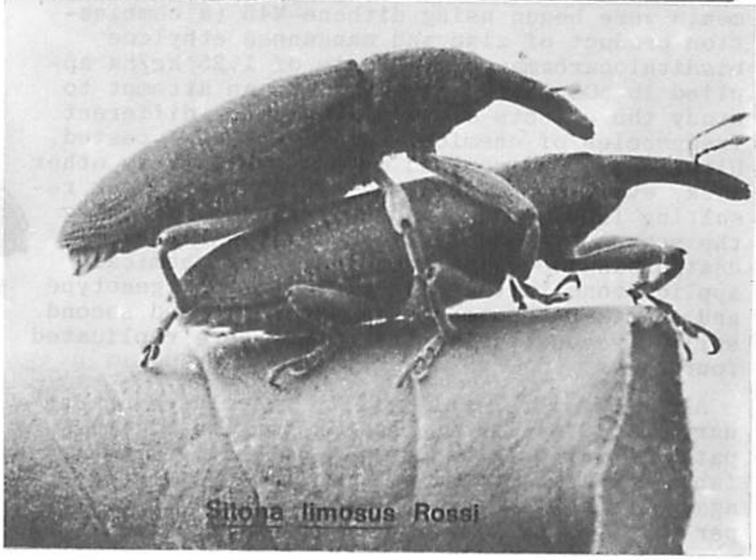
Schreiber, E.R. (1977).'Lebensweise, Bedeutung und Bekampfungsmoglichkeiten von *Ditylenchus dipsaci* (Khun) Filipjev an Ackerbohnen *Vicia faba* L, in Marokko'. Ph. D. Thesis, Technical University of Berlin, 150 pp.



Sitona limosus Rossi

Lamium amplexicaule L. as host plant of the stem nematode Ditylenchus dipsaci in Syria

Mairianne Weltzien and Heinrich C. Weltzien
ICARDA, P.O. Box 5466, Aleppo SYRIA.

Ditylenchus dipsaci seems to be widespread on *Vicia faba* in Syria and other countries of the Mediterranean region. Its potential as seed parasite calls for careful observation and control. Alternative hosts need to be studied, to find possible sources of infection. In a highly infected faba bean field near Ayn Laban on the Aleppo - Lattakia highway, numerous plants of the common weed *Lamium amplexicaule* showed suspicious gallike swellings of stem parts with a reddish discoloration. They were heavily infested with all growth stages of *Ditylenchus dipsaci*, including eggs. We owe the confirmation of the nematode sp. to R. Sikora. The nematodes were first found on February 19 and again observed on April 7, 1980. As *L. amplexicaule* is an almost cosmopolitan weed, which originated in the Mediterranean region, it should be included on any survey work on *Ditylenchus* distribution. It can not be excluded, that other members of the weed flora of Syria serve as *Ditylenchus* hosts as well.

Effect of chemical treatments and host genotypes on disease severity/yield relationships of Ascochyta blight in faba beans

Salim Hanounik
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Ascochyta blight caused by *A. fabae* is a serious disease of faba beans (*Vicia faba* L.) (Hewett, 1973). In Syria destructive epiphytotics can occur, particularly when damp, cool weather conditions prevail early in the season. Although *Ascochyta* blight is a seed borne disease, fungicidal seed treatments do not provide adequate crop protection (Maude *et al*, 1969). However, foliar fungicidal applications have been more successful in reducing disease severity (Kharbanda and Bernier, 1976). The work described here was a study of the combined effects of chemical treatments and host genotypes on disease severity/yield relationships of *Ascochyta* blight in faba beans.

A differential host reaction was established by using the local *V. faba major* cultivar (moderately resistant to *Ascochyta* blight) and a susceptible cultivar, Giza 4, from Egypt. Seeds were sown on October 17, 1978, in 4x4 m plots in the field. Row and plant spacing were 65cm and 20cm respectively. One month after seeding, chemical treatments were begun using dithane-M45 (a combination product of zinc and manganese ethylene bisdithiocarbamate) at a rate of 1.25 kg/ha applied in 500 litres of water. In an attempt to study the effects of this fungicide, different frequencies of chemical treatments were tested. Dithane-M45 was applied once a week, every other week, every third week and every fourth week resulting in 24, 12, 8 and 6 applications during the season, respectively. A split-split-plot design was used with frequencies of chemical applications in the main plot and host genotype and chemical treatments in the first and second splits, respectively. Treatments were replicated four times.

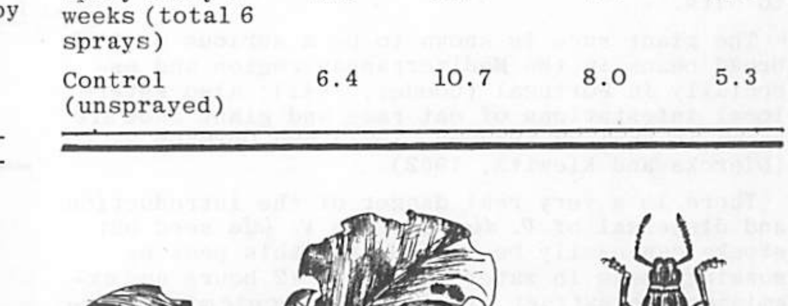
All plots were artificially inoculated on January 25, 1979 with *A. fabae*. An isolate of this pathogen was obtained from a naturally infected faba bean leaf, propagated on faba bean-dextrose-agar, and applied at the rate of 150,000 spores per ml of water. The amount sprayed per plot was calculated on the basis of 25ml of this suspension sprayed on each plant. Relative humidity and temperature at time of inoculation were 90% and 10°C, respectively. The disease severity was rated on a 1 to 9 scale in which plots free from disease symptoms were rated 1 and plots with very extensive defoliation and other plant damage were rated 9. The yield of green beans (fresh weight of whole pods) was also measured in each plot.

A summary of the results is given in Table 1. The susceptible cultivar Giza 4 showed significantly higher disease ratings than the moderately resistant local cultivar. It also responded proportionally better to fungicide application with weekly sprays resulting in a 91% increase in yield over the control compared to a 50% increase in the case of the local cultivar. Even with weekly applications of the fungicide it was not possible to completely control the disease in either cultivar. However, both disease severity and yield responded to the fungicide, even when sprayed at monthly intervals. In both cultivars, increasing the frequency of application from monthly to weekly intervals, resulted in better disease control and higher yields.

At a cost of approximately $3.00 per kg for Dithane M45, and with average prices of green faba beans at around $0.25 per kg during the season, it should be highly economic for farmers to apply the fungicide in seasons when the risk of severe *Ascochyta* blight epidemics is high.

Table 1. *Ascochyta* blight severity and green pod yield in faba beans following different applications of the fungicide Dithane M-45.

Treatment	Local cv.		Giza-4	
	Disease rating	Green pod yield (tons/ha)	Disease rating	Green pod yield (tons/ha)
Spray every week (total 24 sprays)	1.69	16.0	3.7	10.1
Spray every 2 weeks (total 12 sprays)	2.8	14.0	4.8	7.9
Spray every 3 weeks (total 8 sprays)	3.0	13.5	5.9	7.6
Spray every 4 weeks (total 6 sprays)	5.0	11.7	7.4	5.6
Control (unsprayed)	6.4	10.7	8.0	5.3



Sitona lineatus

Ascochyta and Sitona damage on faba bean

Seed Quality and Processing

Effect of cooking on the chemical composition of faba bean seeds

Kamal M. El-Shahy, Aziz H. Fahmi and Ahmed S. Hamed
Seed Technology Research Section, Agricultural Research Center, Giza, EGYPT.

Studies have shown that there is a positive relationship between phosphorus and thiamine content in both cooked and uncooked faba bean seeds. This suggests the presence of thiamine in the form of B_1-pyrophosphoric acid ester. This is in agreement with Rosenberg (1945).

Table 1 shows that cooking had a marked affect on the phosphorus, phosphate and thiamine contents of faba bean seeds. The percentage of phosphorus and phosphate in Giza-1 seeds fell from 1.1 and 3.4% before cooking to 0.8 and 2.5% after cooking while the amount of thiamine fell from 200γ/100g before to 140γ/ 100g after cooking. In contrast, the amounts of ash, fats, proteins, fibres and starch were only slightly affected by cooking. It was also observed that Giza-1 seeds lost much more of their mineral constitutents through cooking when compared to Rebaya-40. This may be explained by the difference in their cooking ability*, which for Giza-1 was 89.3%, for Rebaya-40 45.7%.

Table 1. Effect of cooking on the constituents of two faba bean varieties.

Seed Constituents	Composition of seed (based on dry weight)			
	Giza 1		Rebaya 40	
	before	after	before	after
ash (%)	3.70	2.50	4.10	4.00
fats (%)	2.50	2.10	2.10	1.40
proteins (%)	26.40	25.80	28.10	27.20
starch (%)	43.80	44.40	28.10	44.10
fibers (%)	6.35	6.01	6.84	6.50
phosphorus(%)	1.10	0.80	0.80	0.50
phosphate (%)	3.37	2.45	2.45	1.53
thiamine(γ/100gm)	200	140	180	100
pH value	6.0	6.5	6.1	6.4

There was a high correlation between pH value of cooked seeds and cooking quality. This is in agreement with the work of Youssef who also found a correlation (r = 0.79) in faba bean seeds.

*Cooking ability % = $\frac{A}{A + B}$ x 100% where A = wt. of cooked seeds, B = wt. of uncooked seeds.

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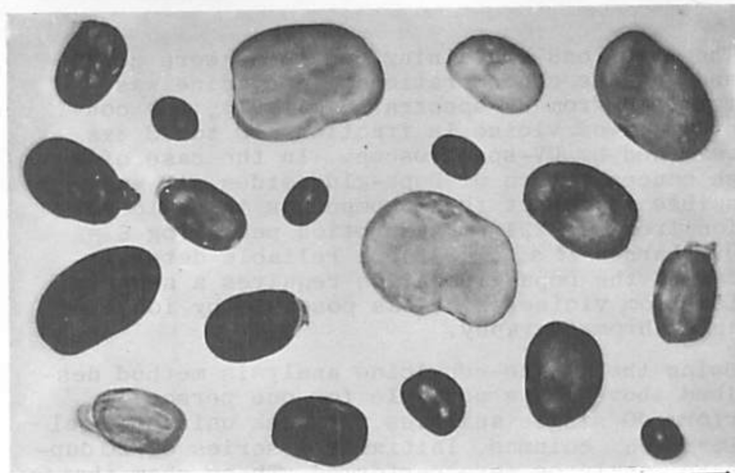
Youssef, M.M.M. (1978). 'A study of factors affecting the cookability of faba beans (*Vicia faba*)'. Ph.D. Thesis, Faculty of Agriculture, Alexandria University, Egypt.



Quantitative estimation of favism releasing factors in Vicia faba seeds

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A plant breeding project has been initiated to investigate the feasibility of eliminating or reducing the content of antinutritional and 'favism releasing factors' in seeds of *Vicia faba* L. Vicine, convicine and a Dopa-glucoside are the compounds most often regarded as the 'favism factors' which affects some people in the Mediterranian and Middle East areas after eating *V. faba* seeds (Kirkman, 1968).

A new method for separation and quantitative estimation of each of the three above mentioned glucosides, which are known constituents of *V. faba* seeds, has been developed. The method is based on separation of low molecular weight compounds from polymers by extraction and gel filtration. By column chromatography vicine is separated from convicine and it is possible to detect a relatively low concentration of Dopa-glucosides with the subsequent UV-method.

Method.

The following procedure was used. Germplasm of *V. faba* originating from various parts of the world, as well as from intercrossing the two subspecies *V. faba major* and *V. faba minor*, were grown in the same field nursery under identical conditions. Seeds from these plants were studied for their content of vicine, convicine and Dopa-glucosides.

The dry seeds were ground in a laboratory mill to a fine powder. The meal (100 mg) was extracted with methanol-water (7:3, 20 ml) at room temperature for 10 min. by additional homogenisation. The homogenate was filtered, the residue washed twice with methanol-water (7:3, 5 ml) then extracted again by the same procedure. The combined filtrates were evaporated to dryness, redissolved in water (2 ml) and transferred to a Sephadex G-25 (fine) column (0.9 x 60 cm). Water was used as an elutant at a flow rate of 40 ml/hr, 3 ml/fraction. UV-absorption (280 nm) of the effluent was continuously recorded.

Most of the proteins and other macromolecules were left in the filtration residue, and the remaining part of these polymers appeared in fractions 4 and 5 corresponding to the void volume of the column, that is the small peak before the convicine fractions (7 to 9) as shown in Fig. 1. Vicine and Dopa-glucoside were eluted in the same fractions (10 to 13).

The fractions containing convicine were combined and the concentration of convicine was determined from UV-spectra. Similarly, the concentration of vicine in fractions 10 to 13 was determined by UV-spectroscopy. In the case of a high concentration of Dopa-glucosides, it was possible to detect these compounds in basic solution from the 294 nm absorption peak (log ε = 3.3) (Larsen *et al.*, 1973). A reliable determination of the Dopa-glucosides requires a separation from vicine which was possible by ion-exchange chromatography.

Using the vicine-convicine analysis method described above it is possible for one person to perform 40 single analyses per week using two gel filtration columns. Initially a series of 20 duplicate analyses were performed. These show that the method is comparatively accurate with a standard deviation of 0.04, calculated on the estimations of the content of vicine + convicine and including all steps in the procedures from preparation of the meal.

The present quantitative analysis results in separate estimation of vicine and convicine and the method appears to be simpler, quicker and more accurate than previously applied methods (Higazi and Read, 1974; Collier, 1976; Jamalian, 1978; Olsen and Andersen, 1978). Work is continuing on the method with the aim of developing a more reliable determination of Dopa, Dopa-glucosides and a rapid micro-technique for screening a large number of genotypes. This is important for breeding programs aimed at reducing the content of antinutritional and favism releasing factors in *V. faba* seeds, which at present severely restrict the value of this important grain legume.

Results.

Table 1 gives a summary of our first results based on analysis of seeds of 170 *V. faba* cultivars. The ratio between the content of vicine and convicine varied from 0.5 to 4.0 but was usually greater than 1, that is with a vicine content exceeding that of the convicine.

Table 1. Mean and range of variation in content of 'favism factors' of 170 genotypes of *Vicia faba*.

Compound	% seed content (with approximately 10% moisture)		
	Mean	Min	Max
Vicine	0.55	0.19	1.02
Convicine	0.32	0.11	0.71
Vicine and Convicine	0.87	0.50	1.67
Dopa-glucosides	0.34	<0.05	0.85

Dividing the plant material according to origin of heritage shows that all groups of germplasm contain nearly the same magnitude of variation in glucoside content as found for the total group shown in Table 1. So far no relationship has been observed between the content of the glucosides in question and geographical origin of the analysed plant material. Our data show that a reduced content of these glucosides may be caused by low levels of convicine or vicine, or both.

As all the analysed samples were from plants grown in the same field nursery the observed variation is assumed mainly to reflect genetic differences. If this is true, then our results indicate that the prospects for obtaining *V. faba* cultivars with low seed contents of these glucosides are good.

The work described here was supported by the Danish Council on Development Research.

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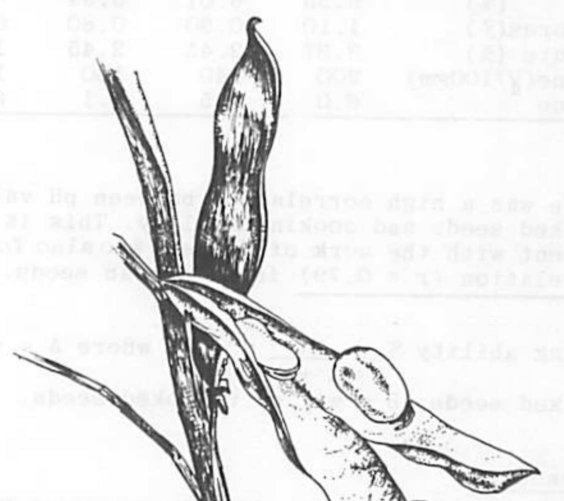

In-Press Abstracts

This is a new section of the newsletter, which will contain abstracts of papers which have been accepted for publication by recognised journals. The aim is to present summaries of work which may otherwise wait some considerable time before appearing in print. Readers are invited to contribute abstracts for inclusion in Newsletter No. 3, stating clearly the Journal and reference.

Isozyme polymorphism in species of the genus Vicia (Leguminosae)

Kiyoshi Yamamoto
Faculty of Agricultue, Kagawa University, Miki-Tyo, Kagawa-Ken, JAPAN.

Abstract of a paper accepted for publication by the Japanese Journal of Genetics.

Thirty nine strains of 24 *Vicia* species representing the main sections of the genus, have been analysed for their isozyme patterns by disc electrophoresis of leaf and cotyledon extracts. The enzyme systems studied were amylase, esterase, glutamate oxaloacetic transaminase (GOT), indophenol oxidase (IPO).

Comparing the zymograms obtained, one can arrive at the following conclusions: there are many bands common to species, series of sections and, in contrast, there are some bands differentiating between certain taxonomic categories. Such characterising bands and patterns do not feature any clear general phylogenetic trend or systematic correlation. The enzymatic similarity does not necessarily correspond with the taxonomic relationships.

GOT show lesser polymorphism, compared with amylase and esterase. The latter systems might be helpful in identifying species or strains.

Species which are polymorphic in many other characters reveal also enzymatic polymorphism.

Other possible correlations are briefly discussed, with a special note on the evolutionary implications of such a study in *Vicia*.

Institution Reports

This is a new section of FABIS with two aims: to enable reports from specific institutions to appear in the newsletter, and to ensure that the Short Communications section is left solely for reports of research results (and not descriptions of an individual's or an institution's research program).

Gezira Research Station

Agricultural Research Corporation, P.O. Box 126, Wad Medani, SUDAN.

Studies being conducted at the Station include the following:-

The isolation of *Rhizobium* strains from different locations and testing their N fixing efficiency; conducting trials of inoculation/NP fertilization using locally prepared inoculants; cross inoculation affinity of *Rhizobium* from crops and weeds with faba beans (Dr. Musa M. Musa).

The water use of irrigated crops in the Gezira; studies of the crop-water requirements of faba beans in Gezira clays. (Dr. Osman A.A. Fadel).

The agronomy of faba beans for marginal agroclimatic zones; varietal adaptation, sowing date, watering, plant population and plant nutrition studies. (Dr. Osman A.A. Ageeb).

Studies of powdery mildew, wilt and root rot diseases of faba beans; effect of different cultural practices and mineral nutrition on the incidence of diseases; chemical control of powdery mildew. (Dr. Mahmoud A. Ali).

Weed and weed control in faba beans; effect of germination stimulants and herbicides on *Orobanche* incidence in faba beans. (Dr. Abdel G.E. Babiker).

Scottish Plant Breeding Station

Pentlandfield, Roslin, Midlothian EH25 9RF, SCOTLAND UK.

For a number of years the Scottish Plant Breeding Station (SPBS) has had an interest in the potential of *Vicia faba* for Scottish conditions. Trials in several seasons have indicated that the crop can produce acceptable yields but that there is a need for varieties more specifically adapted to Scotland. The highest yielding varieties are of non-determinate growth habit and continue to grow and flower for long periods, resulting in tall, rather late crops which ripen unevenly and are difficult to harvest. It is our opinion that types specifically adapted to Scotland will exploit the determinate growth habit and be earlier than existing varieties, but remain high yielding. To this end we have a small composite population where attempts are being made to introgress exotic sources of earliness and several sources of determinate growth habit in to an adapted population (Albyn Tic - a heterogeneous but high yielding population bred a number of years ago and maintained at SPBS). In collaboration with the Plant Breeding Institute, Cambridge, we shall also be exploring in 1980 the potential of several pedigree crosses between determinate types from Finland and high yielding material from the Cambridge program. This work is being carried out in the Cereals Department (headed by A.M. Hayter) of the Forage Division (headed by R.N.H. Whitehouse) and is an extension of work begun by Mr. I.M. Chapman and Mr. M.S. Phillips.

A.M. Hayter

Institute of Agronomy and Plant Breeding

University of Goettingen, von Siebold Strasse 8, D 3400 Goettingen, WEST GERMANY.

Current *Vicia faba* research concèrns genetic studies and breeding work. A germplasm collection with 500 entries is maintained. The seed size of the breeding material is below 1000 g per thousand seeds (*Vicia faba minor*); genotypes with larger seeds (*V. faba major*) are used in the same crossing programs. The breeding method currently used is selection between inbred lines. The main breeding objectives are yield, reliability of yield and quality. The definition of an ideotype will be the result of estimations of yield and direct and indirect yield components. A selection program for high autofertility and for effective pod setting by high pod-flower ratios has started to improve yield stability. A screening and selection program for methionine and protein content is being carried out to improve the quality of the seeds.

Department of Botany, University of Durham Science Laboratories, South Road, Durham DH1 3LE, ENGLAND UK.

Work is in progress to fully characterise flower development, pollen germination, pollen tube growth and fertilization in *Vicia faba* L., and to determine the effect of different floral architectures and environmental variables on these factors. The abscission layer of flowers is being studied, using a novel scanning electron microscope technique, to determine the rate of its development relative to time of fertilization. A study of enzymes associated with flower shedding is being undertaken, with the aim of determining what factors control the development of the abscission layer, and hence flower shedding and maximum yield. Efforts are continuing to identify isoenzymes suitable for use as markers for the identification of inbred lines and crosses between them.

A project is in progress to study the interrelationships between pollen tube growth, fertilisation and flower shedding in field bean plants with different floral architectures, and to determine the influence of environmental stresses on these processes.

Donald Boulter

National Research Council, ITALY.

The National Research Council in Italy supports plant breeding research at nine institutions. The research follows two main approaches:-

Improving faba beans for human consumption and livestock feed.

- Istituto di Agronomia, Universita de Catania (Prof. S. Foti)
- Istituto di Agronomia, Universita de Napoli (Prof. L.M. Monti)
- Istituto di Agronomia, Universita de Palermo (Prof. L. Stringi)
- Laboratorio del Germpolasma CNR, Bari (Dr. G.B. Polignano)
- Istituto de Miglioramento genetico delle piante agrarie, Universita di Bari (Dr. A. Filippetti).

Improving faba beans for fresh consumption, canning and freezing.

- Centro Orticoltura Industriale, CNR, Bari (Prof. V.V. Bianco)
- Istituto de Orticultura e Floricoltura, Universita di Palermo (Prof. P. Caruso)
- Istituto di Orticultura e Floricoltura, Universita di Catania (Prof. La Malfa)
- Istituto di Produzione sementi, Universita di Torino (Prof. L. Quagliotti)

The plant breeders involved in these projects are particularly concerned with germplasm evaluation and the development of material through different breeding methodologies. Germplasm accessions collected from various sources, especially from Mediterranean countries and South Asia, are tested for response to improved agricultural environments. It is also aimed to identify the desirable traits in each accession, and to assess the relative importance of each trait on seed yield and quality.

Selections have been made from local material and have been intercrossed with other germplasm lines in order to obtain varieties which are both high yielding and well adapted. These varieties have been tested at different locations over several years, and some will soon be presented for registration.

Cross pollination rates of 40 to 50% have been detected in *V. faba major* and *minor*. Crosses were made between lines from different sources to determine their combining ability, to produce synthetic varieties and to identify lines with superior performance and a higher degree of self pollination.

At the same time studies of the protein content and quality of the available germplasm, with special reference to the S-amino acids, are continuing. Crosses are being made to improve these characters and to clarify the genetic basis of these traits in the plant.

G.T. Scarascia-Mugnozza
Ciro de Pace

Landessaatzuchtanstalt, University of Hohenheim (4500), Postfach 106, 7000 Stuttgart 70, WEST GERMANY

The breeding program in *Vicia faba* is concerned with West Germany's future foodstuffs containing high levels of protein. The main breeding aims are therefore to increase yield, protein content and yield stability. Our present activites are mainly concentrated in two fields of research:

1. amplification of the genetic basis for selection of improved genotypes.
2. investigation of breeding methods.

The amplification of the genetic basis includes evaluation of diverse collections on yield and other agronomically important characters such as seed quality (protein content, threshing resistance), disease resistance, tolerance to drought. Tests are made of different plant models as represented in forms, sub-groups, varieties and in mutant material, or as can be developed through crossing. Selections for favourable gene combinations in different plant types are also made, and they were tested for adaptation to the climate and cultivation practices in the Central European area.

The mating system of *Vicia faba* (outcrossing and selfing in varying proportions) does not allow us the simple use of breeding methods like 'pure line breeding' or 'population breeding' and the development of hybrid varieties is until now restricted by the instability of the male sterile lines. On the other hand, according to Bond, Berthelem and other authors, heterosis is a significant factor in yield potential and may be also in yield stability in faba beans.

We are investigating how heterotic effects can be used in faba bean varieties, even if hybrid varieties are not available. Our efforts in this field comprise the following investigations:

- studies of autofertility and other aspects of floral biology.
- studies of the relationship between improved yield potential and homogeneity in synthetic populations.
- examination of the outcrossing behaviour of different plant types.
- testing of heterotic effects of yield and other agronomically important characters in crosses of different parents.

Dr. E. v. Kittlitz

Names and Addresses

Names and Addresses of individuals interested in *Vicia faba* are given in this section. Please inform the Editors of FABIS of any correction or additions that should be made to this list.
Please fill in the enclosed Questionnaire for the Directory of World Faba Bean Research. We hope that each person on the following list will do this. Thank you.

Country	Name and Address

NEAR EAST AND AFRICA

AFGHANISTAN

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