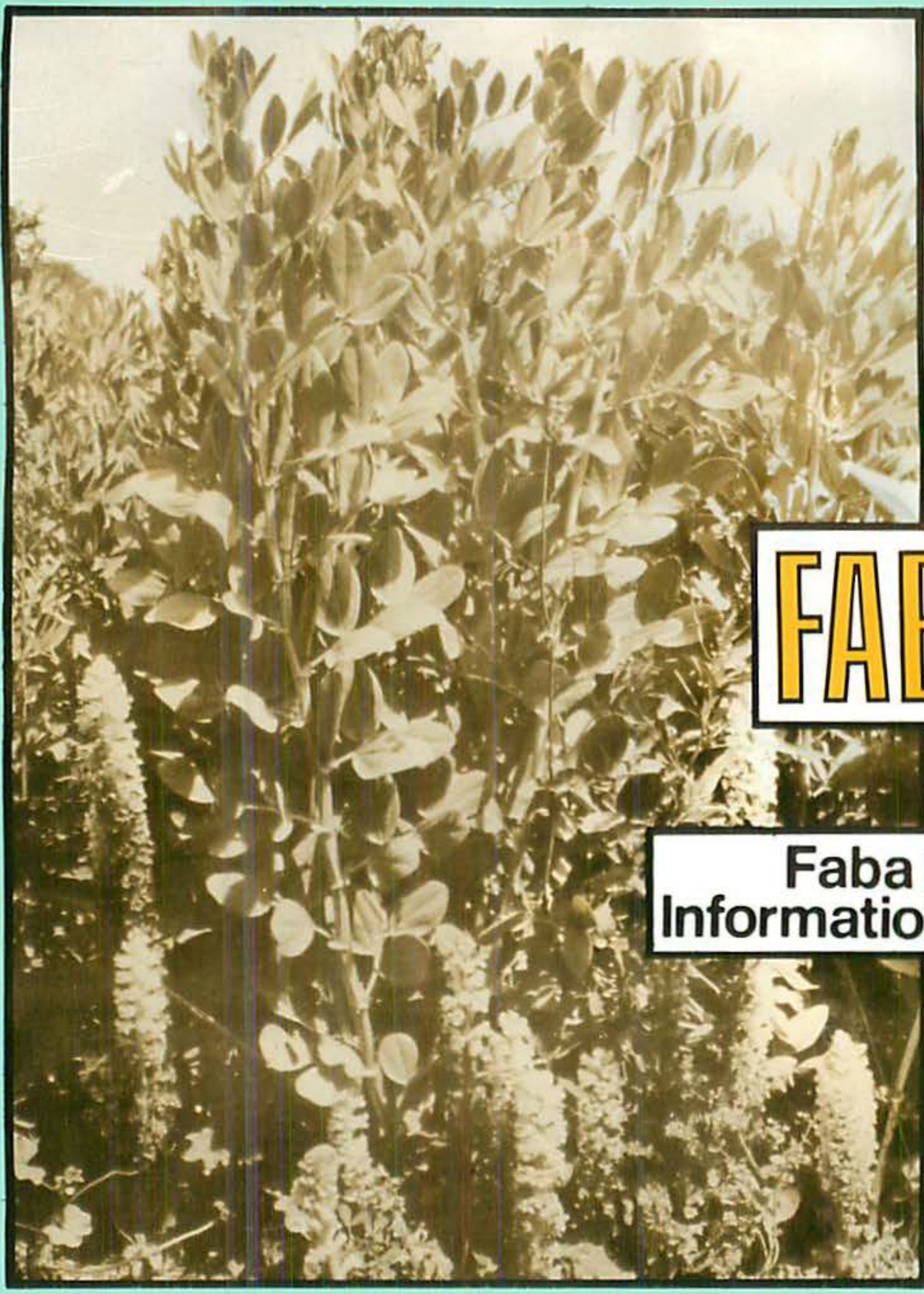

FABIS

Faba Bean Information Service

NEWSLETTER
No. 9
JULY 1984

INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS
(ICARDA)

The Center and its Mission

The International Center for Agricultural Research in the Dry Areas (ICARDA) was established in 1977 to undertake research relevant to the needs of developing countries and specifically for the agricultural systems in West Asia and North Africa. The overall objective of the Center is to contribute towards increased agricultural productivity, thereby increasing the availability of food in both rural and urban areas, and thus improving the economic and social well-being of people.

Though devoted mainly to winter-rainfed agriculture in areas with 200-600 mm rainfall per annum, ICARDA has world responsibility for the improvement of barley, lentil, and faba bean. Where logical, ICARDA's area of concern thus extends into environments with monsoon rainfall or with irrigation. In the winter-rainfed areas, research is also carried out on wheat, kabuli chickpea, and pasture and forage crops. Development of improved farming systems is a major component in the Center's research program. The Center undertakes and supports training.

ICARDA is one of 13 international research centers receiving support from donors through the Consultative Group on International Agricultural Research (CGIAR). Donors to ICARDA have included Australia, the Arab Fund for Social and Economic Development, Belgium, Canada, Denmark, Ford Foundation, France, the Federal Republic of Germany, the World Bank, Italy, International Fund for Agricultural Development, International Development Research Centre, Mexico, the Netherlands, Norway, Organization of Petroleum Exporting Countries, Saudi Arabia, Spain, United Kingdom, Sweden, United Nations Development Programme, and United States Agency for International Development.

Cover photo: *Orobanche* infested faba bean

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NEWSLETTER No. 9

THE INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS
(ICARDA)

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REVIEW ARTICLE

PROBLEMS AND PERSPECTIVES IN BREEDING FOR PROTEIN CONTENT IN VICIA FABA

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The high protein content and quality are important characteristics of pulses. To increase the total content and/or the quality of the protein is often an important objective for faba bean breeders. This paper reviews the main data obtained up to now in this field.

Basic aspects

The range of protein content in faba bean is quite large, e.g., 28.1-36.5% (Frolich *et al.* 1974), 20-41% (Picard 1977), 23-38% (Baudet and Mosse 1980), 26-32% (Griffiths and Lawes 1977), 21-35.1% (Hanelt *et al.* 1978), and 20.3-32% (de Haro *et al.* 1980). Intra-varietal variation is as large as inter-varietal variation: Griffiths and Lawes (1978) found 23.1-37.4% in three British cultivars.

Thus, the approximate range in protein content of the germplasm collections analyzed is 20-35%. Extreme values have not yet been fixed, a fact perhaps indicating an environmental interaction with protein content.

It is well known that the main problem with legume proteins is the low sulfur amino acids content, more specifically methionine and cysteine. These are usually the first limiting amino acids in most of the grain legumes, including *Vicia faba*. The chemical score (CS) of *V. faba* protein (that is, the proportion of the limiting amino acid relative to that of the ideal reference protein, expressed as a percentage) is 40-50%, a value in the bottom of the range (40-75%) for legumes. The total amount of amino acids per gram of nitrogen is 2.20 g, a value close to the FAO proposal of 2.25 g (pulses range from 2 to 2.5 g). Grain legumes are rich in lysine and other essential amino acids.

The NPU value (Net Protein Utilization: percentage of ingested N retained in the body) is close to 50%, a value common for most of the pulses. Digestibility (percentage of ingested nitrogen absorbed) is 85-95%, and the Biological Value (percentage of N absorbed from the intestinal tract actually used for maintenance and growth) is 50-65%. These values are also common for pulses, though in the bottom half of the scale (de Haro 1983).

Protein constituents

Osborn (1924) described four protein fractions following a method based on differential solubility in saline and alcoholic solutions. Many attempts have been made to modify or substitute for this method, but it is still widely used, mainly because of its simplicity. Globulins are the largest fraction in seed legume proteins (70%), followed by albumins (10-20%) and glutelins (10-20%). Prolamins are present in very small amounts.

Albumins contain most of the enzymes present in the seed that will be used in the germination process. This fraction is richer in methionine and cysteine than globulins, at least in peas and faba beans. Lysine shows a similar pattern, but the differences are not as clear as in the previous case.

Globulins are storage proteins used during germination, and form discrete bodies bound to the cell membranes. They are rich in aspartic and glutamic acids, leucine, arginine, and other basic amino acids.

Vicia faba globulins have been split into two main components according to sedimentation coefficients: legumin (11S) and vicilin (7S). The former is richer in sulfur amino acids than the latter. Both legumin and vicilin are complex proteins (Bailey and Boulter 1970, 1972). Vicilin is formed first in the seed, but legumin is synthesized in larger amounts, with the final proportion in the mature seed reaching up to four parts of legumin for each one of vicilin (Wright and Boulter 1970). Gatehouse et al. (1980) found a variation in the legumin/vicilin ratio among cultivars from 2.1 to 3.6, the values being practically constant across two different environments. They also demonstrated qualitative variation in legumin among cultivars, but not between environments, and tentatively suggested a similar conclusion for vicilin. Martensson (1980) determined the legumin/vicilin ratio in six cultivars over two years, finding a variation of 1.75-2.30 between cultivars, and of 1.66-2.47 between progenies of a cultivar. The year affected these ratios, but the cultivars ranked in practically the same order in both years. The increase in legumin was negatively correlated with the sulfur amino acid content in this fraction, the final amount of sulfur amino acids being practically constant in each cultivar. Some differences were observed between cultivars. If confirmed, Martensson's conclusion that the amount of sulfur amino acids in the legumin fraction is genetically controlled could lead to programs to increase the methionine and cysteine content by increasing the legumin fraction.

Very little is known about the two other fractions, glutelins and prolamins. The latter are unimportant, but the composition and structure of glutelins could be of interest to breeding programs.

Constituents related to protein efficiency

The seeds of Vicia faba contain antinutritional factors, the most important being the tannins and the factors inducing favism in susceptible humans.

Tannins are mainly present in the seed coat and reduce the digestibility of the product. Dehulled seeds show a much better digestibility than whole seeds. Heat treatment also produces a similar effect, but the results have sometimes been contradictory. White-flowered cultivars have low tannin content (Picard 1975) and, hence, a better digestibility. However, at present, the yields of these cultivars are not as good as the colored-flowered cultivars.

Among the favism-inducing factors, vicine, convicine, and DOPA (dihydroxyphenylalanine) have been mentioned as the most important. Favism is induced in susceptible individuals after the ingestion of faba bean seeds. Vicine and convicine also have deleterious effects on chickens (Marquardt 1982) and probably young pigs. There is variation in vicine and convicine content among genotypes, and some work to select cultivars free of those substances has been carried out, but without real success, probably due to the lack of a rapid screening method and the absence of any correlation with morphological features.

Other antinutritional factors are less important than in other legumes. Antitrypsic factors, for example, are in low concentration. Though very variable, i.e., 0.5-250 units/mg, high values are rare (MacNab 1977, Griffiths and Jones 1977). The possibility of selecting for lower trypsin inhibitor content has been demonstrated (Sjodin and Martensson 1979). Phytic acid accounts for almost 50% of the total phosphorous present in the seeds, but its effect on calcium metabolism is believed not to be important because faba beans are also very rich in calcium. Phytates are possibly much more important concerning cooking quality. Hemaglutinins are also present, and both positive and negative selections are possible (Sjodin 1977, in Sjodin and Martensson 1979). The effect of hemaglutinins in *Vicia faba* is not worrying the nutritionists for the time being. Both trypsin inhibitor and hemaglutinin effects are eliminated when beans are cooked.

Other factors are practically or totally absent (cyanogens, alkaloids, non-protein amino acids, etc.).

Factors affecting the crude protein content and the Chemical Score

The negative correlation between yield and protein content so typical in cereals has not been found in legumes. Positive correlations have been found in faba beans. In some cases where the correlation was negative, environmental effects were the most likely explanation (Bond 1977).

Seed size also seems to be independent of protein content (Hanelt *et al.* 1978, Abdalla and Gunzel 1979, De Haro *et al.* 1980), but some studies have shown a negative correlation (Lafiandra *et al.* 1979), the *paucijuga* and *minor* types being richer in proteins. Sjodin and Martensson (1979) found a strong positive correlation between seed size and protein content in small- seeded varieties (1000-seed weight of 250-700 g).

In Britain, spring cultivars have been shown to have higher protein contents than winter types (NIAB 1967, Eden 1968). Bond (1977) found that the former had a larger range in protein content than the latter, but that they overlap to a large extent. De Haro *et al.* (1980) found that cultivars and landraces from northern countries were richer in protein than those from Mediterranean countries. To what extent all these differences are genotypically controlled and what is the importance of environmental effects remains largely unknown.

Important differences in nitrogen fixation have been described by Griffiths and Lawes (1977,1978) and El-Sherbeeny *et al.* (1977) depending on the host genotype-rhizobium strain combinations. Using different rhizobium strains, the protein content of the same cultivar ranged from 23 to 31.7%, with a positive correlation between this character and yield per plant. These results should be considered when breeding for high protein content. Environmental effects on protein content can be partially explained by this interaction.

Relationships between crude protein and essential amino acid contents are important for faba bean breeders. As the total protein content increases, only some fractions (mainly storage proteins) increase. Amino acid concentrations are expressed in g/16g N, because if they are expressed as a percentage of dry matter there is a logical positive correlation between crude protein and amino acid values.

The most common findings show that when the protein content increases, there are concomitant increases in arginine and decreases in methionine and lysine. Some workers (Mosse and Baudet 1977, Baudet and Mosse 1980) report that increases in both arginine and tryptophan are proportionally greater than the protein increases. Other amino acids increase proportionately (e.g., aspartic acid and proline), and a few decrease: glycine, hystidine, and, unfortunately, cysteine, methionine, and lysine. The decrease in these three amino acids is a problem in breeding for improved seed quality for animal feeding.

Examples of correlation coefficients between the total protein and individual amino acid contents are: arginine, 0.43 to 0.64; methionine, -0.18 to -0.70; cysteine, -0.11 to 0.80, and lysine -0.48 to -0.60 (Eppendorfer 1971, Hanelt et al. 1978, Lafiandra et al. 1979, Griffiths and Lawes 1977, 1978). The variability in the correlation coefficients with methionine and cysteine, together with the variability in the content of these amino acids found in different collections, suggest that it may be possible to increase the Chemical Score (CS) of faba beans to 70-75%, the maximum for pulses. Conversely, the negative correlation between lysine and protein content limits breeding for higher protein contents. *Vicia faba* is naturally rich in lysine, and is used as a high- lysine supplement to cereals in animal feeds. Any reduction in lysine content will reduce its value in this role.

The genetic background and related problems

Studying crosses between lines differing in crude protein content, Bond (1977) and de Haro et al. (1980) found that F_1 values were closer to the poorer parental line. The distribution of F_2 plants was biased towards the same parental value and Cavalli analysis indicated a good agreement with the additive model and the existence of partial dominance in a negative sense (de Haro et al. 1980). However, Picard (1977) found a bias towards the parent with the higher protein content, a result also found by Bond (1977) in some of his crosses. Picard's results also show an important additive effect and, hence, high general combining ability and good heritability. The studies of Picard (1977) and de Haro et al. (1980) both show the existence of transgressive inheritance, an interesting fact in breeding for higher protein content.

Heritability values (in the broad sense) for crude protein are quite high in faba bean: Bond (1977) found a value of 0.54, Griffiths and Lawes (1978), 0.70 average, and de Vries (1979) 0.64-0.82. Other pulses show similar values.

All these results show the possibility of selecting for a higher protein content. However, the following points should be noted:

a. Additive gene action seems to be the most important, but dominance effects are also present. The studies performed up to now have not been intense and systematic enough to clarify both the importance and the sense of the dominance. The heritabilities found are rather large, but it is important to know what proportion is dependent on additive effects. This is basic to deciding the best method for breeding.

b. Genotype - environment interactions have not been found very important in several works, but this requires more study.

c. Sampling method for seeds for analysis is important. It is well known that there is a gradient in protein content from the bottom to the top of the plant, and also a tiller effect. Detopping or the removal of tillers would affect the protein content of the seeds. An additional complication is that single F_2 plants could get inoculated by a specific rhizobium subpopulation or even genotype, with a strong effect on the protein content. Thus, it would be much safer, from the point of view of sampling, to work with lines instead of individual plants.

d. Transgressive inheritance has been mentioned, but it has to be determined if these values beyond the parental limits are artifacts coming, for example, from genotype - environment interactions (see also below, point 'e') or if there is genuine genetic transgression.

e. A very important problem is that of the determination of protein content. This is done by analyzing the N content and multiplying by 6.25 in the case of Vicia faba. If all the nitrogen were present as protein, this method would be perfect, but this is not the case. Non-protein nitrogen can reach up to 7% of the dry matter. This raises several questions:

- What is this non-protein N ? Most probably, it is constituted of free amino acids, most of which will be essential and not non-proteinic amino acids (e.g., canavanine). But the relative proportions of each group have to be determined, as well as the importance of the non-amino acid nitrogen fraction.

- How is this non-protein N fraction produced, how is it accumulated in the seed (for example, the importance of the growing conditions) ?

- What is the genetic control, if any, of this non-protein nitrogen, and how important are interactions with the environment ?

- Are the difficulties in fixing high protein content (up to 40% protein content) in pure lines derived from single plants related to this non-protein nitrogen ?

It is clear that the answer to these questions and many others are important in a systematic work on breeding Vicia faba for a higher crude protein content.

Breeding perspective

a. Breeding to increase crude protein content

It is a general feeling among pulse breeders that the best strategy, at present, is to increase the total amount of protein per hectare by increasing yield without altering the crude protein percentage in the seed (Rhodes and Jenkins 1977). This is supported by the fact that grain-legume yields are less than their potential maxima, and a big advance can be achieved simply by improving their harvest index. Agronomical practices are also far from perfect. Higher yields are the first concern of the farmers, provided that high protein cultivars do not have a premium in the market.

On the other hand, the independence of yield and protein content, and the possibilities for increasing the latter by selection, as outlined above, shows that to increase both characters simultaneously is possible. Responses to selection have been positive even in short periods, though to fix these can present problems. To solve this, more work is needed to understand the importance and significance of non-protein nitrogen, environmental influences, the importance of plant architecture, and other factors.

Experience with other crops (for example, soybeans; see Shannon et al. 1972) suggests steps in breeding for higher protein contents. Crosses between high yielding lines and high-protein lines with reasonable yields have been the best way to obtain new experimental lines with improvement in at least one of these characters. Fortunately, *Vicia faba* collections frequently contain accessions with more than 30% crude protein and reasonable yield. Composites, recurrent selection, single seed descendent method, or triple or multiple crosses (I would favor triple crosses) can be used, depending on the materials, the equipment, and the experimental requirements.

b. Breeding for quality

The elimination of tannins, favism factors, and trypsin inhibitors may be more important than obtaining higher methionine content. If the seeds will be used as a raw product (in animal feeding, for example), removal of these compounds is essential. However, the discussion here is limited to protein quality.

It has been said that the sulfur amino acid content is not so important as has been stressed. This is true. Mixing a legume and a cereal with biological values of 50 and 60%, respectively, will produce a food with 70-80% biological value. In human diets the problem is even less serious, because a mixture of very different foods will be consumed in most of the cases. However, it is also true that if the sulfur amino acid content were higher (particularly methionine and cysteine), the biological value of faba bean, and its value in mixtures with cereals, would be greater. It would also diminish the concern about the decrease in lysine when increasing crude protein content. The main concern of breeders is to maintain the percentage of lysine in such cases, or to lose as small a fraction as possible. Faba beans have almost 20% more lysine than the ideal protein.

Faba bean has a Chemical Score (CS) of 45%, compared to 50-55% for lentil, 50-60% for peas, 60-70% in lupins, and about 75% in soybean. There are no theoretical reasons why this cannot be increased to 55-65% as a first step, as there is variability in methionine and cysteine content in the germplasm. The only problem is the negative correlation of CS with protein content. If the existence of lines with low correlation coefficients is confirmed, these materials could be used as "starters."

It is unlikely to be possible to produce faba bean protein with as much methionine and cysteine as ideal, but to increase the CS to about 60% could be possible. This increase in sulfur amino acids has to be done without reducing protein content. Further studies are needed. It is necessary to know:

1. The proportion of the different fractions (albumins, glubulins, etc.) and possibly subfractions, such as legumin, of the seed protein, and how these fractions change when the crude protein content changes;

2. the amino acid composition of these fractions, and how their proportions change with increased protein contents;

3. the variability of the important amino acids in each fraction;

4. the importance of the non-protein nitrogen, and how it is controlled;

5. the effect of the environment;

6. the existence of true transgression (i.e., not only observing F_2 plants with greater values than the parents, but fixing lines with such characteristics); and

7. the relationship between the morphological characteristics of the plant and the amino acid content.

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SHORT COMMUNICATIONS

General

A GROWTH STAGES KEY FOR FABA BEANS

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Growth stages keys are necessary for timing of application of pesticides, and in crop improvement research, extension, and practical agriculture. The keys need to be as detailed as possible for scientific investigations, as well as easy as possible to handle for practical agriculture. Thus, a key for general use will be a compromise. In the Federal Republic of Germany the BBA (Biologische Bundesanstalt, Braunschweig) has published growth stages keys for cereals, maize, rape, potatoes, and hops. These are printed and distributed by ACO Druck Ltd., Box 1143, D-3300 Braunschweig.

The author submitted a preliminary proposal for a growth stages key for faba beans at the EEC meeting in Nottingham, UK, in October 1983. The key has since been changed in some points to make it easier to handle, and also to make it possible to describe the development of indeterminate and determinate (terminal inflorescence mutant) faba beans with the same key. The final form of this key is presented in this paper in conjunction with some remarks on the basic concept by which the author aspires to standardize all growth stages keys for plant species used in agriculture.

The basic concept divides the development of a plant into 10 macro stages. The macro stages are further divided into micro stages having a binary code from 00 to 99 for computerization (see Table 1). According to the basic concept, in different plant species equal or similar stages of development are given the same code. Thus, if a macro stage in a plant species does not occur, it is omitted. This situation is present in faba beans. Therefore, the development is divided only into 8 macro stages: germination (00), emergence (10), leaf and stem development (20), bud formation (50), flowering (60), pod development (70), ripeness (80), and dying off (90). The leaf and stem development - usually stage 20 and 30 - are united in macro stage 20, because the development of both occur simultaneously. Macro stage 40 is omitted because it is reserved for crop cover in the key for potatoes.

The description of the leaf and stem development (stage 20) has been altered from the preliminary key and more micro stages were described, because the interval from one micro stage to another was too large (about 3 weeks) and the new version is easier to handle. Also, alterations were necessary in the macro stages 50, 60, 70, and 80 to make it possible to use the growth stages key for terminal inflorescence lines as well.

In a comparison of 86 inbred lines of faba beans from different regions in summer 1983 (presented at the EEC meeting in Nottingham), differences existed in the duration of development phases

Table 1. Growth stages key for faba beans.

Code	Definition
00	**Germination**
01	Dry seed
03	Start of imbibition (embryo distinctly visible under the seed coat)
05	Radicle emerged from seed
07	Shoot length about 1/2 length of seed
09	Shoot length about twice the length of seed
10	**Emergence**
11	Seeding emerges at the soil surface
15	First leaf unfolded
20	**Leaf and stem development**
21	Second leaf unfolded, shoot begins to elongate
23	Third leaf unfolded
25	Fourth leaf unfolded
27	Fifth leaf unfolded
29	Sixth leaf unfolded
30	-
40	-
50	**Bud formation**
53	First flower racemes visible at the tip of the shoot (buds still green)
57	First petals appear on the first flower racemes (petal grown out of sepals)
60	**Flowering**
62	First flower racemes in bloom (buds opened, i.e. flag of the flower steeply erected)
64	3 flower racemes/plant in bloom
66	5 flower racemes/plant in bloom
68	End of blossom
70	**Pod development**
72	First pods visible (pods visible = pods longer than 2 cm)
74	Pods visible on 3 inflorescences

Table 1 contd.

76	Pods visible on 5 inflorescences
78	First pods fully developed in size - seed fully developed in size and distinctly contrasted in the pod (green ripeness)
80	**Ripeness**
82	First pods darkly colored
84	1/3 of all pods darkly colored
86	2/3 of all pods darkly colored
88	All pods darkly colored; seed in the last developed pods can still be cut with fingernail
90	**Dying off**
92	Complete straw ripeness; seed in the last developed pods completely hard: straw dry

If two growth stages occur simultaneously, record the later stage.

For assessments in the field:
Date of emergence: When 75% of the beans have emerged
Beginning of flowering: When 10% of the beans are flowering
End of flowering: When 10% of the beans are still flowering

A minimum border strip of 2 m from the field should be excluded from recording the growth stages.

between the lines. It is necessary, therefore, for investigations to record the duration of the following phases in the development of faba beans: germination (stage 01-11); vegetative phase (stage 11-62); flowering phase (stage 62-69); pod establishment (stage 62-72); pod filling (stage 72-82); ripeness (stage 82-88), and dying off (stage 88-92). In this connection, it is important for comparisons between different investigations to assess a stage of development at the same time. Usually a stage is recorded when more than 75% of the plants have reached it. But there are exceptions which are listed at the bottom of Table 1. Furthermore, there is a remark for assessments - "If two between stages 20 and 50, 60 and 70, and between 70 and 80.

Finally, I wish to point to an appendix of the growth stages key in which the branching of faba beans is described with a two figure code (Table 2). In this code, lateral branching is classified as unbranched, lateral branches visible, and lateral branches longer than 5 cm. If lateral branches are longer than 5 cm, branching is divided into equivalent and unequivalent branching, depending on the relative growth of main and lateral branches. Further, in each, slight, moderate, and strong lateral branch formation is recognized. When this two-figure code is added to the stages of development, a precise description of faba beans is possible for special investigations.

Table 2. Description of branching of faba beans.

Code	Definition
10	Unbranched (lateral branches max. 2 cm long)
20	Lateral branches visible (branches up to a maximum length of 5 cm)
	Lateral branches longer than 5 cm
21	Equivalent branching with slight lateral branch formation (1-2 branches)
22	Equivalent branching with moderate lateral branch formation (2-4 branches)
23	Equivalent branching with strong lateral branch formation (more than 4 branches)
26	Unequivalent branching with slight lateral branch formation (1-2 branches)
27	Unequivalent branching with moderate lateral branch formation (2-4 branches)
28	Unequivalent branching with strong lateral branch formation (more than 4 branches)

Equivalent branching: Development of the main branch does not exceed the development of lateral branch(es).

Unequivalent branching: Development of the main branch distinctly exceeds the development of lateral branches, i.e. the main branch is at least 1/3 longer than the lateral branch(es).

AN EARLY OBSERVATION ON SELECTION IN FABA BEAN

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Probably we will never know how and when primitive farmers began a conscious effort for selection in crop plants. Certainly very early, perhaps simultaneously with the birth of agriculture. It is a pity that they were not aware of future interest in their methods of selection and did not leave any clues for us; they would have been precious keys for understanding how cultivated plants evolve under selection.

Even much more recently, agronomists did not pay attention to the question of how to select seeds for planting. One of the rare authors giving some indication of how farmers chose their seeds, specifically faba beans, was the Spanish agronomist, Gabriel Alonso de Herrera (1477-1540?). His very well known "Libro de Agricultura" (Book on Agriculture) was published in 1513, and was reprinted many times during the next two centuries in Spanish, Italian, French, and Latin. Herrera's agricultural experience was based on his own region (Toledo, Central Spain) as well as on the "Moors" of Granada. He arrived in Granada in the same year as the conquest (1492) and remained there for ten years. He also travelled to France and, mainly, Italy. Thus, his agricultural background was western Mediterranean.

Here is my English version of Herrera's paragraph referring to faba bean seed selection (of course, my version has lost the nice arcaism of his Spanish):

Dedicated to Dr. Geoffrey Hawtin

"Many farmers keep seeds for the next planting in the pods. Each pod is sown into its own hole. The reason for this practice is that "brother" seeds contained in the same pod will germinate better than seeds belonging to different pods. This species flowers during a long period, producing early as well as late fruits; hence, the plants emerging at the same time will agree very well with each other.

"The farmers must choose the seeds from the earliest formed pods because they are much better than the later ones and better filled. The latest pod is worthless. The faba bean seeds must have the same conditions mentioned for chick-pea seeds (big and well filled seeds, neither wrinkled nor eaten by insects, skinny and not very old). They do not require irrigation unless they are sown in very dry places. To be sown in dry places (rainfed conditions) the seeds must be from dry places. To be irrigated, they can be from either dry or irrigated places, as the farmers like."

Some comments can be made on these recommendations:

1) Choosing the first pod produced obviously selects for earliness. This practice is followed up to the present day by south-eastern Spanish farmers; some of these regional varieties are the earliest known in Spain and, very probably, in Europe. But this practice also can produce an increase in self-fertility. Actually, since the latest sowing is in December (as recommended by G.A. de Herrera), the first flower will have more chance of being selfed than outcrossed, because the pollinator population will be not very large.

2) Sowing the "brother" seeds of the same pod in one hole will also produce the same effect of increasing self-fertility. Let's imagine that there are four seeds, and that three of these were produced by outcrossing (75% allogamy: the extreme for faba beans). The four seeds will produce three plants of A_1A_2 type and one of A_1A_1: there will be an excess of A_1 alleles of identical descent, producing more A_1A_1 zygotes. This happens even under intense outcrossing within the group of plants, assuming greater outcrossing within than between hills, as seems to be the typical situation.

3) Selecting big, well-filled seeds will lead to development of major- type varieties.

4) Sowing seeds obtained from a dry environment in dry places will produce adaptation to rainfed conditions in Mediterranean environments.

Summing up: Gabriel Alonso de Herrera gave a method for choosing faba bean seeds for planting performed by Moorish Spaniards (or Spanish Moors - historians use the term "andalusi") at the turn of the 15th-16th centuries. This method can explain some characteristics such as earliness, self-fertility, major type, and adaptation to rainfed (dry) conditions found in the present day in typical western Mediterranean varieties of faba beans.

FABA BEANS IN CHINA

Report of a trip to the Peoples Republic of China, 20 May to 3 June 1982

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China has by far the largest production of faba beans of any country in the world, and accounts for between half and two-thirds of the total acreage and production.

The cultivation of faba beans in the Peoples Republic of China falls into two main categories:

(a) In the south, south-west, and along the Yangtze river, where the winters are mild, faba beans are sown in autumn (September/October) and harvested in the early summer (May/June) before temperatures become prohibitive. The main producing provinces are Si-chuan, Yunnan, Hupei, Zhejiang, Jiangsu, and Shanghai.

(b) In the north and north-west, where winters can be severe, faba beans are planted in the early spring (March/April) and harvested in July and August. The main spring bean provinces are Qinghai, Gansu, Ningxia, and Inner Mongolia.

The winter crop is more important overall than the spring crop, although throughout the country production has declined in recent years. Faba beans are used as a green vegetable, a pulse, an animal feed, or as green manure.

The authors were only able to study faba bean research and production in three provinces; Shanghai, Zhejiang, and Jiangsu, all of which grow only winter beans.

Shanghai Province

Faba beans formerly were an important crop in the Shanghai area. However their importance has diminished from about 30-40,000 ha in the 1950s to 10-11,000 ha in 1980. Approximately 3000 ha of this is harvested as a green vegetable, the rest being harvested dry. Following the harvest of the green pods, the plants are generally plowed-in as a green manure or fed to animals. The dry straw is either chopped and fed to animals or used as fuel. Rice-faba beans, rice-rice-faba beans, and cotton-faba beans are the common rotations in which faba beans are grown. The crop is also commonly grown as a border, usually 1-2 rows, around the margins of fields.

The reduction in area has been partly due to the introduction of two crops of rice in the rotation which, because of late harvest of the second rice crop, prevents the planting of beans at the optimum time. Efforts are now underway to introduce shorter duration rice varieties, but the economic advantage of two rice crops versus one long-duration crop is also being questioned.

Other factors responsible for the reduction of the area under faba beans are low and unstable yields. Average dry seed yields are only about 2250 kg/ha, compared to wheat yields which can exceed 5 tonnes. Winter cereal yields have risen substantially in recent years, whereas yields of faba beans have remained stagnant. High rainfall is regarded as a major contributing factor to low yields in the Shanghai area. Mean annual rainfall is over 1100 mm, with approximately half falling during the main faba bean growing season from November to May. This can result in water logging and insufficient sunlight. It is considered that yields will be reduced if there are more than 100 days of rain and that a minimum of 200 hr of sunlight is required from the start of podding to maturity.

Optimum conditions for faba beans in the Province are considered to be 350 mm of precipitation during the season, falling in about 60 rain-days.

Faba beans are not irrigated in Shanghai Province, and we were informed that irrigation is only applied in parts of northern China.

Another cause of low yields is root-rot (Sclerotinia sp.) which can start from mid-May onwards when temperatures rise, and which is exacerbated by water logging and continuous cropping. The early harvest of green pods, the use of early maturing varieties, improved drainage, and the application of manure can all help to alleviate the problem.

Research on faba beans at the Shanghai Academy of Agricultural Science (SAAS) was suspended during the Cultural Revolution and only resumed about two years ago. The research now is concentrating on both breeding and agronomy. Some crosses have been made, with the objectives of developing earlier maturing cultivars and tolerance of adverse conditions, especially water logging. No good sources of resistance to Sclerotinia have been identified yet.

The germplasm collection at SAAS contains about 200 accessions, most of which are local, but includes about 60 from Qinghai Province and a few from overseas (Japan, France, UK). The collection is maintained in the open, but it is suspected that out-crossing is low due to the small populations of bees.

In addition to these 200 accessions, the Institute of Plant Breeding and Cultivation of SAAS had 132 lines from ICARDA growing in the field. These included 75 BPL accessions, 19 selections from rainfed nurseries, and some selections for high yield. The material was growing on beds, approximately 1.5-2.0 m wide, with small drainage ditches between them. Many lines showed Botrytis fabae infection, although the aggressive stage was not evident. A light infection by rust and some root-rot were also observed.

Du Hang Peoples Commune

The visit to the Du Hang Peoples Commune on 23 April provided an opportunity to learn more about the cultivation of faba beans. The Commune is located about 40 km south-east of Shanghai and has a long history of faba bean production. The Commune has approximately one-sixth of its winter-crop area under faba beans, with most of the rest under wheat. The crop is grown for dry seed (200 ha) which is consumed locally and also bartered for rice, and is grown as a vegetable (230 ha), with the residual green haulm being used for both animal fodder and as a green manure. Another use of the crop is as a green manure for rice nurseries. At the early flowering stage the crop is cut and plowed under; the rice is planted about two weeks later.

In the pre-liberation period, average dry-seed yields were between 0.7 and 1.5 t/ha. With improved management and rotations, yields have now increased to about 2.7 t, with record yields approaching 3.5 t/ha. Very intensive cultivation systems have been developed involving relay and inter-cropping.

The normal production practice at the Commune is to plant faba beans in hills 25 cm apart, with 3-4 seeds per hill. The distance between rows is variable depending upon the intercropping practiced. Relay croppinng with cotton is common, and in this case the row-to-row distance is kept wide to permit easy transplanting or seeding of cotton.

Planting at the optimum time is important and by experience this has been found to be between October 10 and 20. Planting earlier than this leads to development of large plants with increased susceptibility to cold in the winter. Late planting results in delayed emergence, poor tillering, and increased rotting.

Dibbling the seed is not considered as good as seeding in furrows, since the latter results in earlier emergence, more prolific branching, and stronger plants.

Generally, no fertilizer other than 225-300 kg of single superphosphate/ha is applied. Wood ash is sometimes applied to improve the crop stand and vigor. Nitrogen is applied only on very poor soils, as a top dressing in February or March, at the rate of 75 kg of urea or 120 kg of ammonium sulfate/ha.

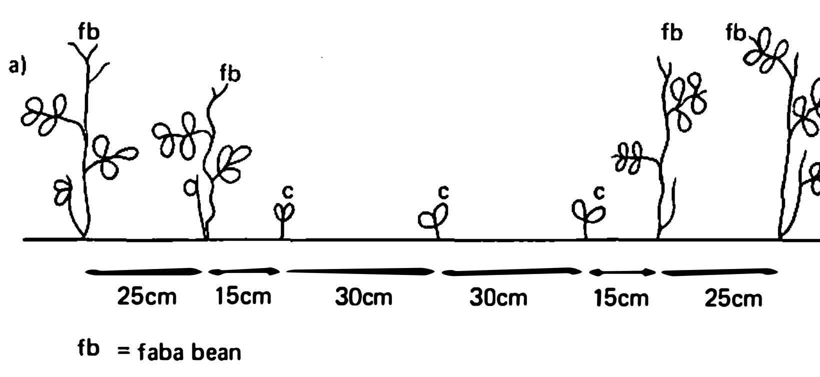
Inter-cultivation by hand hoeing is done to improve aeration and remove weeds, and ditches are dug at regular intervals to ensure good drainage. Three to five branches per plant are considered to be optimum. Detopping of plants at the 7-8 leaf stage is sometimes carried out to encourage branching and the development of plants with greater tolerance to adverse weather conditions.

At the end of April the plants are tied with rice straw in bunches to permit sowing of cotton between the rows. This ensures better light penetration in the faba bean canopy and permits more light for the inter-cropped cotton. The tying of plants is also believed to encourage the translocation of nutrients to pods rather than to the vegetative parts. In the middle of May, pods are picked for green seed and the stems used as animal feed (mainly for pigs) or green manure.

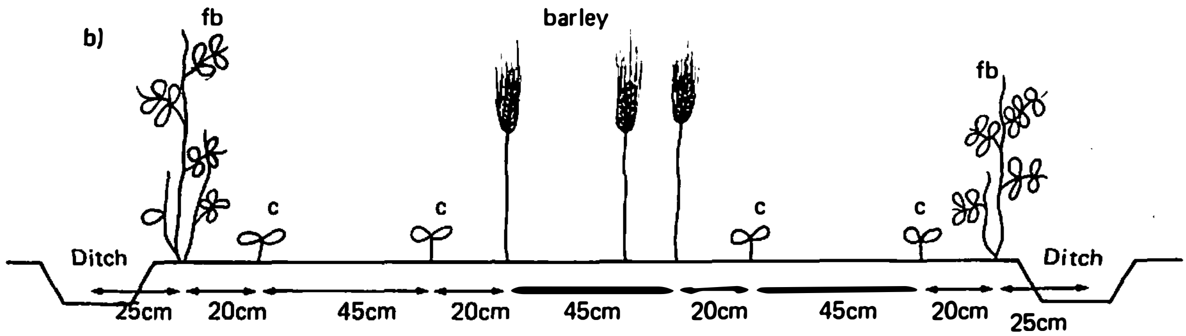
Chocolate spot and powdery mildew were mentioned as the two most important diseases and Topsin (thiophanate) is sometimes used to control them. Aphids and seed weevils were reported to be the major pests. Aphids are controlled by insecticidal sprays (dimethoate) in the field. Infestation in storage is prevented by fumigation.

Two of the intercropping systems observed at the Commune were as follows:

(a) Three rows of cotton had been planted in April in the 90-cm space between paired rows of faba beans. The faba beans were tied together in bunches of 6-12 plants and were about 1 m tall. The cotton plants were in the first true leaf stage at the time of the visit (23 May).



Faba bean/cotton intercropping system used at Du Hang commune, China



Faba bean/cotton/barley intercropping system used at Du Hang commune, China

A slightly different arrangement was also being tested experimentally together with a study of the effects of a plastic mulch on the emergence of the cotton.

(b) In this system two rows of faba beans, with a small furrow between them, had been planted alternately with three rows of barley. Both crops had been planted in mid-October. In mid-May, rows of cotton had been transplanted into the space between the barley and faba beans. The cotton had previously been seeded in nurseries in March.

Several different faba bean cultivars are grown on the Commune:

- large green-seeded types (major), having 2-3 seeds/pod and which are used mainly as a green vegetable but are also exported,
- small green-seeded types (equina) having 2-3 seeds/pod,
- small white-seeded types (equina) having 2-3 seeds/pod,
- small erect-podding types (minor having 2-3 seeds/pod.

In general the equina types are considered to be the highest yielding.

Recipes

Faba beans are usually picked for green seeds when they are quite old and the hilum is beginning to turn black. The pods are shelled; the whole young pod is never consumed. The testa is either completely removed (peeled by hand) or only the hilum region may be pinched off.

The most common method of preparing green beans is to boil them in a little lightly-salted water until soft. A little oil is frequently added to give a glossy appearance.

Dry seeds are normally soaked overnight before cooking. They are frequently ground or mashed.

We were given the following two recipes at the Du Hang Peoples Commune:

(a) **Zhung Zao Zang To** (Salty fresh faba beans-with chives).

Take fresh faba beans, and pinch out the seed coat around hilum.
Saute in a little oil for a few minutes. Add a little cold water, bring to boil until nearly soft.

Add a little salt and chopped chives. Continue to boil 1-2 minutes until soft. At this stage very little water should remain. Serve.

(b) **Zung Zang To Pan** (Salty, fresh faba beans, with water bamboo and tomatoes).
Remove whole seed coat from fresh green faba beans.
Chop tomatoes, bamboo, and chives into small pieces.
Heat a little oil, add bamboo, stir for 1-2 minutes over heat.
Add faba beans, again stir for 1-2 minutes.
Add a little cold water, cover, and boil until soft, by which time most of the water should have boiled away.
Add salt to taste, and the chopped tomatoes and chives.

Zhejiang Province

Faba beans are considered a minor crop in the province with a total area of about 60,000 ha. Major types are grown mainly as a human food, while equina and minor types are used for both feed and as a green fodder. As a food crop, faba beans are normally grown in rotation with rice or cotton.

The Zhejiang Academy of Agricultural Science (ZAAS) is the main agricultural research organization in the Province. Work started on faba beans in the early 1960s but was discontinued during the Cultural Revolution, and only started again in 1979. The institute has released one faba bean cultivar called 'Auchi' (big fighter).

The research currently focuses on screening germplasm with a view to developing high yielding cultivars superior to the local Zhejiang Large White, Zhejiang Small Green, and Zhejiang Small White.

Two screening nurseries (FBISN-L and FBISN-S) were received from ICARDA in 1980, following a request by the Chinese Academy of Agricultural Sciences (CAAS). These were observed growing in the field on the experimental farm of ZAAS in Hangzhou, together with about 200 local ecotypes.

Most of the lines in the ICARDA nurseries were relatively unadapted, compared to the local cultivars. However, the local breeder, Ms. Lang Li-Juan , indicated that she intended to cross three entries (Aquadulce, Seville Giant, and New Mammoth) with lines selected within the local cultivar, a green-seeded equina type called 'green frog'. Ms. Lang Li-Juan expressed a particular interest in receiving more long-pod lines from ICARDA.

The major disease problems in the region were reported to be chocolate spot and, to a smaller extent, rust. As in Shanghai, water logging can be a problem, with total annual rainfall being about 1400 to 1500 mm.

While travelling by train from Hangzhou to Nanking, faba beans were commonly observed being grown along irrigation canals, at the margins of fields, and in patches of poor soil. They were also frequently being grown as an inter-crop in mulberry plantations.

Jiangsu Province

Again, faba beans are regarded a minor crop in the Province. The crop is grown mostly as a green vegetable and occasionally as a green manure. It is more common in the southern part of the Province, where it is grown in a faba bean-rice rotation.

In a visit to the fields of the Jiangsu Academy of Agricultural Science (JAAS) at Nanking, a few plots of faba beans were observed, although no research is being conducted on the crop.

We were told that ascochyta blight, rust, and chocolate spot were the main diseases of faba beans, although we only observed _Botrytis_ sp. and rust in the field. Wilt and root-rot diseases were also mentioned as being important in some areas.

One field was observed in which faba beans had been planted within a peach orchard, and they were also growing in small areas near several houses.

Beijing

The Chinese Academy of Agricultural Science (CAAS) at Beijing is responsible nationally for crop genetic resources. Prior to the Cultural Revolution there were large germplasm collections both at CAAS and in the Provinces. However, much was lost and the scientists are now trying to re-establish collections. The largest provincial collection of faba beans was reported to be in Qinghai Province. The national faba bean collection at CAAS currently stands at about 1900 accessions, of which about two-thirds originated in China and the rest are exotic.

Faba beans are not commonly grown in the Beijing region but they are sometimes grown as a border crop and may be intercropped with wheat or sweet potatoes.

We were unable to obtain national statistics on faba bean production and were told that this was largely due to the problem of getting accurate estimates when such a high proportion of the crop is intercropped or grown as a border around fields, and along ditches and canals.

Breeding and Genetics

PERFORMANCE OF SOME FABA BEAN GENOTYPES UNDER NORTH INDIAN CONDITIONS

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Pulse crops are important in India in the human diet and in improving soil fertility. They are grown throughout the country in predominantly cereal-pulse rotations. The dominant pulse crops are pigeonpea, chickpea, green gram, black gram, lentil, and cowpea. In recent years, however, India has experienced stagnation in production, and a complete absence of a break-through in the productivity of traditional pulse crops. One of the strategies of pulse improvement programs is to achieve a higher level of pulse production by the exploitation of unconventional pulse crops like faba beans, rice bean, and _Phaseolus vulgaris_. The performance of some faba bean genotypes is reported here.

Faba bean (_Vicia faba_ L.), also known as _bakla_ in India, is sporadically grown as a minor vegetable crop in the higher Himalayas. In spite of its substantial production potential, no attention has been paid to its improvement and to increasing the production of local strains in different parts of the country. However,in recent years, some agricultural universities initiated breeding work on faba bean.

At Haryana Agricultural University, 83 exotic and 9 indigenous lines of faba bean were evaluated in the field at Hissar during the 1982/83 winter season, following a randomized block design with three replicates. Each entry was planted in 3-m long single- row plots spaced 50 cm apart, with 20 cm inter-plant spacing. Five plants from each plot were sampled for seed yield, its components, and other economic traits.

Hissar is located at 29^{o} 10'N and 75^{o} 46'E. Its climate is semi-arid temperate, with an average annual rainfall of 400 mm, and an average annual temperature range of 20^{o}-35^{o}C. The experimental research farm in Hissar has sandy loam soils.

The mean and range of variation for seed yield and other characters (Table 1) showed large differences within and between exotic and indigenous groups. The indigenous lines were superior to exotic types for seed yield, seed protein, early maturity, number of branches, pods per plant, and seeds per pod. The exotic cultivars were nearly 50% taller than the indigenous genotypes and had much larger seeds.

The characteristics of the four highest yielding lines are presented in Table 1. There is little or no variation among them for maturity, plant height, total pods, and seeds/pod (Table 1). There were, however, significant differences for seed yield, seed protein, number of branches, and seed weight. Although Hissar Local was the highest yielding variety, its seed protein content was considerably lower. Of greater interest was the excellent performance of an exotic genotype, VH-5, having a high protein content, a large number of branches, and a very high seed weight. The use of this line in breeding programs may result in development of suitable genotypes combining high seed yield with other desirable traits.

Table 1. Mean and range (parentheses) data for yield and yield components of exotic and indigenous lines, and some promising faba bean genotypes at Hissar, India, 1982/83.

Cultivar	Seed yield (q/ha)	Seed protein (%)	Days to maturity	Plant height (cm)	No. of branches/ plant	Total pods/plant	Seeds/pod	100-seed wt (g)
Exotic: mean	4.0	18.1	163	76.3	1.9	10.4	2.3	33.9
range	(1.6-24.0)	(12.3-25.6)	(121-188)	(53.7-100.2)	(1.0-6.0)	(4.0-73.7)	(2.0-3.0)	(18.6-78.9)
Local : mean	15.4	19.5	126	55.0	4.5	57.7	2.8	25.3
range	(9.0-33.2)	(12.5-25.9)	(122-149)	(44.1-62.4)	(3.0-5.7)	(31.3-70.7)	(2.3-3.0)	(19.0-27.7)
C.D. 5%	1.5	0.5	1.6	5.1	0.3	3.3	0.2	3.4
Hissar Local	33.2	12.5	127	62.4	3.0	65.3	3.0	26.8
VH-129 (local)	20.0	18.0	122	54.2	4.3	66.0	3.0	27.2
LM-1 (local)	19.5	19.9	126	54.8	5.7	73.7	3.0	25.3
VH-5 (exotic)	24.0	23.6	123	57.6	6.0	64.7	3.0	78.9
CD 5%	5.5	2.0	6.5	20.7	1.3	13.3	0.7	16.0

NEW INTERESTING MUTANTS IN *VICIA FABA* AFTER SEED TREATMENT WITH GAMMA RAYS AND ETHYL-METHANE-SULPHONATE

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Mutagenesis is a tool to increase variability in species in which natural variation is not large or, as often happens, where phenotypes desired by plant breeders are not available because they have disappeared due to their poor competitive ability in natural conditions (Ricciardi *et al.* 1982).

Vicia faba L. has been widely used to ascertain and compare mutagenic effects of chemical compounds (Wolff and Read 1952, Read 1954 and 1961, Sjodin 1962, 1971a, and 1971b, Wakonig-Vaartaja and Read 1962, Kumar and Natarajan 1965, Read and Kihlman 1956, Filippetti and de Pace 1983) and physical agents (Gray and Scholes 1951, Thoday 1951, Evans *et al.* 1959, Sjodin 1962, 1964, 1971a, and 1971b, Filippetti *et al.* 1982, Filippetti and de Pace 1983, Nagl 1979, Abdalla and Hussein 1977). A review of the new variants induced in *Vicia faba* L. for simply inherited characters has been made by Chapman (1981) and for quantitative variation by Abdalla and Hussein (1977).

A breeding program for *Vicia faba major* using mutagenic agents was started at Bari in 1978. Preliminary results have been reported (Filippetti *et al.* 1982, Filippetti and de Pace 1983). The program aimed to induce the same spectrum of variability in *V. faba major* as is already available in *V. faba minor*, and to identify new morphological types, sources of disease and pest resistance, and other factors.

In this note we report results of the analysis of new chlorophyll and morphological mutations induced by treatments with gamma-rays (doses of 5000 and 8000 rad) and ethyl-methane-sulphonate (EMS, concentrations of 1.2 and 1.7%) of seeds of two commercial cultivars of *Vicia faba* L., "Aquadulce" (*major* type, long pod) and "Manfredini" (*minor* type).

A total of 33,000 dry S_4 seeds were treated. The treated seeds were planted in paper pots filled with a mixture of peat and sterilized soil. As soon as the M_1 seedlings were large enough, having 1-2 leaves, they were counted and planted in the field at 30 cm intervals in rows 80 cm apart. The M_1 plants were isolated from pollinators with a plastic net (mesh 2 x 2 mm). The following parameters were measured: 1) emerged plants, 2) survival rate, and 3) fertility of each plant at maturity.

The percent of emerged and surviving plants decreased with increased doses of mutagenic treatments. There was a clear difference in fertility between control and treated material, but small differences between different doses of treatments (Table 1). In total, about 58,000 plants, including controls, were grown in the M_2 generation (1982/83). Chlorophyll and morphological mutations were counted and selected. The mutagenic effect in M_2 was expressed as a) number of mutants/100 M_2 plants and b) number of mutations/100 M_1-progeny plants (Table 2).

In both cultivars, the effect of EMS was about 2-3 times that of gamma-radiation. The frequency of the albina, xantha (yellow leaves, resulting in death), chlorina (yellow-green leaves, resulting in death), and chlorotica (yellow-green leaves, viable) chorophyll mutations were 7, 32, 25, and 37%, respectively.

Table I. Emergence and fertility in M_1 generation of gamma-ray and EMS treated seeds of cv Aguadulce (V. faba major) and cv Manfredini (V. faba minor).

Treatment	Emergence (%)	M_1 plants (% of treated seeds) Fertile[1]	Semisterile[2]	Sterile + Dead
Aquadulce				
Control	95	87.4	1. 9	10.7
Gamma-rays, 5000 rad	86	51.7	7. 7	40.6
Gamma-rays, 8000 rad	43	14.1	12.4	73.5
EMS, 1.2%	90	46.4	13.2	39.4
EMS, 1.7%	87	35.7	17.5	46.8
Aquadulce mean	77	36.9	12.7	50.4
Manfredini				
Control	94	87.5	1.7	10.8
Gamma-rays, 5000 rad	66	30.0	8.1	61.9
Gamma-rays, 8000 rad	44	15.5	11.3	73.2
EMS, 1.2%	86	57.3	13.4	29.3
EMS, 1.7	83	41.4	23.0	35.6
Manfredini mean	70	36.1	14.0	49.9

1. Fertile = mean seeds/pod > 1
2. Semisterile = mean seeds/pod < 1

Determinate types with terminal inflorescence, dwarf type, flower color, leaf shape, pod size, seed size, seed color, semisterile, and other morphological mutations were identified in the M_2 generation.

Two mutants of particular potential value, one characterized by terminal inflorescence, and the other by very short plant height, were produced. The determinate mutant produced 10 inflorescences below the terminal one on the main stem, with 3-4 secondary stems. Seed setting and pod fertility were good. Plant height at maturity was 70-80 cm (Figure 1). The second mutant showed very short plant height (20-30 cm at maturity) and low seed setting; pod fertility was normal (Figure 2).

Fig. 1. Mutant with terminal inflorescence.

Table 2. Values for mutation parameters after gamma-ray and EMS treatments in cv Aquadulce (V. faba major) and cv Manfredini (V. faba minor).

Treatment	Mutations % M_1 progenies			Mutants % M_2 plants			Segregation rate (%)		
	Chloroph.	Morph.	Total	Chloroph.	Morph.	Total	Chloroph.	Morhph.	Total
Aquadulce									
Gamma-rays, 5000 rad	2.40	2.69	5.09	0.42	0.59	1.01	12.76	22.83	17.21
Gamma-rays, 8000 rad	3.86	3.09	6.95	0.77	0.52	1.29	14.29	16.00	14.93
MS, 1.2%	9.22	11.14	20.36	1.84	2.44	4.28	12.55	18.60	15.42
EMS, 1.7%	9.77	10.33	20.10	1.98	2.20	4.18	13.32	21.75	16.75
Aquadulce mean	6.14	6.88	13.02	1.15	1.43	2.58	12.94	20.30	16.19
Manfredini									
Gamma-rays, 5000 rad	0.39	4.39	4.78	0.07	1.09	1.16	9.76	20.99	19.57
Gamma-rays, 8000 rad	1.65	3.86	5.51	0.20	1.41	1.61	16.13	30.00	27.15
EMS, 1.2%	5.22	4.48	9.70	0.91	0.97	1.88	10.82	18.34	13.73
EMS, 1.7%	4.59	5.73	10.32	1.23	1.23	2.46	15.00	13.39	14.15
Manfredini mean	3.76	4.68	8.44	0.77	1.08	1.85	11.96	18.05	14.88

Fig. 2. Dwarf mutant.

The obtained rate of segre_ation of total mutants was lower than the expected rate of 25% (Table 2). This may be attributed both to the nat're of chimera of some M_1 plants and, or some mutations, to the defici of recessive genes.

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SOME OBSERVATIONS ON RATE OF OUTCROSSING AND DEGREE OF AUTOFERTILITY IN RELATION TO HETEROZYGOSITY

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Introduction

Bond (1982) showed that synthetic varieties hardly out-yielded their highest yielding inbred-line components. The main reason for this seems to be the negative relations between autofertility and rate of outcrossing, depending on the level of heterozygosity. Drayner (1959) in her extensive experiments had already discovered similar relations. However, she used only autosterile inbred lines. So the question is raised on the influence of inbred parents with higher degrees of autofertility on autofertility and rate of outcrossing in the heterozygous offspring of crosses between these lines. Thus, in 1980 we tested the rate of outcrossing of three lines and their cross-progenies.

Materials and Methods

For parents we used three lines differing in autofertility (Table 1) and seed size, where line 1 belongs to the ssp. major, line 3 to the ssp. minor, while line 7 has intermediate seed size. The lines also differ in plant type.

Autofertility in the present experiment was defined as:

$$\frac{\text{no. of pods/plant in isolating cages}}{\text{no. of pods/plant in open field}} \times 100$$

Table 1. Autofertility and rate of outcrossing in lines and their cross progenies.

Line		Percent outcrossing	Autofertility
L1		37.5	60
L3		17.4	58
L7		30.7	81
Cross Progeny			
L3 x L1	F1	0.0	95
	F2	12.0	79
	F3	14.0	57
L7 x L1	F1	3.5	92
	F2	17.4	93
	F3	56.5	56
L7 x L3	F1	0.0	91
	F2	26.2	101
	F3	40.7	68
Mean lines		28.5	66
	F1	1.2	93
	F2	18.5	91
	F3	37.0	60

The number of pods were means of 10 nodes per plant of 30 plants in three replications. This proportion relates more closely to the practical consequences of autofertility than does a quotient like number of pods to number of flowers per plant or per node.

Outcrossing of the F_1, F_2, and F_3, progenies and parental lines, was tested by using the dominant marker gene for black hilum. This means lines and their offsprings were homozygous for colorless hilum. The test crosses were conducted with an eight-fold number of black hilum testers in cages with pollen-collecting bees.

Results and Discussion

As expected, in general, rate of outcrossing showed considerable increases from the most heterozygous F_1 progenies, with rate of outcrossing near zero, to F_2 and F_3 (Table 1). As rate of outcrossing increased, the degree of autofertility declined from F_1 to F_3. From the data it is not clear why the F_2 (with exception of cross $L_3 \times L_1$) did not reach medium range in outcrossing, as expected. It seems possible that the high degree of autofertility of line 7 could have influenced the results.

More importantly, differences in rate of outcrossing were observed between crosses, indicating genetic variation in outcrossing behavior. Furthermore, between lines the rate of outcrossing and degree of autofertility did not correspond as expected. For example, comparing lines 1 and 7, these lines are clearly different in autofertility but similar in rate of outcrossing, while line 3, similar in autofertility to line 1, showed much less outcrossing than line 1.

Conclusions

The present results encourage us to continue investigations concerning relations between autofertility and outcrossing at several levels of heterozygosity. From the practical point of view, we elaborated a selection scheme for the development of synthetic varieties, which includes systematic selection for rate of outcrossing in inbred lines. This scheme was presented and discussed at the EEC Seminar in Sutton Bonington, UK, 14-16 Sept 1984. With respect to the question of further progress in breeding synthetic varieties, our results indicate that rate of outcrossing of inbred parents possibly may have only little influence on the outcrossing behavior of the heterozygous offspring. This means that selection of inbred parents with a high rate of outcrossing would only contribute slightly to solving the still existing problems.

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NATURAL OUT-CROSSING IN FABA BEANS UNDER NORTH INDIAN CONDITIONS

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In India, faba beans have a long history of cultivation, but only as a minor vegetable crop. In view of its high yield potential, it has drawn the attention of breeders in recent years, and breeding work has been initiated at several agricultural universities.

Reported here are some data on the extent of natural out-crossing of faba beans under north Indian conditions.

Thirteen exotic faba bean lines obtained from West Germany were observed for natural out-crossing. All of these lines are comparatively dwarf, have small leaflets, narrow leaf angles and short internodes. The line UH7 is homogenic for the terminal inflorescence, recessive character. Lines VH17, and VVH78 are white flowered. The 13 lines were grown in the vicinity of genotypes characterized by broad leaflets, wide leaf angle, longer internodes, and colored flowers, i.e., black patch on the wings. These characteristics are of dominant nature. Thus, plants resulting from out-crossing could be easily spotted. Insect activity in the field was moderate. Seed collected from about 10 plants of each of the 13 lines was planted during the 1982/83 cropping season in plots 4 m long, with one or two rows per plot. Total and off-type plants were recorded, and the extent of out-crossing was calculated.

Results and Discussion

The observed proportion of out-crossing ranged from zero in VH7, VH67, VH87, VH95, VH98 and VH120 to about 47% in VH78 (Table 1). VH17 and VH47 showed a fairly high degree of out-crossing. The lines which did not show any out-crossing are apparently autogamous. This preliminary study was conducted without following any standard design. The total population observed in some lines was quite low and thus the out-crossing rates reported here might be under-estimates and need further confirmation.

Table 1. Estimates of natural out-crossing in some faba bean lines.

Line	Total no. of plants	No. of off-type plants	% out-crossing
VH7	28	0	0
VH17	17	6	35.3
VH47	11	3	27.3
VH59	51	2	3.9
VH68	26	0	0
VH70	41	1	2.4
VH78	32	15	46.9
VH87	20	0	0
VH95	24	0	0
VH98	24	0	0
VH106	30	2	6.7
VH118	14	1	7.1
VH120	15	0	0

EFFECT OF SOIL WETTING DEPTH ON FABA BEAN YIELD

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A field trial was carried out in 1982/83 at Sakha (Northern Delta), Sids, Mallawi (*Middle Egypt*), and Matana (Upper Egypt) experimental stations to study the effect of soil wetting depth on faba bean yield. Statistical analysis indicated that the wetting depth of soil had a significant effect upon yield at Sids, Mallawi, and Matana, while no signficant response occurred in the Sakha experiment. Optimum yields were obtained with a wetting depth of 60 cm (intermediate level of irrigation). The lowest yield was obtained by decreasing the wetting depth to 30 cm (very light irrigation).

Water requirement for different treatments was calculated by a moisture balance study following gravimetric determination of moisture content. The water requirements are shown in Table 1.

It can be seen that water requirements of faba bean were lower at Sakha than those in the Matana experiment. The values recorded for Sids and Mallawi were intermediate. This reflects the differences in climatic conditions prevailing at the different locations.

The lightest level of watering (wetting depth of 30 cm) produced the highest water-use efficiency in Sakha, while heavy watering (wetting depth of 75 cm) resulted in the lowest water-use efficiency. These data are in agreement with those reported by Chandani et al. (1960), who indicated that the efficiency of water utilization decreased with increasing quantities of irrigation water. Contrary to the above, in the Sids, Mallawi, and Matana experiments the relative increase in water use with increasing wetting depth resulted in corresponding increases in seed yields, and no significant differences in water-use efficiency were observed. Vites (1965) stated that no generalization can be made about water-use efficiency in relation to available water supply, since seasonal evapotranspiration and yield are related to many other factors, such as plant cover and soil moisture stress.

Table 1. Water requirements of faba bean with different wetting depths at Sakha, Sids, Mallawi, and Matana experimental stations, Egypt, 1982/83.

	Water Requirements (m^3 /ha)			
	Wetting Depth (cm)			
Site	30	45	60	75
Sakha	3080	3550	4032	4510
Sids	3700	4057	4462	4831
Mallawi	3917	4432	5036	5253
Matana	4248	5086	6033	6892

In conclusion, at Sakha light applications of water produced the highest water-use efficiency, while at Sids, Mallawi, and Matana, intermediate levels of irrigation resulted in higher yields without reducing water-use efficiency.

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EFFECT OF THE TIMING OF FIRST POST-PLANTING IRRIGATION (MOHAYA) ON THE YIELD OF FABA BEANS

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To evaluate the effect of the time of the first post-planting irrigation (Mohaya) on the yield of faba beans, a field trial was carried out at Sakha (Northern Delta), Sids and Mallawi (Middle Egypt), and Matana (Upper Egypt) experimental stations. The Mohaya was given 3, 4, 5, 6, 7, and 8 weeks after sowing. Seed yields were greatly affected by delaying Mohaya irrigation in the Middle and Upper Egypt regions, whereas at Sakha no differences were observed. At Sakha, some rainfall was recorded during the establishment phase of the crop, which explains the lack of treatment effects. At the experimental sites in the Middle and Upper Egypt regions, applying the first post-planting irrigation after four weeks gave optimum yields of faba beans. Delaying Mohaya irrigation to eight weeks after planting resulted in a decrease of 26, 38, and 57% in seed yield at Sids, Mallawi, and Matana, respectively.

Early application of the Mohaya increased the seasonal evapotranspiration (Table 1).

Table 1. Seasonal evapotranspiration of faba beans as affected by timing of Mohaya (weeks post-planting) at four sites in Egypt, 1982/83.

	Seasonal evapotranspiration (cm water)					
	Delay in Mohaya (weeks)					
Site	3	4	5	6	7	8
Sakha	29.78	28.70	27.77	26.27	26.29	26.24
Sids	43.58	42.21	39.97	38.12	38.28	37.69
Mallawi	43.27	42.00	40.04	40.45	39.48	38.74
Matana	48.20	46.36	45.21	44.10	42.49	41.33

The size of the root system is extremely important in determining the extraction of stored water from the soil (Hebblethwaite 1982). Data on soil moisture extraction revealed that most of the water was removed from the top 30 cm of soil. Also, it was noticed that as the Mohaya irrigation was delayed, plants extracted more water from deeper soil layers. These results are in agreement with those obtained by Maertens and Cabelquenne (1971) who indicated that in the presence of adequate available water plants absorb water from the surface layer of soil, and extract water from deeper levels under conditions of reduced soil moisture.

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HOST RANGE AND PROPERTIES OF CUCUMBER MOSAIC VIRUS (CMV-Su) INFECTING VICIA FABA IN SUDAN

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Introduction

Vicia faba is an important cash crop in Sudan. A survey of faba bean crops around Shambat, Khartoum North, showed a high incidence of chlorosis and necrosis. When indicator plants were inoculated with sap from these plants, symptoms distinct from those of known viruses in Sudan were produced.

Materials and Methods

Vicia faba plants showing chlorosis and necrosis from the Khartoum University Farm, Sudan, were ground in 0.05 M phosphate buffer, pH 7.0. The expressed sap was used to inoculate carborundum dusted Chenopodium amaranticolor. Single lesion isolates were taken from C. amaranticolor and maintained on Nicotiana tabacum cv. Harrow Velvet.

The host range of this virus was determined by mechanically inoculating several plants of each species using infected N. tabacum sap. Back tests were made on to C. amaranticolor after 3 weeks.

For determination of dilution end-point and thermal inactivation point, crude sap was extracted from systemically infected N. tabacum cv Harrow Velvet three weeks after inoculation. Tests were performed as described by Gibbs and Harrison (1976).

Inoculated and systemically infected N. tabacum leaves were harvested 14 days after infection. Purification was by the method described earlier (Ahmed and Mills, in press).

Antisera to CMV-PY and CMV-G were used with purified virus in microprecipitin tests. Antisera and antigen were diluted in 0.005 M borate buffer, pH 9.0. Drops of 10 µl were mixed at room temperature (approx. 22°C) for 4 h.

^{3}H-cDNA copies of CMV-Su RNA were made and used in hybridization tests essentially as described by Robinson et al. (1980). For hybrid formation, RNA samples from CMV-I_{17}N (DTL serotype) were used at 25 and 50 µg/ml. Duplicate 10 µl samples of each were mixed with 2 µl ^{3}H-cDNA (6000 cpm/µl).

Aphid transmission tests were done with non-viruliferous apterous adults of Myzus persicae. Aphids were starved for 2 hours, given a 2-3 minute acquisition period on infected Nicotiana tabacum and transferred to healthy N. tabacum for 30 minutes. Five aphids were transferred to each plant.

Results and Discussion

Experimental host range is shown in Table 1. The virus infected all 15 species tested. No symptoms were apparent in tomato, although the virus was detected when back tested on to *C. amaranticolor*. Both French bean and cowpea developed strong systemic symptoms and all *Nicotiana* species had symptoms on the inoculated leaves. An isolate described by Fischer and Lockhart (1976) from Morocco showed similar reactions in cowpea and certain French bean cultivars but differed in many other host reactions, notably *Vicia faba* in which they had no symptoms in inoculated leaves and were unable to recover the virus from upper leaves. On the basis of host range alone it was not possible to diagnose the Sudanese isolate as cucumber mosaic virus (CMV).

Table 1. Host range and symptomatology of CMV-Su.

Host plant	Inoculated leaves*	Uninoculated leaves*
Capsicum annuum	Mo, LC	VB
Chenopodium amaranticolor	LLn	-
C. quinoa	LLn	-
Cucumis sativus	LLc	Mo
Datura stramonium	L	L
Dolichos lablab	LLc	Mo
Gomphrena globosa	L	L
Lycopersicon esculentum cv. Ailsa Craig	L	L
Nicotiana debneyi	LLc	Mo, Ma
N. glutinosa	LLc	Mo, Ma, FL
N. rustica	Mo	Mo
N. tabacum		
cv. Harrow Velvet	LLc	Mo
cv. Xanthi	LLc	Mo
Phaseolus vulgaris cv. The Prince	LLc	Mo
Vicia faba	N	Mo, N
Vigna sinensis	LLn	Mo, VC, Stu

* Symbols used: FL = fernleaf, L = latent, LC = leaf curl, LLc = chlorotic local lesion, LLn = necrotic local lesion, Ma = malformation, Mo = mosaic, N = necrosis, Stu = stunting, VB - vein banding, VC = vein clearing, -= no reaction and negative back test.

Thermal inactivation of the virus occurred at c 70°C. In 10-fold dilution steps, infectivity was lost between 10^{-3} and 10^{-4}

In microprecipitin tests, the virus reacted weakly with antiserum to CMV-PY down to 1/32 dilution and not at all with CMV-G. Purified virus was precipitated in phosphate buffered saline *(pH 7.0)* at room temperature. These results suggested that the virus had a weak relationship with CMVDTL serotype but was not related to ToRS serotype.

In 10 attempts, the virus was not transmitted by *M. persicae* from infected to healthy *N. tabacum*. Neither was the virus transmitted when aphids were allowed to feed on purified virus through parafilm membranes. However, aphid transmission tests from *N. tabacum* were performed following several generations of mechanical transmission from the original isolation. This may have affected the ability of *M. persicae* to transmit this isolate.

The non aphid-transmissibility of the virus coupled with abnormalities in host range and poor serological reactions necessitated further confirmation that the isolate was CMV. ^{3}H-cDNA hybridization experiments with a DTL serotype isolate of CMV showed there was a 93% sequence homology between the two isolates, confirming the test isolate to be CMV. Hence we named this virus as CMV-Su.

These results underline the variability in diagnostic properties of CMV isolates and add to the already long list of plant species naturally infected with CMV.

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RESISTANCE IN VICIA FABA TO ASCOCHYTA FABAE

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Introduction

Ascochyta blight disease of faba bean (*Vicia faba* L.) caused by *Ascochyta fabae* Speg. is widely distributed throughout the world (Hebblethwaite 1983), and under wet weather conditions has been reported to inflict heavy losses in faba bean production (Beaumont 1950, Hewett 1973, Sundheim 1973).

Partial resistance to *A. fabae* has been reported from studies in Russia (Sestiperova and Timofeev 1965), Canada (Kharabanda and Bernier 1980), and England (Bond and Pope 1980). Unfortunately, none of these sources seemed promising enough to justify the development of commercially resistant cultivars. Therefore, this study was initiated to detect reliable sources of resistance to *A. fabae* in the germplasm collection of the International Center for Agricultural Research in the Dry Areas (ICARDA).

Materials and Methods

A mixed inoculum of *A. fabae* collected from a wide range of naturally infected faba bean seeds from the Lattakia and Homs regions of Syria was propagated for 2 weeks on a faba bean dextrose-agar (FDA) medium. It was then used to inoculate 10-week old faba bean plants of 1730 germplasm accessions in the field. An inoculum density of 500,000 spores/ml was used, employing 20 ml of spore suspension per plant. Twenty seeds of each accession were planted in October of each year, in single rows 2 m long and 50 cm apart. A susceptible cultivar, Giza 4, was planted after every two test entries.

Disease rating was made on a 1-9 scale, where:

1 = No disease symptoms, or very small brown nonsporulating flecks (highly resistant);

3 = Few localized leaf lesions with 1-5% of leaf area infected (resistant);

5 = Lesions very common, coalesced, and damaging, with 26-50% leaf area infected (susceptible);

9 = Extensive lesions on leaves, stems, and pods, severe defoliation, stem girdling, with more than 50% of leaf area infected (highly susceptible).

In order to identify reliable sources of resistance, a two-cycle screening technique, and multilocation testing procedures were adopted. During the first cycle, in 1978/79, 1730 lines were screened using a mixed inoculum of A. fabae. Resistant and highly resistant selections made in 1978/79 developed a few scattered lesions which were believed to have been induced by rather more virulent pathotypes present in the original mixed inoculum. A. fabae isolates selected from such lesions were then used in a second screening cycle in 1979/80 to re-inoculate progenies from resistant selections made in the previous season. Seeds of resistant genotypes selected in 1979/80 were increased during the off-season, and then used for multilocation testing in Syria, Canada, England, and Sweden.

Another test was conducted to determine differences in virulence between the two inocula used in this study. Ten pure-line faba bean accessions (BPL 4, 21, 211, 220, 383, 390, 395, 405, 582, and 521) were inoculated separately in moist chambers by the first- and second-cycle inocula of A. fabae.

Results and Discussion

Ascochyta blight lesions were first observed 12 days after field inoculation. Distribution of accessions over different disease-reaction categories is presented in Table 1. Of the 1730 accessions tested in the first screening cycle, 533 were rated one and three, with the remaining 1197 entries rated 5 and 7, indicating a wide range of genetic variability among the accessions. Disease reaction ranged between 5 and 7 on the susceptible local check-rows.

Of the 533 entries selected in 1978/79 and re-evaluated in the second screening cycle during 1979/80, 15 were rated 3 and 133 rated 5. The remaining 385 entries were rated 7 and 9 (Table 1). Average scoring for the susceptible local check rows was 7-9, with 51% and 49% rated 7 and 9, respectively.

Resistant selections made during the second screening cycle and used in multilocation testing in Syria, Canada, England, and Sweden in 1982/83 were rated highly to moderately resistant (Table 2), compared to the local commercial cultivars at these locations (Drs. Bernier, Jellis, and Sjodin, personal communication). This is the first report concerning resistance in faba bean to A. fabae in different geographical regions.

The two-cycle screening technique adopted in this study provided a means by which faba bean accessions were effectively screened for resistance to a wide range of pathogenic variability in naturally occurring populations of A. fabae (Kharabanda and Bernier 1980). Data presented in Table 3 indicate that the selected inoculum of A. fabae used in the second screening cycle induced significantly greater disease levels on all 10 faba bean genotypes, as compared to that used in the first cycle. The two cycle screening technique helped the detection of genetic materials with resistance to normally predominant populations of A. fabae, and also contributed, through the second cycle, to the identification of certain selections with resistance to certain pathotypes that seemed considerably more virulent. It should be noted that the resistant and moderately resistant selections identified during the first cycle which were no longer resistant after the second cycle, may still possess genes useful against less virulent pathotypes that might occur in other regions.

The multilocation testing has revealed a considerable specificity between sources of resistance in faba

Table 1. Host status of different faba bean germplasm lines in relation to Ascochyta fabae, Syria, 1978-80.

Disease rating (1-9 scale)	Host status	No. and % of germplasm tested			
		1978/79*		1979/80**	
		No.	%	No.	%
1	Highly resistant	13	0.75	0	0.00
3	Resistant	520	30.06	15	2.80
5	Moderately resistant	882	50.98	133	24.95
7	Susceptible	315	18.19	265	49.71
9	Highly susceptible	0	0.00	120	22.51
Total		1730		533	

* Inoculated with a mixture of A. fabae obtained from a wide range of naturally infected faba bean seeds.

** Inoculated with A. fabae isolated from lesions on resistant selections only.

Table 2. Disease reaction on 15 promising faba bean genotypes in Syria, Canada, England, and Sweden.

BPL	Selection	Origin	Host status (1982/83)*				
			Syria	Canada** A	Canada** Y	England	Sweden
74	79-70015	Iraq	R	MR	MR	HR	HR
ILB 161	80-14986	Greece	R	MR	MR	R	NT
230	80-14200	Morocco	R	S	S	R	R
ILB 382	80-14998	UK	R	S	MR	MR	NT
365	80-14336	Turkey	R	R	MR	R	NT
369	80-14339	Turkey	MR	S	MR	R	NT
435	80-14398	Spain	MR	S	S	R	NT
436	80-14399	Spain	MR	R	S	R	NT
460	80-14422	Lebanon	R	MR	R	R	HR
465	80-14427	Lebanon	R	R	MR	HR	NT
471	80-14434	Lebanon	R	R	MR	R	R
472	80-14435	Lebanon	R	S	MR	R	HR
818	80-15035	Ethiopia	R	R	MR	R	HR
ILB 752	80-15025	Unknown	R	R	R	NT	NT
2485	80-10026	Spain	R	R	R	NR	NT
Giza 4			HS	NT	NT	NT	NT
Erfordia			NT	S	S	NT	NT
Hylon			NT	NT	NT	MR	NT
Diana			NT	NT	NT	NT	S

* HR = Highly resistant (rated 1), R = Resistant (rated 3), MR = Moderately resistant (rated 5), S = Susceptible (rated 7), HS = Highly susceptible (rated 9), NT = Not tested.
** A and Y are two races of Ascochyta fabae in Canada.

Table 3. Differences in pathogenicity between the two inocula of A. fabae used in the first and second screening cycles of faba bean germplasm lines.

	Disease reaction on certain faba bean genotypes on 1-9 scale									
Inoculum	BPL 4*	21	211	220	383	390	395	405	582	521
A**	1.0a	3.0a	5.5a	3.5a	3.5a	1.0a	5.0a	3.5a	5.5a	3.5a
B***	5.5b	7.5b	9.0b	7.0b	7.5b	7.5b	9.0b	7.0b	9.0b	7.0b
Water only	1.0c	1.0c	1.0c	1.0c	1.0c	1.0c	1.0c	1.0c	1.0c	1.0c

* Readings followed by different letters are significantly different at $P = 0.05$.
** Mixed inoculum used in the first screening cycle.
*** Selected inoculum from lesions on resistant genotypes used in the second cycle.

bean and naturally occurring populations of A. fabae in different production areas. However, genes for resistance from these sources can be incorporated to develop any desired gene combination that fits different patterns of pathogenic variability in A. fabae across various regions.

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Resistance to bean yellow mosaic virus in Vicia faba

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Bean yellow mosaic virus (BYWV) is an important virus disease of faba bean (Vicia faba L.) throughout the world. The virus is transmitted by many aphid species in a non-persistent manner and its very wide host range provides many sources for infection and/or possibilities for overwintering. Yield losses may be high, especially when early infections occur. Therefore, identification of sources of resistance to BYMV is very important for plant breeding.

Two sources of resistance to BYMV were found in sibling groups of inbred lines in a screening program. In the first case, four out of 20 siblings were resistant, segregating in the third generation; there was no further segregation in the following two generations. This indicates that the responsible gene is recessive and homozygosity has been established. In the second case, the resistance segregated in the fourth inbreeding generation: one out of 10 siblings was resistant and all inbred progenies of the resistant one were also resistant. This gene may also be recessive.

The two sources of resistance found are different, as they are directed to different strains of BYMV. Crossings have now been carried out to elucidate the real heredital pathway and the evaluation of the progenies is in progress.

Preliminary investigations on the mechanism of resistance showed that no hypersensitivity is involved. Probably there is an extreme resistance to virus infection. Eight and 16 days after inoculation no virus could be detected by enzyme-linked immunosorbent assay in either the inoculated or in subsequent leaves of a resistant line. High concentrations of virus were found in all plant parts of a susceptible line, irrespective of symptom expression.

EFFECTS OF CHLOROTHALONIL ON DISEASE SEVERITY AND YIELD OF FABA BEAN (VICIA FABA) IN SCOTLAND

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In Britain, chocolate spot, caused by infection of the foliage by Botrytis fabae Sard. and B. cinerea Pers., is the most serious disease of faba bean (Vicia faba L.), particularly in autumn-sown crops (Wilson 1937, Soper 1952). In Scotland, where most faba bean crops are spring-sown, the aggressive, destructive phase of the disease is rare. However, during the summer many small brown lesions appear on the leaflets, from which B. fabae and B. cinerea can often be isolated (Harrison 1981). Leaf and pod spot lesions, caused by Ascochyta fabae Speg., with their characteristic small black pycnidia, are also common in many crops, particularly if a farmer uses his own seed. Although less frequent, bean rust, caused by Uromyces fabae (Pers.) de Bary, may also occur, especially during a dry summer. While these pathogens do not usually appear to cause serious damage, they may reduce the supply of assimilates to developing seeds by destroying photosynthetic tissue, leading to lower yields.

Table 1. Experimental details for each year.

	Year		
	1981	1982	1983
Cultivars	Felix, Minica, Maris Bead, Herz Freya	Maris Bead, Diana	Maris Bead, Diana
Sub-plot size	3 x 4 m	4 x 10 m	4 x 10 m
Date sown	16 Apr	9 Mar	18 Mar
Dates of fungicide application	2, 16, 30 July, 14 27 Aug	10, 24 June 8, 23 July	11 July 25 July 8 Aug
Dates of disease assessment	27 July 18 Aug	29 June, 21 July	4 July, 4 Aug
Date harvested	22 Sept	23 Aug	6 Sept

The work described here attempts to investigate the effects of these leaf pathogens on yield by controlling them with regular applications of fungicide.

Materials and Methods

A field experiment was carried out during 1981, 1982, and 1983. Details of each experiment are given in Table 1. Seeds of more than one cultivar, from various commercial sources, were sown each spring at a rate of circa 45/ m^2, 20-40 mm deep in rows 125 mm apart, in to a well-drained medium loam soil at Invergowrie. A randomized split plot design with 4 replications was used, with fungicide application as the main-plot and cultivars as sub-plot treatment. Plants were either sprayed to run-off with 0.15% (V/V) Daconil Flowable 500 (Midox Ltd., Albright and Wilson, Oakham, Leicestershire, England), which contains 500 g chlorothalonil/l, at 14 day intervals on four or five occasions during the summer, or were not sprayed at all. Foliar disease was assessed visually on two occasions. At maturity, when most pods were black and few leaves remained, plants were lifted from two 1-m^2 areas close to the center of each plot. After allowing plants to dry for 2-4 weeks on a bench in a glasshouse, the yield and yield components were determined for each sample.

Results

Lesions caused by Ascochyta spp. or Uromyces spp. were not seen at all.

Table 2. Effects of spraying with chlorothalonil on severity of foliar disease and yield of various faba bean varieties, Invergowrie, 1981-83.

Year	Cultivar	Disease severity*		Yield (dry wt of seeds, g/m^2)	
		Chlorothalonil		Chlorothalonil	
		+	-	+	-
1981	Felix	0.75	1.25	530	522
	Minica	0.00	1.00	586	542
	Maris Bead	0.50	2.00	466	427
	Herz Freya	1.25	1.25	434	391
1981	Mean	0.63	1.38	504	471
	S.E.D. between means	+ 0.128 (P<0.001)		+16.6 (N.S.)	
1982	Maris Bead	1.00	1.00	307	375
	Diana	1.00	2.00	295	259
1983	Maris Bead	0.25	1.25	317	306
	Diana	0.75	1.25	324	316
1982/83	Mean	0.75	1.38	311	314
	S.E.D. between means	+0.129 (P=0.01-0.001)		+13.5 (N.S.)	

* 0= no leaf lesions, 1 = very few leaf lesions, 2 = few leaf lesions. Assessed on 27 July 1981, 21 July 1982, and 4 Aug 1983.

There were no significant treatment differences in disease severity at the first assessment each year. Although disease levels remained low throughout the three seasons there was less disease in chlorothalonil-treated plots than in controls when assessed on the second occasion each year (Table 2). Differences between cultivars were not significant.

Yield results from the experiments done in 1982 and 1983 were combined for statistical analysis, while those from the experiment done in 1981 were analyzed separately. Table 2 shows that chlorothalonil had no significant effect on yield. It also had no effect on any of the yield components. Only in 1981 was there a significant effect of cultivar on yield. There was no interaction between chlorothalonil and cultivar.

Discussion

Harrison (1981) isolated B. fabae from an increasing proportion of leaf lesions during the growing season in faba bean crops on two farms in Scotland between 1975 and 1980. The calculated mean dates on which it was recovered from half the lesions for the two farms, respectively, were 15 July and 4 Sept. B. cinerea was also isolated from many small brown lesions, and the proportion of successful B. cinerea isolations also increased as the season progressed (unpublished data). These results, together with the observed absence of Ascochyta spp. and Uromyces spp. from the experimental plots, suggest that most lesions were probably caused by Botrytis spp. However, although chlorothalonil effectively controlled leaf diseases, lesions appeared in untreated plots only after most seeds had swollen, and then remained at low levels. Williams (1975) reported that a reduction in area of photosynthetic tissue in faba beans caused by infection by B. fabae was compensated for by an increased net assimilation rate. It therefore seems likely that leaf diseases might reduce yields only if they appear early in the season and affect a substantial proportion of leaf tissue before most seeds become fully swollen with assimilates.

Acknowledgement

I thank Miss. J. Ross for technical assistance.

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RESSELIELLA MIDGE: A NEW PEST OF FABA BEANS

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Damage to crop plants and forest trees by species of the genus Resseliella is well documented, the attack occuring inter alia upon raspberries (R. theobaldi), soya (R. soya), currants and gooseberries (R. ribis), and Japanese cedar (R. odai), firs (R. picea) and pine species (R. silvana). Red larvae of an unnamed species reported upon faba beans in 1924 may have been identical with the Profeltiella spp. found more recently (Barnes 1946), which were almost certainly the same as that now known as Resseliella midge identified in wide-spread attacks upon faba beans in the East Anglian region of Britain in 1981 and 1982. In 1981 epidemic proportions of the red larvae were found in the stems of faba bean crops in Essex and Suffolk, causing extensive lodging. They were considered to have entered the plants after infection with Fusarium spp. had left the stem vulnerable. In contrast, in raspberries initial damage by the midge is considered to lead to later Fusarium spp. entry (Pitcher 1952, Pitcher and Webb 1952, Williamson and Hargreaves 1979). It is possible to suggest a number of alternative factors which could influence the susceptibility of faba bean plants to attack in this way. For example, sub-lethal levels of herbicides are often present in agricultural soils under modern farming conditions and in certain cases predispose plants to pest attack, since it has been shown that dinitroaniline herbicides and glyphosate may induce brittleness and splitting of stems near the base (Marriage and Khan 1978, Putnam 1976, Baur 1979).

There seem to be no reports on the yield reduction caused by this insect, nor on what factors influence levels of attack. We have regularly found small numbers of the larvae on both Vicia faba minor and V. faba major in Hertforshire since 1979.

As part of a program to establish early warning or integrated control systems for insect and other pests of legumes, we began an examination of factors governing population levels of Resseliella spp. on V. faba major and minor and of possible control measures, and are attempting to assess the amount of damage resulting from attacks of differing intensity. In addition to monitoring population changes on control crops and the effects of insecticide residues, level of Fusarium spp. infection and the variation of numbers geographically have been examined.

Materials and Methods

Population sampling: Normally a series of twelve-plant samples were taken from each plot or field. The soil immediately surrounding the roots was also taken. The roots were washed and the soil and root washings examined for larvae. The washed roots and the stems were examined and any larvae visible were collected. Samples from large fields were restricted to the outer 23 m strip around the field.

Experimental plots: Faba beans var. minor were normally sown at a rate giving an inter-row distance of 18 cm and an intra-row distance of 7 cm. V. faba major cultivars were sown in double rows having an intra-row distance of 8 cm, and an inter-row·distance of 15 cm, the double rows being separated by a distance of 35 cm. Each treatment plot was usually 2 x 2 m, giving a final stand of 140-210 plants(mean 160)/plot. Herbicides were applied at rates of one quarter, one half, and full recommended field application rate, insecticides at the full recommended field rate.

Results

Typical changes in the number of larvae/m row length through the season in spring sown V. faba minor at Lea Hoe, Hertford are given in Figure 1. Table 1 gives some similar figures and illustrates the movement of larvae from stem to soil as the season progresses. Figure 2 shows the regional variation in numbers of larvae, the figures referring generally to the mean of 12 samples. Table 2 shows the influence of sowing date on the numbers found. Winter sown crops showed much higher infestation.

Table 1. Changes in distribution of Resseliella spp. larvae on faba bean crops through the season, 1982, Hertford.

Date sampled	No. per m row	Percent stems attacked	Percent Larvae in Stems	Soil
Winter beans				
6 June	330	55	74	26
9 July	417	64	18	82
5 Aug	497		1	99
Spring beans				
9 July	24	35	89	11

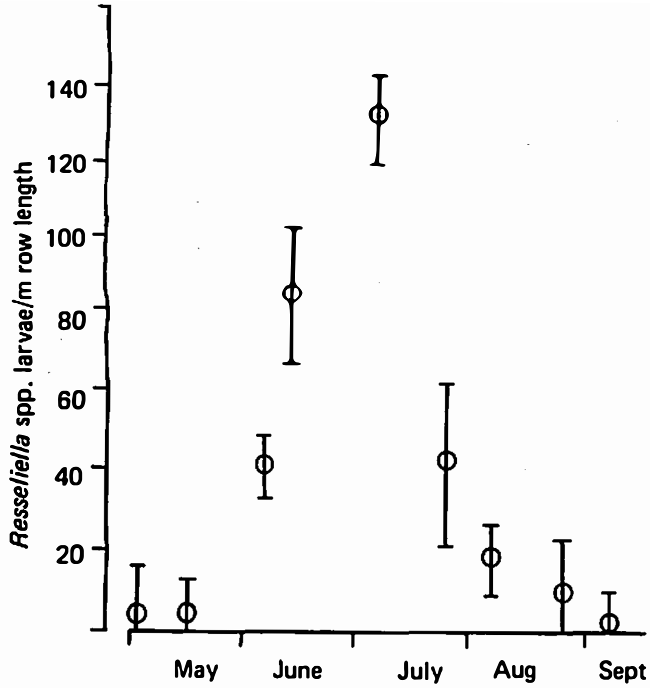

Fig. 1. Variation in *Resseliella* numbers from May - September, 1982

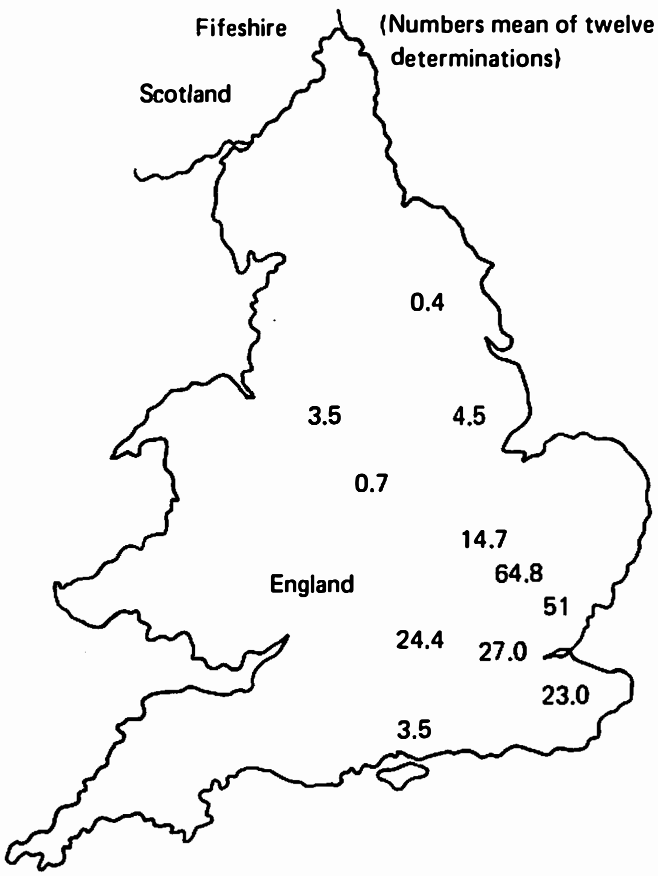

Fig. 2. Mean numbers of *Resseliella* larvae at different sites in July *1982 (larvae/m* row).

Table 2. Influence of sowing date on maximum numbers of Resseliella spp. larvae recorded on faba bean Hertford, 1981/82.

Date of sowing	Estimated maximum no. of larvae/meter row
27 Oct 81	497
8 Mar 82	8
15 Mar	5
29 Mar	17
12 Apr	42

Some results on the efficiency of different insecticide treatments for the control of the larvae are given in Table 3. Table 4 lists some results on the effect of phorate on populations of the adult and larval stages of the faba bean weevil Sitona lineatus and on Resseliella larvae comparing adjacent fiels of field beans, one having been treated at normal field rate, the other untreated. Figure 3 shows the effect of added nitrogen fertilizer on the rate of attack by the midge. The lack of correlation between levels of Fusarium spp. infection and the numbers of larvae is shown in Figure 4. Table 5 shows the influence of sub-lethal residual levels of some herbicides on the rate of infestation.

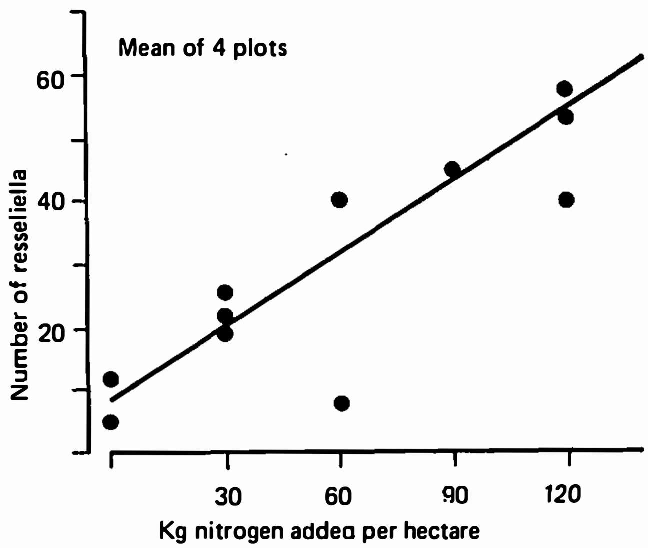

Fig. 3. Mean number of *Resseliella* spp. larvae as affected by added nitrogen levels on *V. faba minor,* 1982.

Discussion

Sampling from crops in different regions showed midge numbers to be signficant only in the Mid- and East-Anglia regions of England. Levels of attack were higher on winter beans than on spring beans. On any particular crop, numbers increased exponentially through June, reaching a maximum in July, and thereafter falling rapidly. Large numbers of the larvae were found in the soil in August, suggesting possible overwintering in the soil. For spring crops a general increase in maximum numbers of the midge was found from early- to late-sown crops.

Considerable size variation noted in the larvae in mid season was consistent either with egg-laying over an extended period, or with paedogenesis, which has been observed in other species of this genus. Good control was obtained by a single application of bromophos in early May, but uneven control resulted from phorate or 'Dursban' (chlorpyrifos) treatments; phorate treatment, recommended for control of bean weevil (Bardner et al. 1982) was effective in controlling adult weevils in these experiments,

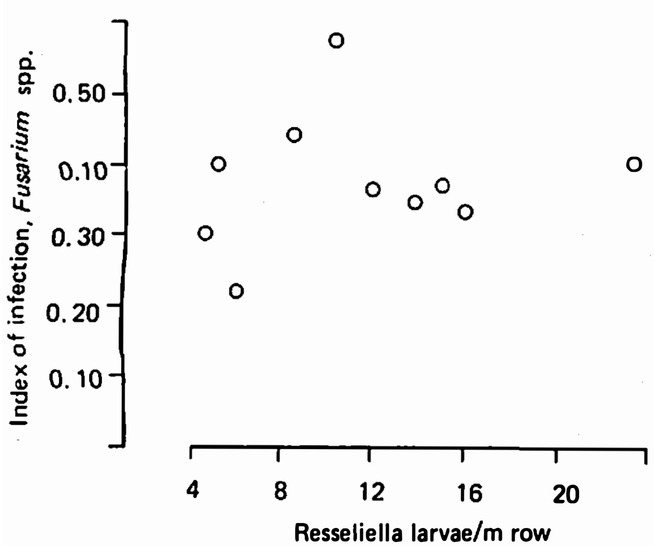

Fig. 4. Plot of number of *Resseliella* spp. larvae per meter row against *Fusarium* spp. index of infection.

Table 3a. Mean number of larvae per meter row in insecticide treated plots of V. faba minor.

Insecticide	Application rate, kg. a.i./ha	Larvae/ m	Percent stems attacked	Percent reduction in larval nos.
Dursban	2.0	23	21	87
Bromophos	1.0	15	18	95
Carbofuran	2.0	24	18	92
Permethrin	0.2	63	27	79
Phorate	1.2	280	53	7
Phorate	2.5	170	45	43
Untreated		303	58	

Table 3b. Effect of bromophos* on Resseliella spp. larvaenumbers/m row on spring planted faba beans.

Crop	Date of sample	Mean number		Percent reduction
		Treated	Control	
Vicia faba minor	2 July	14.6	97.3	85
	20 July	15.5	38.5	60
	4 Aug	14.4	20.4	29
	26 Aug	15.7	17.4	10
Vicia faba major	2 July	0.5	6.5	92
	18 July	8.2	16.4	50
	2 Aug	39.6	40.7	3

* Single application May 15.

Table 4. Effect of phorate treatment on populations of larval Resseliella spp., Sitona spp. adults, and Sitona larvae/m row of V. faba minor.

	Resseliella		Sitona larvae*		Sitona adults	
Site	Phorate	Control	Phorate	Control	Phorate	Control
A	112	92	7	229	1.6	4.8
B	40	164	180	140	9.6	28.4
C	420	32	133	360	2.9	5.5

*Including pupae.

Table 5. Influence of herbicide residues on Resseliella spp. populations on V. faba minor, 1982, Hertford.

Herbicide	Application rate, kg/ha	Mean no. larvae/m	Significance level (P)
a) Sandy soil loam			
Control		7.4	
Simazine	1.25	15.6	< 0.001
Compound T7	1.25	10.5	NS
Mecoprop	0.5	11.1	NS
Mecoprop	2.0	14.3	< 0.02 > 0.01
Glyphosate	1.25	18.8	< 0.001
b) Clayey soil			
Control		12.6	
Simazine	3.0	56.5	< 0.01
Glyphosate	0.5	22.4	< 0.05 > 0.02
Glyphosate	2.2	37.6	< 0.02 > 0.01
Compound T7	1.0	19.1	NS
Compound T7*	4.0	55.0	< 0.01

* Applied post emergence.

but was erratic in control of weevil larvae or midge larvae. Although Fusarium spp. infection of beans has been suggested to offer a focus for entry of the midge, no evidence was found for any correlation between occurrence of the two organisms. The level of Fusarium spp. infection was apparently similar, on control plots, at all levels of Resseliella spp. infestation; further, whilst increased levels of nitrogen in the soil paralleled increased numbers of the midge, levels of fungal attack decreased significantly with higher soil nitrogen levels. Similarly, sub-lethal residual levels of certain herbicides, in particular simazine and glyphosate, were associated with significantly higher populations of Resseliella spp. larvae, *whereas* reduced levels of fungal attack were found on the same experimental plots; likewise, no correlation with numbers of Sitona lineatus was discerned.

Calculation of the impact of the midge upon productivity is difficult since chemical control of the midge carries with it also control of other insects. Some approximation can be made on the basis of the numbers of plants lost at different Reselliela spp. levels, from which it can be estimated that an average infestation rate of 143 larvae/meter row may lead to a 20% loss in numbers of plants surviving to flowering. However, the ability of the crop to respond to a reduction of stand density is such that this might lead to as little as 3-4% loss in overall yield.

Empirical observations in 1981 had suggested that larvae were more often found on plants at the site of chocolate spot lesions, but the very low intensity of chocolate spot infection in the 1982 season could suggest that the apparent relationship was illusory. Although there was no apparent correlation between levels of infestation with Resseliella spp. Sitona spp., and Fusarium spp., it is likely that some contribution to entry of the midge arises from these sources, and variation in the midge populations probably represent an opportunistic response to lesions already present, including fungal attack, growth lesions, and herbicide lesions; cuticular thickness may also play some part.

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Seed Quality and Nutrition

VARIATION IN PROTEIN AND OIL CONTENT IN AN INDIAN COLLECTION OF FABA BEAN (VICIA FABA L.)

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Introduction

The present world shortage of animal protein has focused attention on the need for greater utilization and production of plant protein, particularly in developing countries. In India new sources of protein together with increasing the total production of traditional pulses would be required to overcome the present shortage. Faba bean, as a high-yielding legume, should have high potential. Protein content of the crop has been reported as ranging from 23 to 32% (Evans et al. 1972, Abdalla 1979), 26 to 35% (Bhatty 1974), 28.1 to 36.5% (Frolich et al. 1974), 15 to 29% (Foti 1979), and 24 to 31% (Singh et al. 1982). Reports on oil content are very limited, and indicate that faba beans have a very low oil content of approximately 1% (Evans et al. 1972, Olsen and Poulsen 1974) or 2.0 to 2.6% (Bjerg et al. 1981).

Materials and Methods

In the present study the experimental material comprised forty genotypes of Vicia faba collected from the northern states of India, 18 of the genotypes were black-seeded types, 11 were yellow seeded, and 11 brown seeded. The experiment was laid out in a randomized block design with three replications. Ten plants were selected at random and their seeds were composited for preparation of samples. Protein content was determined by the micro Kjeldahl method. Oil content was estimated using Soxhlet extraction procedure (AOAC 1965).

Results

There was a wide variation in protein content and 100-seed weight, i.e., 23.01 (JV-34-81) to 30.03% (JV-70-81), and 11.35 (JV-23-81) to 41.56 g (JV-12-81), respectively (Table 1). Oil content was low, ranging from 0.90 to 1.99%.

Black-seeded genotypes had higher protein content (25.41-30.03%) than yellow (23.87-26.96%) and brown-seeded genotypes (23.01-27.72%). There were no appreciable differences in oil content and 100-seed weight between the three groups.

The correlation coefficients calculated for protein, oil, and 100-seed weight among the different groups of faba bean as well as the overall coefficient did not reveal any significant associations.

These findings show that protein content of faba bean is as high as 30%, which is more than other common pulse crops in India, and that the crop can serve as a good source of functional protein, like soybean. The low oil content may also result in good cooking quality, i.e., for making split dal, as with other pulses.

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Table 1. Protein and oil content in forty genotypes of faba bean.

Black seeded group				Yellow seeded group				Brown seeded group			
Genotype	Protein (%)	Oil (%)	100-seed wt (g)	Genotype	Protein (%)	Oil (%)	100-seed wt (g)		Protein (%)	Oil (%)	100-seed wt (g)
JV-2-80	28.1	1.61	12.7	JV-3-80	25.5	0.91	18.7	JV-4-80	27.7	0.98	21.0
JV-6-80	27.3	0.99	22.7	JV-5-80	25.0	1.50	22.1	JV-10-80	25.4	1.45	18.1
JV-9-80	27.3	1.17	17.7	JV-7-80	25.5	1.68	20.8	JV-15-81	26.2	1.74	17.2
JV-13-81	27.3	1.50	19.1	JV-11-80	25.4	1.14	17.9	JV-16-81	25.8	1.50	22.5
JV-23-81	26.9	1.22	11.3	JV-12-81	25.6	1.15	41.6	JV-19-81	24.3	1.09	20.6
JV-24-81	25.5	1.33	13.4	JV-17-81	23.9	1.56	16.0	JV-20-81	25.8	0.98	18.4
JV-28-81	27.7	0.90	17.1	JV-18-81	25.0	1.00	18.9	JV-21-81	26.2	1.88	18.7
JV-33-81	25.5	1.17	17.2	JV-22-81	24.6	1.46	21.7	JV-25-81	23.5	1.14	13.9
JV-36-81	26.5	1.26	16.1	JV-27-81	27.0	0.94	16.8	JV-26-81	25.0	1.29	20.3
JV-67-81	25.4	1.41	22.6	JV-68-81	23.9	1.23	19.2	JV-29-81	25.0	1.71	24.7
JV-70-81	30.0	0.98	12.1	JV-69-81	26.9	1.14	16.0	JV-30-81	26.2	1.28	17.0
								JV-31-81	26.6	1.26	21.8
								JV-32-81	26.2	1.84	21.4
								JV-34-81	23.1	0.96	21.7
								JV-35-81	25.1	1.28	21.5
								JV-37-81	25.0	1.06	18.8
								JV-38-81	27.7	1.99	21.6
								JV-39-81	26.2	1.56	17.7

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ANNOUNCEMENTS

Disclaimer

The article in FABIS Newsletter No.8 entitled "Spring beans: is early sowing an advantage?," under the authorship of J.B. Lee, L.J. Allen-Williams, and N.M. Hamon, was submitted without the knowldege of Dr. Allen-Williams and Dr. Hamon. Dr. Hamon and Dr. Allen-Williams have stated that they would not have wished to be associated with the article as published.

The article was partly derived from a thesis by N.M. Hamon, entitled "Some aspects of the biology of the pea and bean weevil *Sitona lineatus* L., with particular reference to its status as a pest of field beans *Vicia faba* L.," and not as given in the references.

Reprints

ICARDA has been designated as the world center for information on faba beans, and as such we are trying to assemble a complete collection of papers relevant to this subject.

We would be most grateful if readers who have published papers relating to faba beans would send reprints to:

FABIS
Documentation Unit, ICARDA
P.O.Box 5466, Aleppo, SYRIA

Lentil Experimental News Service (LENS)

LENS, a scientific newsletter published jointly by the University of Saskatchewan and ICARDA with financial support from IDRC, is designed to improve communication among world lentil researchers.

For your free copy write to:
LENS
Documentation Unit ICARDA
P.O.Box 5466, Aleppo, SYRIA

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Opportunities for Training and Post-Graduate Research at ICARDA
ICARDA has active training courses on the development and improvement of food legumes, cereals, and forages with ICARDA's research scientists, trained instructors and proven programs. For a complete brochure of the training opportunities at ICARDA, please write to Training Department.

Madrid Food Legume Conference

December 21-23, 1983.

A conference on grain legumes organized by the Ministry of Agriculture, Spain, was held in Madrid, 21-23 Dec 1983. The purpose of the meeting was to try to define future policies for grain legumes. The participants included breeders, agronomists, extensionists, and animal nutritionists, as well as representatives from private companies working on seed production and on animal food.

Papers were presented on pulse breeding prospects, farming techniques, problems of seed production and certification, possibilities of pulses for animal feed, and compound feed industry opinion on this topic. Faba beans, peas, lupins, and bitter vetches were proposed for future research and official support.

For further information write to:

Mr. Andres de Leon
Ministerio de Agricultura
Direccion General de la Produccion Agraria,
Avda. Infanta Isabel 2
Madrid
SPAIN

M.Sc.
COURSE IN AGRONOMY
(the science and practice of crop production)

Applications are invited from GRADUATES in Agriculture, Horticulture, Agricultural Botany, Plant Science, Ecology, Botany, or Biology or other appropriate science subjects for admission to an advanced course of study leading to the degree of M.Sc. (by examination) in Agronomy. The course is designed to provide those having appropriate scientific training with specialist knowledge of agronomy.

The course is of eighteen months duration commencing in January and ending in July of the following year and it consists of four parts:

Principles I includes studies of crop nutrition, fertilizers, weed biology and control, crop water relations and irrigation, variety testing, and plant breeders rights.

Principles II includes computing, crop environment, climatology, biometry, principles of crop protection and crop physiology.

Production I and II provide a detailed study of the production, mechanization, and utilization of agricultural and horticultural crops and grassland, together with field experimentation. In addition each candidate will carry out a research project on an agronomic topic approved by the Head of Department and will be required to submit a thesis.

For suitable UK applicants, scholarships may be available.

Those seeking admission for the 1985-86 session should write before 15 October, 1984, requesting an application form from The Secretary (Ref. PGA), School of Agriculture, University of Nottingham, Sutton Bonington, Loughborough, Leics. LE12 5RD.

3rd International Symposium on Parasitic Weeds, May 7-9, 1984, ICARDA, Aleppo, Syria.

Fifty participants from 18 countries attended the workshop, which was sponsored by the International Parasitic Seed Plant Research Group, the German Agency for Technical Cooperation (GTZ), and ICARDA.

Nine technical sessions covered various aspects of parasitic angiospermic plants of the Loranthaceae, Hydnoraceae, Scrophulariaceae, and Orobanchaceae families. Subjects covered included basic research on structure, ecology, physiology, and biochemistry of the parasites, and their biology and control. The symposium provided a unique opportunity for interaction between scientists specializing in different research disciplines.

The proceedings of the symposium have been printed by ICARDA for the International Parasitic Seed Plant Research Group (IPSPRG). They include four papers on the biology and host resistance for Loranthaceae; five papers on the biology, ecology, and host specificity for Scrophulariaceae; seven papers on the biochemistry and physiology of Striga; four papers on host resistance, and control and research techniques for Striga; five papers on biochemistry, physiology, and control of Cuscuta; seven papers on physiology, resistance breeding, and control of Orobanche and one paper on the key to an East African species of Striga. The proceedings comprises 265 pages and is avaialble from:

C. Parker
Weed Research Organization,
Begbroke Hill, Sandy Lane,
Yarnton, Oxford OX5 1PF, UK

Cost including postage is US$ 20.00 or equivalent in sterling, payable to °Third Parasitic Weed Symposium.'

A single copy, free of charge is available from Communications and Documentation Department, of ICARDA, P.O.Box 5466, Aleppo, Syria, to scientists from the developing countries.

Forthcoming Conferences 1984 and 1985

1-7 Sept, 1984

Sixth International Congress on Virology, Sendai, Japan. Details from:

Prof. S. Glover, Department of Genetics, University of Newcastle, Newcastle upon Tyne NE1 7RU, UK

24-28 Sept, 1984

A Symposium on **Experimental Manipulation of Ovule Tissues-Micromanipulation, Tissue Culture, and Physiology'** will be held at Wye College, Nr. Ashford, Kent, UK. Details from:

Dr. G. P. Chapman, Convenor of the Symposium,
Department of Biological Sciences, Wye College, Ashford, Kent, TN25 5AH, UK

1-6 Oct, 1984

Sixth Congress of the Mediterranean Phytopathological Union, Cairo, Egypt. Details from:

Dr. Mustafa Fahim
P.O.Box 198, Orman, Giza, EGYPT

3-10 Oct, 1984

Twelfth International Congress on irrigation and Drainage, Colorado, USA. Details from:

Secretary ICID,
48 Nyaya Marg, Chanakyapuri,
New Delhi 110012,
INDIA

November 3-7, 1984.

The Third Scientific Arab Conference for Biological Sciences

The Jordanian Society for Biological Sciences is pleased to announce that, in collaboration with Yarmouk University and the University of Jordan, the Third Scientific Arab Conference for Biological Sciences will be held in Amman at the Yarmouk University Liaison Office and at the University of Jordan, November 3-7, 1984. The conference represents one of the important activities of the Jordanian Society for Biological Sciences. The goal of the conference is to strengthen the links of cooperation among Arab researchers in the biological sciences.

The Steering Committee of the International Biosciences Network (IBN) will hold its annual meeting at the same time, enabling members of the committee to be among the lecturers at the conference.

Further information can be obtained from:

Dr. R. Natour
Dept. of Biological Sciences,
University of Jordan,
Amman,
JORDAN

OR Dr. S. Suleiman
Dept. of Biological Sciences,
Yarmouk University, Irbid, JORDAN

12-16 Nov, 1984

FAO/IAEA International Seminar on the Use of Isotopes in Studies of Biological Nitrogen Fixation, Ankara, Turkey. Details from:

Dr. SKA Danso,
Soil Fertility, Irrigation and Crop Production Section,
Joint FAO/IAEA Division, Wagramerstrasse 5, P.O.Box 100, A-1400 Vienna,
AUSTRIA

15-19 April 1985 .

3rd International *Vicia faba* Review Meeting: Genetics and Breeding of *Vicia faba*, Gatersleben, German Democratic Republic.

This review meeting follows the two earlier ones held at Wye College, UK, in 1983 and 1984. The subjects to be covered include:

a) Chromosomal research and genetics
b) Breeding
c) Protein metabolism and genetic engineering
d) Germplasm resources

Attendance at the meeting is limited to 40 participants. The approximate cost of registration, accommodation and meals will be US $180.00. For participation, please write to:

Prof. Dr. R. Rieger,
Zentral Institut fur Genetik und Kulturpflanzenforschung,
DDR-4325 Gatersleben,
DDR

24-28 June 1985

3rd International Symposium on Iron Nutrition and Interactions in Plants, Lincoln, Nebraska. Details from:

Dr. R.B. Clark,
USDA-ARS, 101 KCR (Agronomy),
University of Nebraska,
Lincoln, NE 68583-0817,
USA

8-10 July 1985

Potassium in Agriculture Symposium, Atlanta, Georgia. Details from:

Chairman,
Arrangements Committee,
Potash and Phosphate Institute,
2801 Buford Hwy, N.E. Suite 401,
Atlanta, GA 30320,
USA

18-23 Aug 1985

13th International Congress of Nutrition, Brighton, UK. Details from:

Nutrition Society,
Chandos House,
2 Queen Anne Street,
London, W1M 9LE,
UK

Science and Technology Education and Future Human Needs

An international conference will be held at Bangalore, India, August 8-15, 1985. The principal aim of the conference is to identify practical ways in which science and technology education can contribute to national development. It is hoped that one of the outcomes of the conference will be a reappraisal of what should be taught in both schools and universities in order to promote development.

BOOK REVIEWS

Hebblethwaite, P.D. (ed.). 1983. **The Faba Bean (Vicia faba L.). A basis for Improvement.** Butterworths, Kent, England. 624 pp., hard cover, illustrated. $ 55.00. ISBN 0 408 10695.

Although one of the oldest crops in the world, interest on the improvement of faba bean has gained momentum in only the past few decades. One of the most productive food legumes, this crop could play a very significant role globally in providing good quality vegetable protein at a low price, for human food and animal feed. Recognition of this fact has *been* responsible for the increased research thrust on the improvement of this crop.

'The Faba Bean' attempts to bring together and critically review the substantial amount of basic and applied research that has been carried out globally on this important crop. The book consists of five major sections. The first deals with the back-ground, physiology, and breeding in 11 distinct subsections. The second deals with crop husbandry in two subsections. The third section provides a coverage of pest problems in three subsections, one each dealing with aphids, nematodes, and other pests. The fourth is devoted to diseases in four subsections, one each covering root, viral, shoot, and parasitic diseases. The last section of the book deals with harvest and post- harvest technology of the crop. The presentation of the subject matter is very balanced and systematic. Each subsection is contributed by one or more authors, who are all experts in their particular subject. Thus a wealth of information has been put together in a concise fashion in each section, which ends with an impressive bibliography. The book is well printed, with high quality line drawings and photographs. An exhaustive word index at the end of the book enhances its value to the readers.

This book comes to readers after the arrival of the first authoritative book on the crop, 'Faba bean Improvement' (edited by G. Hawtin and C. Webb), published for ICARDA/IFAD Nile Valley Project by Martinus Nijhoff, The Hague, The Netherlands in 1981. Nevertheless, the comprehensiveness of its coverage, and its emphasis on highlighting the areas in which further research is needed, makes 'The Faba Bean' an indispensible book for all those who are interested in increasing and stabilizing the productivity of faba beans.

M.C. Saxena
Food Legume Improvement Program, ICARDA, Aleppo, Syria

Allen, D.J. 1983. **The Pathology of Tropical Food Legumes. Disease Resistance in Crop Improvement.** John Wiley & Sons Ltd., Chichester. 413 pp. ISBN 0471 10232 6.

This book gives a critical review of the pathology of the legume crops grown for food in the tropics. The crops covered are those widely grown in the tropics: groundnut, soybean, bean, cowpea, pigeonpea, and chickpea. The foreword of the book is written by Dr. A.H. Bunting, an authority on the International Agricultural Research System and on the subject of agricultural research and development needs of the developing countries. The author has himself been closely associated with the activities of the International Agricultural Research Centers in the tropics and has devoted a number of years to research on the diseases of food legumes in many parts of the tropics.

The opening chapter deals with the tropical environment, the evolutionary diversity of legumes, and the complex cropping systems in which they are grown. Then follows a discussion of crop-pathogen evolution, the stability of cropping systems, germplasm exchange, and new encounters between the hosts and parasites.

Chapters 2 and 3 discuss the pathogens themselves. The subsequent six chapters deal with the diseases of individual crops, and the final chapter covers the subject of resistance breeding and disease management. The book has an extensive list of references and an index.

As the author notes in the preface, "this book has been written principally for those actively engaged in the improvement of the legume crops, particularly plant breeders, plant pathologists and entomologists." It would be of value to those who are involved in the resistance breeding in tropical legumes, and even those working on other crops.

M.C. Saxena
Food Legume Improvement Program, ICARDA, Aleppo, Syria

Bibliography of the Scientific Research Papers Published by ARC Staff 1970-1983, Vol. 1. Ministry of Agriculture, Agricultural Research Center (ARC), Giza, Egypt. 1984.

This is a comprehensive bibliography of material published by staff of research institutes of the ARC Egypt. There are more than 50 references on faba bean, including agronomy, irrigation, pathology, and pest control.

Biological Husbandry. A scientific approach to organic farming (B. Stonehouse, ed.). Butterworths, London, England. 1981. 352 pp.

Biological husbandry, based on organic farming, seeks to maintain and improve the productivity of land by encouraging and enhancing natural biological processes. This book, the proceedings of the first international symposium of the International Institute of Biological Husbandry, 26-30 Aug 1980, presents a detailed scientific review of the subject.

Chapters cover: the interrelationships of soil, flora, and fauna; agricultural methods, including biological pest control, problems of energy saving and recycling, and an assessment of the limits to productivity; the application of methods of organic farming to a variety of agricultural systems; studies of energy utilization, crop quality and yield, and the economics of biological husbandry as compared with conventional agriculture. Of particular interest to FABIS readers is the chapter on "Plant-Microbial Interactions," which largely relates to rhizobium-legume symbiosis.

Paul Neate ICARDA, Aleppo, Syria

Nitrogen Fixation, Volume 3: Legumes (W.J. Broughton, ed.). Oxford University Press, UK. 1983. 325 pp. $47.95. ISBN 0-19-854555-X.

This book emphasizes the host aspect of symbiotic nitrogen fixation. It has chapters on taxonomy of legumes, mineral nutrition, agronomy, physiology and morphology of perennial legumes, nodule development and senescence, nodule metabolism, nitrogen uptake, transport, and utilization, and energy relationships.

Biology of the Rhizobiaceae. Supplement 13 of the International review of Cytology (Giles, K.L. and Atherley, A.G., eds.). Academic Press, USA. 1981. 331 pp. ISBN 0-12-364374-0.

The book discusses the taxonomy and identification of the Rhizobiaceae. Of particular interest to FABIS readers are the later chapters which present the genetics, molecular biology, and agricultural and morphological aspects of Rhizobium spp.

Cubero, J.I., Moreno, M.T. (Eds.). **Leguminosas de grano.** Mundi-Prensa, Madrid, Spain. 359 pp.

Various aspects of grain legumes production and improvement are presented in this multi-author book. The legumes covered include Vicia faba, Lens culinaris, and Cicer arietinum. The coverage includes environmental requirements, symbiotic nitrogen fixation, mineral nutrition, method of cultivation in Spain, diseases and pests, and nutritive value for human consumption and animal feed.

Vincent, E.M. (ed.). 1982. Nile Valley Faba Bean Abstracts. Published by the Commonwealth Agricultural Bureaux (CAB) for the ICARDA/IFAD Nile Valley Project 131 pp. ISBN 085 198 5033.

This publication is a compilation of abstracts of research papers and theses on research carried out on faba beans in Egypt and in the Sudan up to and including 1980. Abstracts have been reproduced from CAB journals as well as being prepared at the Documentation Unit, ICARDA, and at the Commonwealth Bureaux of Pasture and Field Crops, Hurley, UK.

Copies may be obtained from:

FABIS
Documentation Unit, ICARDA
P.O.Box 5466, Aleppo, SYRIA

Saxena, M.C. and Stewart, R.A.(eds).1983. **Faba Bean in the Nile Valley.** Report of the First phase of the ICARDA/IFAD Nile Valley Project(1979-82). Martinus Nijhoff Publishers, The Hague, The Netherlands. 151 pp. ISBN 90-247-2846-0.

This book gives a detailed report of the first phase of the ICARDA/IFAD Nile Valley faba bean project. Much of the work described concerns on-farm trials, which involve farmers, extension workers, and national program scientists from Egypt and Sudan.

The multidisciplinary nature of the research, bringing together socioeconomic and agricultural researchers, is a major feature of this unique and highly praised project.

This report should prove useful to all scientists, agricultural administrators, and agricultural research organizations interested in faba beans.

Copies of the book are available free to scientists in developing countries from the Food Legume Improvement Program at ICARDA. Others may obtain copies from Kluwer Academic Publishers Group, P.O. Box 322, 3300 Dordrecht, The Netherlands.

ISBN 90-247-2940-8
256 pages, Paperback

The International Center for Agricultural Research in the Dry Areas (ICARDA)
and
The International Board of Plant Genetic Resources (IBPGR)
Introduce . . .

GENETIC RESOURCES AND THEIR EXPLOITATION – CHICKPEAS, FABA BEANS AND LENTILS

By J.R. Witcombe and W. Erskine (editors)

ICARDA and IBPGR present a 256 page book designed for all breeders. This unique work provides a continuum between the collection,evaluation, and utilization of genetic resources.

'Genetic Resources and their Exploitation–Chickpeas, Faba beans and Lentils is a reference that bridges the gap between the genetic resources literature and the legume breeding literature.

Genetic Resources and Their Exploitation - Chickpeas, Faba beans and Lentils

The book, a joint endeavor of ICARDA and IBPGR, is based on lectures delivered by specialists in a 1982 training course sponsored by both institutions at ICARDA on the genetic resources of chickpeas, faba beans, and lentils. The book provides a continuum between the collection and evaluation of genetic resources, and their utilization. It discusses collecting and maintaining genetic resources of food legumes: chickpeas, faba beans, and lentils.

The book is divided into eighteen chapters covering:

- practical collection and initial documentation of food legume germplasm.
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- main steps for computerizing passport and evaluation data.
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- plant quarantine principles, methodology, and seed health of food legumes.
- utilizing food legumes' wild relatives and primitive types.
- utilizing genetic resources in a national food legume program.
- taxonomy, distribution, and evolution of chickpea and its wild relatives.
- collecting and evaluating chickpea genetic resources.
- exploitation of chickpea genetic resources.
- taxonomy, distribution, and evolution of faba bean and its wild relatives.
- genetic resources of faba beans.
- strategies for exploiting the faba bean gene pool.
- evaluating and utilizing faba bean germplasm in an international breeding program.
- taxonomy, distribution, and evolution of lentil and its wild relatives.
- genetic resources of lentils.
- evaluating and utilizing lentil germpalsm in an international breeding program

A limited number of copies of the book are available free for ICARDA cooperators working in developing countries, from FABIS/ICARDA/P.O.Box 5466/Aleppo, Syria.

Other copies are available from the publisher:

Martinus Nijhoff/Dr. W. Junk
Publishers
P.O.Box 566, 2501 CN The Hague,
The Netherlands

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Contributors' Style Guide

Policy

The aim of the newsletter is to publish quickly the results of recent research. Articles should normally be confined to a single subject, be of good quality and of primary interest to research, extension and production workers, administrators and policy makers. Articles for publishing in the newsletter should not be submitted to or published in any other journal.

Editing

Articles will be edited to preserve uniform style but substantial editing will be referred to the author for his approval; occasionally, papers may be returned for revision.

Disclaimers

The views expressed and the results presented in the newsletter are those of the author(s) and not the responsibility of ICARDA.

Similarly, the use of trade names does not constitute endorsement of or discrimination against any product by ICARDA.

Language

The Newsletter will be published in English but ICARDA will endeavour to translate articles submitted in Arabic and French.

Manuscript

Articles should be typed double spaced on one side of the page only. The original and two other legible copies should be submitted. The contributor should include his name and initials, title, program or department, institute and postal address and telex number if available. Photographs, figures, tables etc. should be either 8.5 cm wide (single column) or 17.5 cm wide (double column including space). Figures and diagrams should be drawn in India ink; send original artwork, not photocopies. Define in footnotes or legends any unusual abbreviations or symbols used in a figure or table.

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

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

Examples of common expressions and abbreviations

3g, 18 mm, 300 m^2, 4 Mar 1983; 27% ; 50 five-day old plants; 1.6 million; 23 u g; 5°C; 1980/81 season; 1981-82; Fig., No.; FAO, USA. *Fertilizers:* 1 kg N or P_2O_5 or K_2O/ha.
Mon, Tues, Wed, Thurs, Fri, Sat, Sun; Jan, Feb, Mar, Apr, May, June, July, Aug, Sept, Oct, Nov, Dec.
versus = vs, least significant difference = LSD, standard error = SE±, coefficient(s) of variation = CV(s).
Probability: Use asterisks to denote probability * = $P < 0.05$; ** = $P < 0.01$; ***= $P < 0.001$.

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

References

Journal articles: Murphy, P.T. and Milfin, B.J. 1982. The origin of barley. Euphytica 31: 183-192.

Books: Brues, A.M. 1952. Mineral cycling. Prentice-Hall, Englewood Cliffs, NJ, USA. 200pp.

Articles from books: Hastings, Sir G. 1908 (reprinted 1966). *Cajanus indicus* (arhar). Pages 196-200 *in* The Farm Products of India (Rao, D.M. and Murphy, R.E., eds.). Today and Tomorrow Printer and Publisher, New Delhi, India.

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

FABIS 9/1200/July 1984