FABIS

Faba Bean Information Service

NEWSLETTER
No.25
December 1989

INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS

(ICARDA)

ICARDA and CGIAR

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

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

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

FABIS

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

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

COVER PHOTO: Faba bean infected with broad bean mottle virus, a virus which is transmitted by the weevil *Apion arrogans*

ISSN 0255 6448

FABIS

Faba Bean Information Service

NEWSLETTER 25 December 1989

CONTENTS

Agronomy and Mechanization

Pests and Diseases

NEWS

SHORT COMMUNICATIONS

بحوث مختصرة

General Article

مقالة عامة

Fungal Diseases of Faba Bean in the Peoples' Republic of China

Liang Xun-yi
Zhejiang Academy of Agricultural Sciences
Hangzhou,
PEOPLES' REPUBLIC OF CHINA

Abstract

Thirteen fungal diseases have been reported to be occurring on faba bean in the Peoples' Republic of China. Of these diseases, chocolate spot caused by *Botrytis fabae* is the most common and most destructive. Root-rot and wilt disease complex is next in importance. In the strategy of disease control, the principle of prevention and integrated control have been emphasized. Chocolate spot was most widely studied among the different diseases. Of the 966 faba bean germplasm accessions tested for resistance to the *B. fabae*, 105 accessions showed varying degrees of resistance to the disease, with one of these accessions cv 'Lu-Xiao-Li Zhong' ('small-seeded green') showing stable resistance.

Introduction

Thirteen fungal diseases have been reported on faba bean in China. These include chocolate spot, ascochyta blight, zonate spot, rust, *Sclerotinia* rot, powdery mildew, *Pythium* root-rot, *Rhizoctonia* stem-rot, *Fusarium* root-rot and wilt, downy mildew, *Verticillium* wilt, and faba bean blister disease. Among these diseases, chocolate spot and root-rot and wilt disease complex are the most widespread and destructive. Meng (1982) reported that mycotoxins produced by *Fusarium* sp., which causes root-rot and wilt in faba bean, may be harmful to humans and farm animals.

Chocolate spot, caused by *Botrytis fabae*, is the most prevalent disease and usually causes heavy infection, particularly in regions where faba bean is autumn-sown, i.e., southern China and the Yangtze Valley (ZAAS 1961). However, in localized areas of southwestern China, faba bean rust caused by *Uromyces viciae fabae* is a very important disease. In the plateau regions of northwestern China, where faba bean is spring-sown, the zonate spot caused by *Cercospora fabae* is very severe in some years. A blister disease, caused by *Olpidium viciae* Kusano, was reported recently in the plateau regions of Sichuan, Tibet, and Gansu Provinces (Xin 1982).

Chocolate spot was first reported in China in 1945 (Yu 1945). Its occurrence and severity vary with years, localities, and cultivars. In general, it becomes more severe and develops rapidly at blooming and podding stages of crop growth. Weather conditions in April (temperature and rainfall) are favorable for development of the disease. Wang (1986) found a highly significant correlation ($r = 0.8073$; $p < 0.01$) between disease severity and the days of continuous rainfall (> 0.1 mm/day) during early to mid-April.

Studies of ways to control chocolate spot, undertaken for many years, have followed two directions, cultural practices and use of fungicides. Certain cultural practices such as crop rotation, early sowing, application of potash fertilizer and ditching to improve drainage have been shown to reduce disease incidence. Spraying faba bean plants at the blooming and podding stages with either Bavistin (Carbendazim) or Topsin-M (Thiophanate-methyl) was found to be effective in suppressing lession development and inhibiting spore production.

Another approach for the control of chocolate spot is the utilization of resistant host plants. The differential interaction detected in the Chinese faba bean varieties indicated the existence of resistant sources in the germplasm collection. However, the germplasm collection in China has not been systematically developed and tested for resistance to *B. fabae* until only recently. In the past four years, 966 accessions of faba bean obtained from 15 provinces in China were tested using an artificial inoculation technique. Of the accessions tested, 105 accessions were either resistant, or moderately resistant to *B. fabae*. Some of these accessions are already grown by farmers, namely cv 'Lu-Xiao-Li Zhong' (small-seeded green) which has shown stable resistance during the three years of tests in Hangzhou and the cultivars 'Xiao-Qing-Dou' and 'Zao-Jia-Zhong' which proved moderately resistant. This type of work will be continued in the future with the aim of detecting resistant genes and making them available to the breeders, who, in turn, will develop new varieties of faba bean resistant to chocolate spot.

In China, variations among different isolates of *Botrytis fabae* has been observed, and cultures can be classified into three groups: 1) cultures that produce abundant sclerotia with minimal growth of mycelium; 2) cultures that produce few sclerotia with excessive growth of mycelium; and, 3) cultures that show moderate production of sclerotia and mycelium. The pathogenicity of these three forms needs to be studied in the future.

References

Meng, You-Ru. 1982. A preliminary study on broad bean root-rot and wilt caused by *Fusarium* sp. Gansu Agricultural Science and Technology 3: 12-14.

Wang, Kun 1986. Forecast and control of the chocolate spot of broad bean. (in Chinese). Bulletin of Agricultural Sciences and Technology 5: 31.

Xin Zhe-Sheng. 1982. A preliminary study of blister disease on broad bean in northern parts of Sichuan Province. Plant Protection 2: 18

Yu, T.F. 1945. The red-spot disease of broad beans (*Vicia faba* L.) caused by *Botrytis fabae* Sard. in China. Phytopathology 35: 945-954.

ZAAS (Zhejiang Academy of Agricultural Sciences). 1961. Disease survey and control on chocolate spot of faba bean caused by *Botrytis fabae*. Pages 49-54 *in* ZAAS Annual Report 1960. Hangzhou, China.

أمراض الفول الفطرية في جمهورية الصين الشعبية

ملخص

أفادت التقارير بوجود 13 مرضا فطريا على الفول في جمهورية الصين الشعبية، منها : التبقع الشوكولاتي، المتسبب عن *Botrytis fabae* ، الذي يعتبر أكثرها شيوعا وتدميرا. يليه في الأهمية مركب مرضي تعفن الجذور والذبول. وضمن استراتيجية مكافحة الأمراض، تم التركيز على مبدأ الوقاية والمكافحة المتكاملة. وقد درس التبقع الشوكولاتي بتوسع أكثر من أي من هاتيك الأمراض؛ فمن 966 أصلا وراثيا من الفول اختبرت لمدى المقاومة له، أظهرت 105 مدخلات درجات متباينةً من المقاومة، إلا واحدا منها، هو الصنف 'Lu-Xiao-Li Zhong'، فإنه أظهر مقاومة ثابتة لذاك المرض.

Breeding and Genetics

التربية والوراثة

Some Studies on the Basis of Resistance of Vicia faba Cultivar 'Giza 402' to Orobanche crenata Parasitism

Khaled A. Khalaf and F.I. El-Bastawesy
Botany Department,
National Research Center,
Cairo, Dokki, EGYPT

Abstract

Plants of *Vicia faba* cvs 'Giza 402' and 'Aquadulce' were studied for root biomass, existence of *Orobanche* germination stimulant(s), and histological root features to develop some basis for observed field tolerance/resistance of Giza 402 to *O. crenata* parasitism. The level of *O. crenata* infection was much higher in Aquadulce than in Giza 402. This was mainly due to the large root mass produced by Aquadulce. Lateral root cross sections of the two cultivars at first flower bud and flowering stages showed slight differences in the vascular system with a thicker cortex layer in Giza 402 compared to Aquadulce. Root extracts of the two cultivars, after partial purification by silica gel column chromatography, induced the germination of *O. crenata in vitro* to nearly equal extent.

Introduction

Remarkable efforts have been made in recent years to select cultivars of *Vicia faba* resistant to *Orobanche crenata.* Kasasian (1973) reported that out of 53 cultivars of faba bean tested for resistance to broomrape, one was identified as moderately resistant. Research on the resistance of *V. faba* to *Orobanche* is active in Spain (Hernandez *et al.* 1984), and lines of *V. sativa* resistant to *O. crenata* have been successfully identified by Martin *et al.* (1982). In Egypt, the faba bean cv 'Giza 402' is regarded as a promising source for reducing *Orobanche crenata* parasitism (Nassib *et al.* 1985). However, this characteristic was only partially confirmed for the conditions in Syria (ICARDA 1986).

Limited information is available on the factors involved in the host resistance to *Orobanche* spp. and other parasitic weeds. Mechanisms of resistance in various hosts suggested so far include low *Orobanche* seed germination stimulant production (Williams 1959; Whitney 1979), the production of high levels of inhibitors (Whitney 1979), and the occurrence of mechanical and physiological barriers (Nassib *et al.* 1978). Vranceanu *et al.* (1981) found that the resistance to *O. cumana* Wallr. in sunflower is associated with single dominant gene.

As breeding of resistant varieties of host plants has become a major objective for controlling *Orobanche* spp. recently, the present work was undertaken to study the difference between the faba bean cvs Giza 402 and Aquadulce in *O. crenata* parasitism and its relation to some factors which may be involved in the host-parasite relationships. Aquadulce was included in this study because of its susceptibility to *Orobanche* (Kasasian 1973; Mallet 1973; Khalaf 1982).

Materials and Methods

The experiment was conducted under greenhouse conditions. Forty-clay pots (30x30 cm^2) were filled with a mixture of clay and sand (ratio 1:1). A set of 20 pots was used for the testing of each cultivar. Half of each set (10 pots) was infested with *O. crenata* seeds (o.1g/pot) at 5 cm soil depth. The crop seed, obtained from the Ministry of Agriculture, Egypt, was sown on 25 Nov 1986 (10 seeds/pot) at 3 cm soil depth. The root system of each cultivar was tested for *O. crenata* infestation at the occurrence of the first flower bud and at the flowering stage of the bean plants (50 and 70 days after sowing, respectively), corresponding to the critical time of establishment and development of *O. crenata* tubercles on *V. faba* roots. Roots from infected and uninfected pots were removed gently from the soil, collected carefully, and washed thoroughly with tap water. The fresh and dry weight (105 ^{o}C for 12h) of the roots were determined. The non-emerged *O. crenata* plants on the roots of the infected faba bean plants were separated and counted at the above mentioned growth stages. Fresh and dry weights (105 °C for 12h) were determined. The number of days from the date of sowing until *Orobanche* spikes started to emerge was noted on five additional pots/cultivar. Root samples (1 kg fresh weight) obtained from the infected faba bean plants were washed in tap water and stored at -20°C until required for extraction of *Orobanche* seed germination stimulant(s).

For anatomical studies, cross sections (15 µm thick) were made in the lateral roots of bean plants sampled at the above mentioned growth stages. The cross sections were fixed in a fixing solution consisting of formalin (40%), acetic acid (100%), and ethyl alcohol (96%) at a ratio of 10:5:85 ml, stained in crystal violet and erythrosin, and then examined under a microscope with 50-fold magnification.

Extraction and partial purification of Orobanche seed germination stimulant(s)

A root sample (1 kg fresh weight) was left to thaw at room temperature for 4h, ground with acid washed sand in a mortar, and then transferred into a dark screw-capped bottle and covered with re-distilled petroleum ether (40-60 °C, 1l) for 6h at room temperature. The petroleum ether extract was discarded and the ground roots were retreated with 1l re-distilled ether and kept over night at room temperature. Separation and concentration of the ether extract to about 5 ml was done by a rotary evaporator at 35°C. This concentrate was transferred to a column (21.3 x 3.2 cm^2) containing silica gel 40 (30g), 70-230 mesh ATSM (Merck), pre-treated at 125°C for 4h, cooled in a desiccator, and deactivated with distilled water. The column was eluted with 20% diethyl ether in 700 ml benzene; the first 200 ml was rejected, whereas the subsequent 500 ml of eluate, containing *Orobanche* seed germination stimulant(s), was retained and developed to dryness. The residue was redissolved in 100 ml diethyl ether. An aliquot (1 ml) of ether extract of each treatment was evaporated to dryness, redissolved in 0.5 ml acetone, and diluted to 5 ml with distilled water.

The activity of the aqueous *Orobanche* seed germination stimulant(s) was examined in germination tests with each 0.1g of *Orobanche crenata* seed. Seeds were sterilized in 50 ml aqueous ethanol (50%) for 2 min, and the floating sterilized *Orobanche* seeds were transferred to a test tube containing 50 ml distilled water and kept at room temperature for 10 days. A few seeds were transferred with a tip of a brush to the center of a filter paper disc (Whatman No 1) contained in a glass petridish (6 cm diameter). The test solution (1 ml) was added to each petridish at the beginning of the experiment, followed by a further 0.5 ml after 8 days. The petridishes where then incubated in the dark at 18-20°C for 16-20 days, and checked for seed germination every 4 days using a binocular with 50-fold magnification. The number of germinated seeds was recorded and expressed as percentage of the total number of seeds/petridish. Each treatment was replicated three times.

Results and Discussion

The data summarized in **Table 1** indicate that the two *V. faba* cultivars varied in their response to *O. crenata* infection at the two stages of crop growth (first flower bud and flowering). The susceptible cultivar, Aquadulce had a higher level of *O. crenata* infection compared with Giza 402. The fresh and dry weight of Aquadulce roots exceeded that of Giza 402 by 16.1 and 43.9% at the first and second sampling, respectively. Observation of *O. crenata* establishment and development on *V. faba* roots revealed that tubercles of *O. crenata* were established on Aquadulce at the first and second samplings (50 and 70 days after sowing, respectively), but at the flowering stage only on Giza 402 (**Table 1**). At the flowering stage, roots of both cultivars were attacked by *O. crenata* and many tubercles at the main and lateral roots were observed. The total number of both fresh and dry weight of *O. crenata* tubercles, however were much higher in Aquadulce than in Giza 402 at this stage. *Orobanche* spikes started to emerge at the pod stage in both cultivars. However, in Giza 402, *Orobanche* spikes required a longer time (98 days after sowing) than in Aquadulce (88 days after sowing). These results indicate that the root development of cv Giza 402 may be involved in the defence mechanism against *O. crenata* parasitism. The reduction of root biomass may help the cultivar to escape infection. Alternatively, the distribution of lateral roots must be taken into consideration. However, in the present study this could not be investigated due to difficulties associated with the technique. These results partly agree with the work of Nassib *et al.* (1985), who found that the resistance of cv Giza 402 is associated with less lateral root production and a more compact root mass, resulting in the reduction of the parasite population compared with the susceptible cv 'Giza 2'. Aalders and Pieters (1986) found that *O. crenata* infestation is related to the growth vigor of the *V. faba* host, i.e., the greater the root and shoot biomass of the host plant, the higher the number of *Orobanche* tubercles.

The anatomical features of root for the two *V. faba* cultivars at the stages of first flower bud and

Table 1. *Orobanche crenata* parasitism in relation to root biomass and sp. of *Orobanche* seed germination stimulant(s) in the two faba bean cvs Aquadulce (susceptible) and Giza 402 (resistant) at the first flower bud (50 days after sowing) and flowering (70 days after sowing)stages.

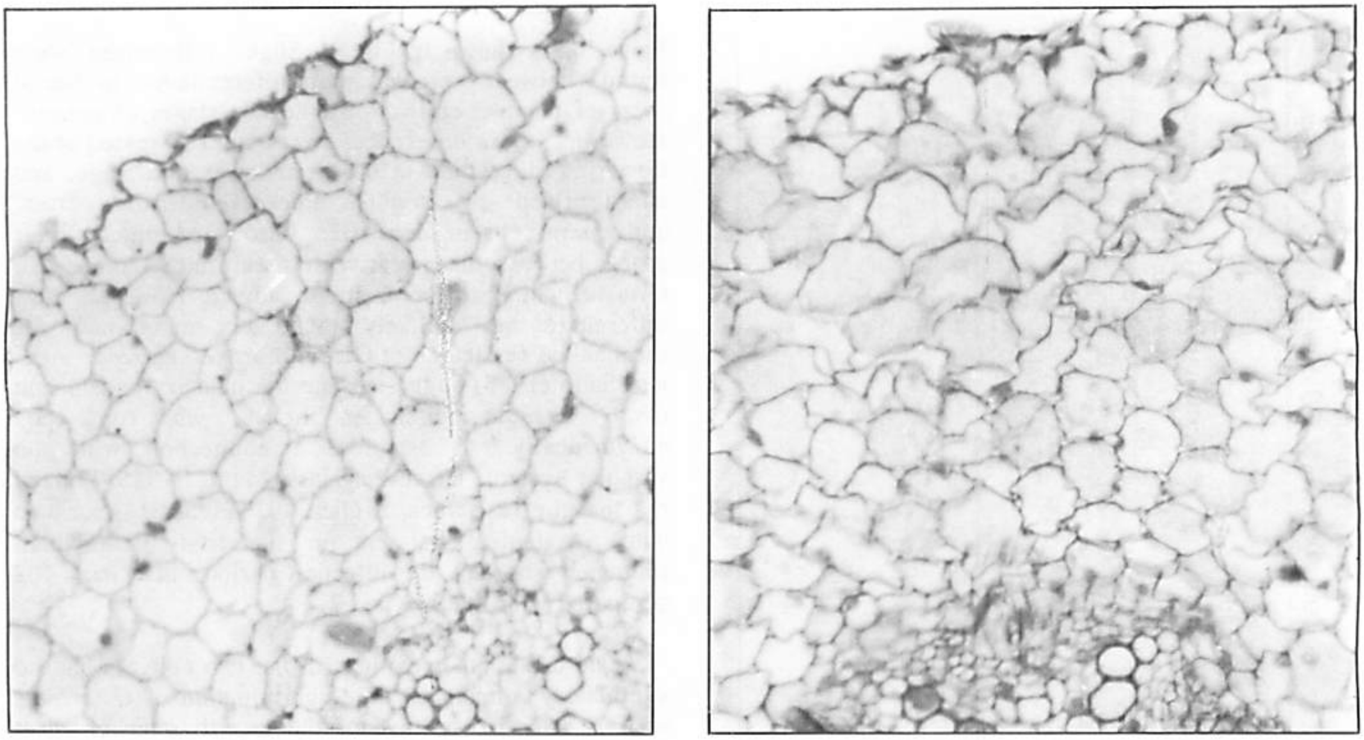
Growth stage	Cultivar	*O. crenata* parasitism on infected *V. faba* roots/10 plants				Root biomass of non-infected *V. faba*/10 plants		Germination (%) of *O. crenata* seeds *in vitro*	
		Number of *Orobanche* tubercles	FW of *Orobanche* tubercles (g)	DW of *Orobanche* tubercles (g)	Time of emergence of *O. crenata* spikes(days)	FW (g)	DW (g)	Crude root extract	Purified root extract
First flower bud	Aquadulce	0.8	0.243	0.017		233.1	38.5	0	25.0
	Giza 402	0	0	0		157.9	21.6	0	28.3
Flowering	Aquadulce	17.4	120.5	26.7	88	273.9	46.7	0	30.0
	Giza 402	2.2	30.5	10.6	98 (pod stage)	178.4	39.2	0	33.3

flowering is shown in **Fig. 1**. Slight differences were found between the vascular differentiation in lateral roots of the two cultivars at the two stages of growth. However, these differences were more expressed at the flowering stage than at the first flower bud stage, and characterized by slightly thicker epidermis, cortex, and xylem cells in Giza 402. Also, the intercellular spaces between the xylem vessels were more compact in Giza 402 when compared with Aquadulce. However, these differences are unlikely to be very important in the mechanical resistance of Giza 402 to *O. crenata.* Aber and Salle (1983) suggested that the primary haustorium of *O. crenata* penetrates the *V. faba* root cells enzymatically to establish a connection with the vascular system. However, Nassib *et al.* (1985) pointed out that the resistance of Giza 402 might be associated with mechanical barriers in the host tissue which ultimately shortens the infection period in Giza 402 compared with that of Giza 2.

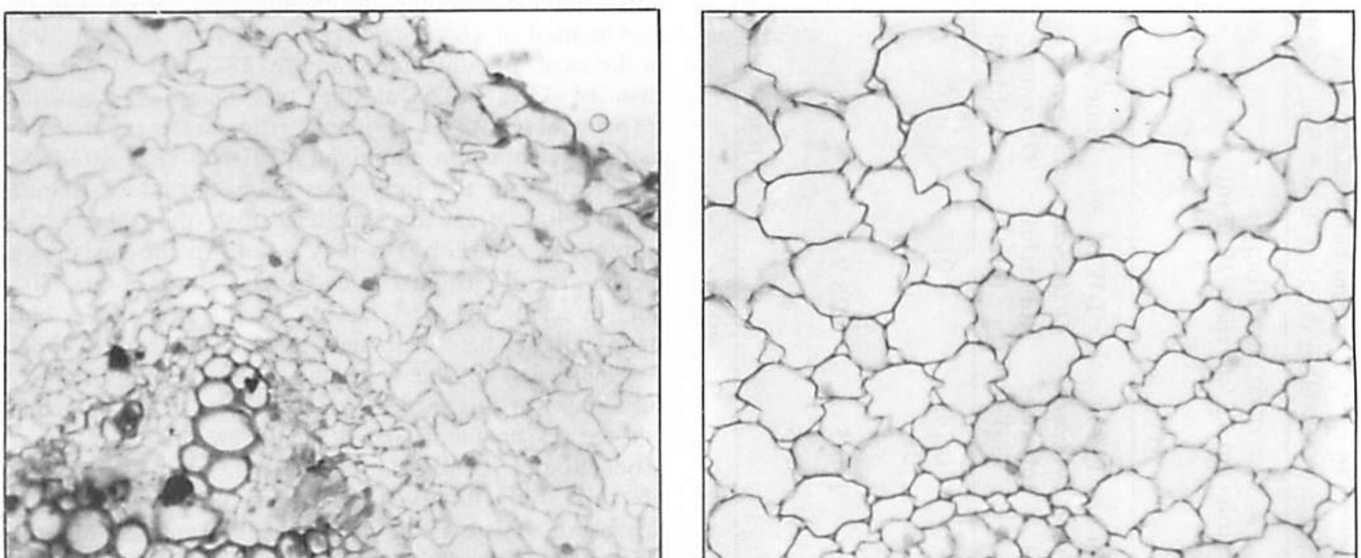
The crude ether extracts of the two culivars had no stimulatory effect on the germination of *O. crenata* seed *in vitro* irrespective of the growth stage of host plant at time of extraction (**Table 1**). However, ether root extracts of both cultivars, after partial purification by column chromatography, promoted the germination of *O. crenata* seed *in vitro* by 25 and 30% in the case of Aquadulce, and by 28.3 and 33% in the case of Giza 402, at the two stages of growth, respectively. It is evident from these results that natural germination stimulant(s) exist in Giza 402. As the results of the field tests show partial resistance of Giza 402, it can be concluded that the ether root extract is unlikely to play a role in the resistance mechanism of Giza 402 to *O. crenata.* Roots of Giza 402 not infected by *O. crenata* at the first flower bud stage might be attributed to the course of root development and/or to the release of inhibitory substances at this stage. Nassib *et al.* (1978) claimed that the resistance of Giza 402 may be due to a reduced production of germination stimulants. From the results of this study however, it is difficult to substantiate this claim. There is a lack of information on the amount, characteristic, and structure of *Orobanche* seed germination stimulant(s), and thus this area needs more investigation.

Conclusions

Based on the results of this study, it can be concluded that the faba bean cv Giza 402 is partially resistant to *O. crenata,* mainly because of its low root biomass. Thus, it can be grown successfully in low-infected soils, but under highly infected soils, it may become infected.



50 days after sowing   Aquadulce   70 days after sowing



50 days after sowing   Giza 402   70 days after sowing

Fig. 1. Vascular system of the lateral roots of the faba bean cvs Aquadulce (susceptible) and Giza 402 (resistant) at the first flower bud (50 days after sowing) and flowering (70 days after sowing) stages.

References

Aalders, A.J.G. and Pieters R. 1986. Plant vigor as a misleading factor in the search for resistance in broad bean to *Orobanche crenata.* Pages 140-149 *in* Biology and Control of *Orobanche*: Proceedings of a Workshop (Borg, S.J. ter. ed.), 13-17 Jan 1986, Wageningen, The Netherlands. Agricultural University, Wageningen, The Netherlands.

Aber, M. and Salle, G. 1983. A scanning electron microscope study of germination and early stages of development of *Orobanche crenata* Forsk. FABIS Newsletter 7: 45-48.

Hernandez, L., Moreno, M.T. and Cubero, J.I. 1984. Studies on the resistance of *Vicia faba* to *Orobanche crenata.* Pages 210-220 *in* Proceedings of the Third International Symposium on Parasitic Weeds (Parker, C., Musselman, L.J., Polhill, R.M. and Wilson, A.K., eds.), ICARDA/International Parasitic Seed Plant Research Group, 7-9 May 1984, Aleppo, Syria. ICARDA, Aleppo, Syria.

ICARDA (International Center for Agricultural Research in the Dry Areas). 1986. *Orobanche* studies. Pages 191-217 *in* Food Legume Improvement Program Annual Report 1986. ICARDA, Aleppo, Syria.

Kasasian, L. 1973. The chemical control of *Orobanche crenata* in *Vicia faba* and the susceptibility of 53 cultivars of *V. faba* to *O. crenata.* Pages 224-230 *in* Proceedings of the European Weed Research Council Symposium on Parasitic Weeds, 11-13 Apr 1973, Malta. Malta University Press, Malta.

Khalaf, K.A.H.A. 1982. Some studies on the control of *Orobanche crenata* parasitism of Vicia faba. Ph.D. Thesis, University of London. 223 pp.

Mallet, A.I. 1973. Studies in the chemistry of *Orobanche crenata* germination factor present in the roots of *Vicia faba* and other host plants. Pages 89-98 *in* Proceedings of the European Weed Research Council Symposium on Parasitic Weeds, 11-13 Apr 1973, Malta. Malta University Press, Malta.

Martin, L.M., Moreno, M.T. and Gil, J. 1982. Three new cultivars of common vetch (*Vicia sativa* L.) An. Inst. Nac. Inves Agrar (Spain), 21: 33-39.

Nassib, A.M., Hussein, A.H.A. and El-Rayes, F.M. 1984. Effect of variety, chemical control, sowing date and tillage on *Orobanche* spp. infestation and faba bean yield. FABIS Newsletter No. 10: 11-15.

Nassib, A.M., Ibrahim, A.A. and Saber, H.A. 1978. Broomrape (*Orobanche crenata*) resistance in broad beans. Pages 133-135 *in* Food Legume Improvement and Development: Proceedings of a Workshop (Hawtin, G.C. and Chancellor, G.J., eds.), 2-7 May 1978, Aleppo, Syria. ICARDA/IDRC, Aleppo, Syria.

Whitney, P.J. 1979. Broomrape seed germination and inhibitors from host roots. Pages 182-192 *in* Proceedings of the Second Internationl Symposium on Parasitic Weeds (Musselman, L.J., Worsham, A.D. and Elplee, R.E., eds.). North Carolina State University, Raleigh NC. USA.

Williams, C.N. 1959. Resistance of sorghum to witchweed. Nature 184: 1511-1512.

Vranceanu, A.V., Tudor, V.A., Stoenescu, F.M. and Pirvu, N. 1981. The evolution of virulence in the parasite *Orobanche cumana* Wallr. and the corresponding resistance genes in sunflower. An. Inst. Cercet. Cereale Plante Teh. 48: 37-43.

بعض الدراسات حول مقاومة صنف الفول جيزة 402 للعشب الطفيلي *Orobanche crenata*

ملخص

دُرِست نباتات صنفي الفول "جيزة 402 و Aquadulce" لتحديد الكتلة الحيوية للجذور، ووجود محفِّزات إنبات الهالوك *Orobanche* والخصائص الجذرية النسيجية، بغية وضع أساس ما لصفة المقاومة/التحمل الحقلي لتطفل الهالوك، المشاهدة عند الصنف جيزة 402 . وقد كان مستوى الإصابة بالهالوك أعلى بكثير في الصنف الثاني مما هو في جيزة 402 ، ويرجع ذلك أساسا إلى الكتلة الجذرية الكبيرة التي ينتجها الصنف Aquadulce . وقد أظهرت قطاعات عرضية في الجذور الجانبية للصنفين، وهما في طوري تشكل أول برعم زهري والإزهار، وجودَ فروق طفيفة في الجهاز الوعائي، مع وجود طبقة قشرية أكثر سماكة في الصنف جيزة 402 مقارنة بالصنف الآخر. كما أن مستخلصات جذور الصنفين قد حثّت، بعد تنقيتها جزئيا بواسطة التحليل اللوني في هلام السيليكا، الهالوك المفرِّض *O. crenata* على الإنبات في المختبر بدرجة متساوية تقريبا.

Faba Bean Dwarf Selections Outyield Dutch Top Varieties

A. van Norel and J. Hoogendoorn
Foundation for Plant Breeding (SVP),
P. O. Box 117,
6700 AC Wageningen,
THE NETHERLANDS

Abstract

Seed and protein yields of SVP dwarf selections were about 15% and 25% higher than those of the currently widely grown Dutch cultivars 'Alfred' and 'Victor'. The dwarfing gene involved is most probably causing a block in the gibberellin biosynthesis. The dwarf plant type appears more promising than the determinate type.

Introduction

In *Vicia faba* L., two dwarfing genes are known (Chapman 1981). The best studied gene, *dw-1*, reduces internode length by about 50% and increases harvest index in comparison with normal straw genotypes. Such effects of dwarfing genes have also been found for those genes affecting gibberellin (GA) metabolism, although it was not known whether this dwarfing gene in *Vicia faba* also operates via GA biosynthesis.

In pea and maize, normal plants show an increased elongation when treated with exogenous GA, and plants with a GA dwarfing gene are either more sensitive to GA because of a block in the biosynthesis of the hormone, or are less sensitive to GA due to a block in the turnover of the hormone (Reid 1987). Dwarf types are likely to be more resistant to lodging because of the lower center of gravity and the stronger stalk. Normal straw types are often very tall and produce an excess of straw in years with favorable weather conditions. In wheat, Austin *et al.* (1980) found that grain yield differences between old tall and modern semi-dwarf varieties of wheat were associated mainly with greater harvest index, caused by reduced stem length. It was also thought that in faba bean a dwarfing gene might offer a possibility to improve seed yield through a more efficient partitioning of the biomass between seeds, stems and leaves.

Materials and Methods

The faba bean cv 'Veritas', carrying the dwarfing gene *dw-1*, was crossed and backcrossed once to the faba bean cv 'Herz Freya'. In subsequent generations, selection was carried out for the presence of the dwarfing factor, pod setting at a relatively greater height (> 20 cm above soil level), no or little branching, lodging resistance, and a 1000-seed weight of about 500 g. **Fig. 1** shows the dwarf and a normal tall straw types.

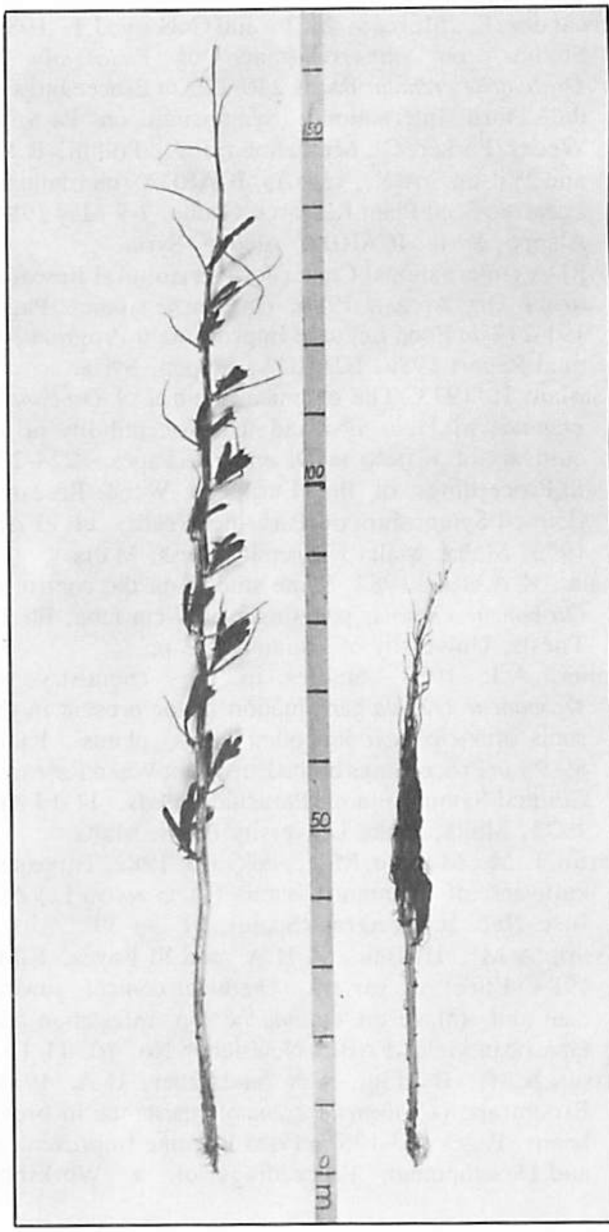


Fig. 1. Normal tall and dwarf straw types of faba bean plants at harvest.

In 1988, three closely related F6 families were incorporated in a yield trial together with the cv 'Herz Freya', and the cvs 'Alfred' and 'Victor', which are the two leading faba bean cultivars in the Netherlands at present. The experiment was laid out in a randomized block design with four replications. Plot size was 30 m^2 (5 x 6 m), of which the central 10 m^2 (2.5 x 4 m) were harvested. Tall cultivars were sown at the rate of 30 seeds/m^2 in rows 50 cm apart, as is common in the Netherlands. To achieve a similar rate of crop cover, the dwarf genotypes were sown at 40 seeds/m^2 using a row spacing of 25 cm. The soil was a light clay in the Dutch Flevopolders. Sowing was on 11 Apr 1988. Plants were counted in each plot at the four leaf stage (17 May). Vinchlozolin was applied twice to control *Botrytis fabae* during the growing season. The experiment was harvested on 15 Sept 1988.

To investigate the effect of the *dw-1* dwarfing gene on the gibberellin biosynthesis in the plant, a seedling test for sensitivity to GA was carried out. This was adapted from the test used for wheat by Gale *et al.* (1981). The cvs Alfred, Victor, Herz Freya, Veritas, and two dwarf F6 genotypes were pre-germinated for 24h in water, subsequently planted in trays filled with coarse sand, and kept for 3 days in the dark at 6°C to break dormancy and to ensure an even germination. The trays were then moved to a growth cabinet at 18°C, 16h day, and light intensity 130 W/m^2 at plant level. From then onwards the seedlings were given standard Steiner nutrient solution with or without GA3. Three concentrations of GA3 were used: 1, 10, and 100 ppm. The experiment was carried out in a split-plot design in three replications, within each replication four trays, each representing a GA3 treatment. Rows of five plants, one for each of the six cultivars, were randomized over a tray. Plant height, length of three elongated internodes (the highest one being the internode between the first and second true leaf) and leaflet length for the first and second true leaf were measured 18 days after the trays had been moved to the growth cabinets.

Results

In the seedling GA test, differences between the dwarf and tall faba bean genotypes were evident in the control, but no differences were detected when the genotypes were treated with GA3 at 100 ppm (**Table 1** and **Fig. 2**). The three dwarf genotypes reacted more strongly to GA3 than did the tall cultivars with an average seedling length increase of 4.3% in the former and 2.0% in the latter group. Similar reaction was found for individual internodes with an average increase of 1.9 and 4.6% for the tall and the dwarf genotypes, respectively. No effect of GA was found on the length of the tall cvs leaves, but leaf length of the dwarf genotypes was increased by 16%. **Table 1** also shows that within both groups of genotypes the differences in relative sensitivity to exogenous GA were slight.

Average seed and protein yields of the six genotypes, as well as protein content, plant density, plant height, and lodging are shown in **Table 2**. Dry seed yields of the dwarfs were 15 to 18% higher than the yield of the control cv Alfred, while differences for protein yield were as high as 25%. As expected, the dwarf genotypes did not lodge whereas, Herz Freya, in particular, was found to be very sensitive. In spite of the small height of the dwarf plants, pod set was at least 20 cm above soil level and acceptable for mechanical harvest. Dwarf genotypes ripened about a week after the tall cvs. This may be due to the fact that the dwarf lines had been selected for high pod set to facilitate mechanical harvest, and hence to some extent for lateness.

Table 1. Seedling height (mm) as affected by exogenous GA3.

Treatment	Genotype					
	Alfred	Victor	H. Freya	Veritas	C2-1A1	C2-1B2
Control	200	170	221	84	101	107
1 ppm GA3	283	222	266	223	250	271
10 ppm GA3	399	312	358	369	376	392
100 ppm GA3	425	361	396	416	407	414
100 ppm/control	2.12	2.12	1.80	4.92	4.04	3.87
SED				15.9		
CV (%)				6.5		

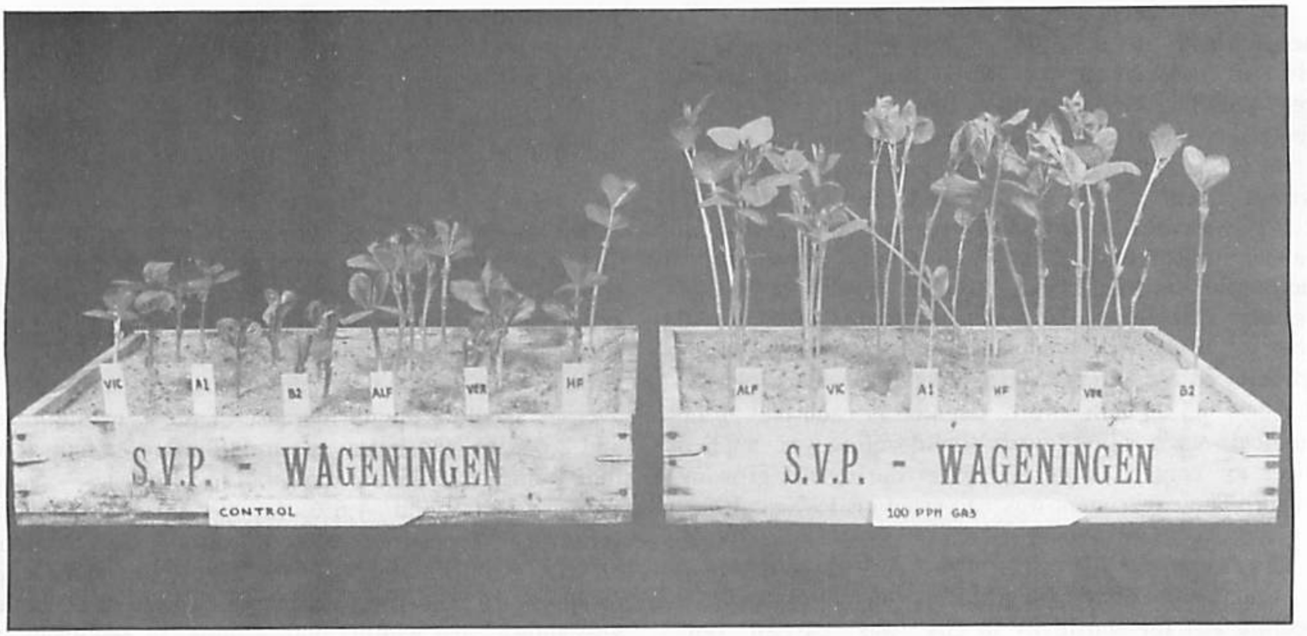


Fig. 2. The GA test after 9 days, showing the control treatment on the left and the 100 ppm GA3 treatment on the right. Where VIC = Victor; A1 = C2-1A1; B2 = C2-1B2; ALF = Alfred; VER = Veritas; and HF = Herz Freya

Table 2. Dry-matter yields of seeds and protein, protein content, plants/m^2, plant height, lodging, and 1000-seed weight of three dwarf selections and three tall cultivars of Vicia faba L.

Selection/ cultivar	Dry seed weight/ 10 m^2 (g)	Seed yield as % of control	Dry protein weight/ 10 m^2 (g)	Protein content (%)	Plants/ m^2	Plant height (cm)	Lodging (1-9)[a]	1000-seed weight at RH 11% (g)
C2-1A1	5400 a[1]	118.2	1592 a	29.5 ab	27.2 abc	83 a	9.0 a	515 b
C2-1B2	5353 a	117.2	1617 a	30.2 a	28.3 ab	85 a	9.0 a	511 b
C2-1-mas	5251 a	115.0	1612 a	30.7 a	29.9 a	86 a	9.0 a	514 b
Alfred(control)	4567 b	100.0	1282 b	28.1 b	23.6 cd	153 c	6.3 b	600 c
Victor	4648 b	101.8	1225 b	26.3 c	24.9 bcd	136 b	7.3 b	596 c
Herz Freya	3982 c	87.2	1059 c	26.6 c	21.0 d	161 c	3.5 c	448 a

1. Means followed by different letter(s) are significantly different at $p < 0.01$

a. 9 = no lodging

Discussion

The results presented in **Fig. 2** and **Table 1** indicate that the *dw-1* dwarfing gene does not belong to those dwarfing genes that convey insensitivity to GA, but does the opposite, and makes plants more sensitive to gibberellin. This strongly suggests that the *dw-1* dwarfing gene has its effect through a block in the biosynthesis of gibberellins, such as has been demonstrated for maize and peas (Reid 1987).

Numbers of plants counted in the field experiment were somewhat fewer than the numbers of seeds sown (**Table 2**). This may be because sowing took place at the beginning of a long dry period, and therefore some seeds did not emerge before the plant counting date. Nevertheless, plant densities for the cvs Alfred and Victor were about 25/m^2, which is optimal for Dutch conditions. It is possible that after 17 May some more seeds might have germinated both for the dwarf selections and for the tall cvs. However, the yield contribution of these later emerging plants is not likely to be of great significance due to the advantage of the older and bigger plants, and the late emergence time.

The favorable weather conditions prevailing during the experiment, with no drought occurring during the later period of the season, might have been of advantage to the dwarf genotypes because of their longer growing period. The yield capacity of the dwarf lines seems very promising with seed yields 15% higher than that of the control. Also, in the preceding years in smaller trials, the dwarf selections have been found to produce yields more than, or equal to, tall control cultivars (SVP 1986 and 1987).

The determinate growth character has been used widely to curtail excessive biomass production in faba bean. However, up till now the results have not been very encouraging, with seed yields in general less than, or at the most equal to, that of standard genotypes (Ebmeyer 1986; Saxena *et al.* 1986). The results of this study suggest that the dwarfing gene from Veritas may offer a better way to turn excess biomass production into seed and protein. However, further experiments are required to assess whether the dwarf types will also have an advantage in other growth conditions and, if not, whether an adjustment of seed rate and other agronomic practices are needed to achieve improved seed yield with the dwarf genotypes over a wide range of environments.

References

Austin, R.B., Bingham, J., Blackwell, R.D., Evans, L.T., Ford, M.A., Morgan, C.L. and Taylor, M. 1980. Genetic improvements in winter wheat yields since 1900 and associated physiological changes. Journal of Agricultural Science, Cambridge 94: 675-689.

Chapman, G.P. 1981. Genetic variation within *Vicia faba*. FABIS Newsletter No.3: 12.

Ebmeyer, E. 1986. Some results of 1985 EC Joint Field Bean Test. Vortrage in Pflanzenzuchtung 11: 151-157.

Gale, M.D., Marshall, G.A., and Rao, M.V. 1981. A classification of the Norin 10 and Tom Thumb dwarfing genes in British, Mexican, Indian and other hexaploid bread wheat varieties. Euphytica 30: 355-361.

Reid, J.B. 1987. The genetic control of growth via hormones. Pages 318-340 *in* Plant Hormones and Their Role in Plant Growth and Development (Davies, P.J., ed.). Martinus Nijhoff Publishers, Dordrecht, The Netherlands.

Saxena, M.C., Silim, S.N., and Murinda, M.V. 1986. Build-up and partitioning of dry-matter and yield of faba bean genotypes of differing plant type. Pages 55-66 *in* Vicia faba, Cultivation, Breeding and Nitrogen Fixation: Proceedings of a Workshop in the CEC Program of Coordination of Agricultural Research, Ebmeyer, E. and Roebbelen, G. eds.). 16-19 July 1986, University of Goettingen, Germany F.R.

SVP (Stichting voor Plantenveredeling). 1986. Annual Report 1986. Wageningen, The Netherlands.

SVP (Stichting voor Plantenveredeling). 1987. Annual Report 1987. Wageningen, The Netherlands.

أصناف فول قزمة منتخبة تتفوق على أفضل الأصناف الهولندية

ملخص

تجاوزت غلة البذور والبروتين في أصناف SVP القزمة المنتخبة غلة الصنفين الهولنديين 'Alfred و Victor' - المزروعين حاليا على نطاق واسع - مقدار 15٪ و 25٪ . ولعله من المرجح جدا أن تسبب مورثة التقزم المعنية عائقا أمام التركيب الحيوي للجبيريلين. ويبدو أن طراز النبات القزمي مبشرٌ أكثر من الطراز المحدود النمو.

Physiology and Microbiology

الفيزيولوجيا والأحياء الدقيقة

Nitrogen Fixation in Faba Bean (Vicia faba L.) and its Economic Benefit in Central Alberta, Canada

C.L. Rweyemamu[1] and Z.P. Kondra[2]
1. Department of Crop Science and Production, Sokoine University of Agriculture, P.O. Box 3005, Chuo Kikuu, Morogoro, TANZANIA
2. Department of Plant Science, University of Alberta, Edmonton, Alberta, CANADA

Abstract

A two-year study was conducted at the Edmonton Research Station, University of Alberta, Canada, to estimate N fixed by faba bean (*Vicia faba* L.) crop and assess its economic benefit in relation to fertilizer nitrogen. Seeding rate did not have much influence on fixation/unit area. The amount of N fixed averaged 34.8 and 127.5 kg N/ha for 1984 and 1985 cropping seasons, respectively. The nitrogen requirements were not fully met from symbiotic fixation and a substantial amount of N came from the soil. At 29 days after flowering, farmers can plough-in the crop if it is to be used as green manure. The study also showed that the economic benefit from N fixation can improve as the nitrogen-supplying power of the soil declines while the price of N fertilizer increases and the price of seed decreases.

Introduction

Although faba bean is regarded as a "break-crop" in Canada, there is limited information on the amount of nitrogen fixed by faba bean in central Alberta. Thus, it is difficult for both crop growers and animal producers to fully understand the crop and formulate rotation programs suitable for the region. The present work was initiated to study the ability of three cultivars and one experimental line of faba bean to fix nitrogen at different stages of growth. The economic benefit of nitrogen fixation, and the nitrogen balance after grain harvest, also were calculated.

Materials and Methods

The study was conducted in 1984 and 1985 at the Edmonton Research Station, University of Alberta (53°31'N and 113°31'W). Soil characteristics are shown in Table 1. Rainfall during the cropping seasons was 249.4 mm and 336.6 mm for 1984 and 1985, respectively. The sites used had been under fallow for three years and no fertilizer had been applied in the area for the previous six years. The experiment was laid out in a randomized block design with four replications. Three faba bean cultivars (Ackerperle, Aladin, and Outlook) and one experimental line ("80F-21") from the University of Alberta breeding program were sown at 33 and 50 plants/m^2. One barley (*Hardeum vulgare* L.)

Table 1. Some soil characteristics at the experimental sites at seeding for the 1984 and 1985 growing seasons.

Year	Seeding date	Soil type	pH		Soil N (ppm)		Soil P (ppm)		Soil K (ppm)	
			0-6 cm	6-12 cm	0-6 cm	6-12 cm	0-6 cm	6-12 cm	0-6 cm	6-12 cm
1984	7/5/1984	Clay loam	5.9	5.9	48	30	19	18	299	313
1985	4/5/1985	Clay loam	6.2	6.2	14	18	11	11	307	319

cultivar (Conquest) at 50 kg/ha seeding rate was included for comparison purposes.

Individual plots consisted of 8 rows, 6m long, spaced 23 cm between rows and between plots. No fertilizer was applied. Seed was sown on 7 May and 3 May, 1984 and 1985, respectively. Weeds were controlled by manual hoeing at 30 and 50 days after emergence. In both years, plots were harvested in August. Plant samples, harvested at 75% flowering, and at 29 days after flowering (DAF), were analyzed for total nitrogen concentration according to Bremner (1965). At maturity, vegetative and reproductive parts were analyzed separately for N content. Barley was harvested (at the time when the earliest faba bean cultivar was ready for harvest, at flowering, 29 DAF, and at maturity) and analyzed for N content. The treatments used in this study permitted comparison of the response of a cereal (barley) and annual legume (faba bean) to soil N and provided information whereby the amount of N_2 symbiotically fixed by nodulated faba bean could be determined.

Previous work by Richards and Soper (1982) had shown that faba bean and barley extracted similar quantities of inorganic soil N. Therefore, symbiotic N_2 fixation of nodulated faba bean was determined by subtracting N content of the barley shoots from the N content of nodulated faba bean shoots. The economic value of this nitrogen was calculated using the price of nitrogen from urea. The nitrogen's production cost was calculated using the cost of seed/ha. The cost: benefit ratio was calculated by dividing the value of N fixed (CAD of N fixed/ha) by seed cost (CAD/ha). The nitrogen balance was calculated by taking the total nitrogen fixed, minus total nitrogen taken off with harvested grain, as outlined by Richards and Soper (1982). The data of each season were subjected to factorial analysis and treated as a separate experiment.

Results

Seeding rates had no significant effects on the amount of nitrogen fixed by the crop in both years, but cultivar effects were significant (**Table 2**). In 1984, the net amount of nitrogen fixed could be measured only at maturity, whereas in 1985 it could be measured starting from 29 DAF onwards. In 1985, the net nitrogen fixed decreased from 29 DAF to maturity.

In 1984, the value of nitrogen fixed at maturity increased to 40% of the seed cost when the nitrogen value was 0.44 CAD/kg. However, in 1985, there was higher economic benefit when 43-140% of the seed cost was recovered (**Table 3**). The nitrogen balance after grain harvest was negative (**Table 4**).

Discussion

The results on the effect of seeding rate on nitrogen fixation reported in this study are in agreement with those of Sprent and Bradford (1977) who reported that plant density did not have much influence on nitrogen fixation/unit area and, within the range of economic

Table 2. Amount of nitrogen fixed by faba bean (kg/ha) as calculated at different stages of plant growth during the 1984 and 1985 seasons.

Seed rate (seeds/m^2)	Cultivar/ line	N (kg/ha)							
		Flowering		29DAF		Maturity		%N fixed	
		1984	1985	1984	1985	1984	1985	1984	1985
33	80F-21				127ab*		88b		39
	Outlook				191a	41ab	143ab	18	51
	Aladin				191a	28ab	112ab	13	45
	Ackerperle				253a	38ab	134ab	17	49
50	80F-21				88b	23b	84b	11	38
	Outlook				18c	43a	121ab	18	47
	Aladin		7		170ab	36ab	185a	16	57
	Ackerperle				124ab		128ab		48

* Means followed by same letter(s) within each column are not significantly different at $P < 0.05$ according to the Duncan's Multiple Range Test.

Table 3. Economic benefit of nitrogen fixation in faba bean relative to fertilizer nitrogen.

Seed rate (seeds/m²)	Cultivar line	Seed cost (CAD/ha)[1]	N fixed (kg/ha)	Value of fixed N (CAD/ha)[2]	Benefit: cost ratio
			1984		
33	80F-21	44			
	Outlook	44	41	18	0.40
	Aladin	44	28	12	0.27
	Ackerperle	44	37	16	0.36
50	80F-21	66	24	10	0.15
	Outlook	66	43	18	0.28
	Aladin	66			
	Ackerperle	66			
	Mean		34.8		
			1985		
33	80F-21	44	88	38	0.86
	Outlook	44	143	61	1.40
	Aladin	44	112	48	1.09
	Ackerperle	44	134	57	1.31
	80F-21	66	84	36	0.55
	Outlook	66	121	58	0.88
	Aladin	66	128	55	0.84
	Mean		127.5		

1. Seed cost was 0.44 Canadian Dollars (CAD)/kg
2. Based on urea nitrogen fertilizer costing 0.44 CAD/kg N in Alberta, and 100% fertilizer use efficiency.

seeding rates, N fixation per unit area remained remarkably constant. Although the net amount of nitrogen determined in the 1984 experiment was lower than that reported in literature, the values of the 1985 experiment are within the range of values reported under Western Canadian conditions (Rice 1976; Dean *et al.* 1980; Richards and Soper 1982). The nitrogen requirements in both years were not fully met from symbiotic fixation and the substantial amount of nitrogen required by the crop came from the soil.

Since Western Canadian soils do not have indigenous rhizobia for faba bean (Candlish and Clark 1975; Rennie *et al.* 1982), competition between indigenous rhizobial strains and that applied did not arise in this study. The independently controlled genetic variations among the cultivars used and *Rhizobium* spp. applied may have influenced the results on nitrogen fixation, as reported by El-Sherbeeny *et al.* (1977a and 1977b), Mytton *et al.* (1977), and Dean and Clark (1979). The decrease in the amount of nitrogen fixed at 29 DAF until maturity suggests that farmers can plough-in the crop after 29 DAF if the crop is to be used as green manure.

The economic benefit results show that cost benefit ratio values of 1984 and 1985 are higher than those reported by Twonley-Smith and Slinkard (1984) for faba bean grown in Western Canada. The cost benefit ratio values show that the economic benefit can improve as the nitrogen-supplying power of the soil declines while the price of nitrogen fertilizer increases, and that of the seed decreases.

The results of the present study also show that most of the soil nitrogen was removed from the area of production at the time of harvest, as it was contained in the seed at harvesting (Table 4). Therefore,

Table 4. Nitrogen balance sheet.

Variable	Average value (kg/ha)	
	1984	1985
Faba bean		
Soil N at seeding (0-12 cm depth)	46.47 (20.15 CAD)	19.56 (8.41 CAD)
Total N yield (crop N)	214.11 (92.07 CAD)	262.88 (113.04 CAD)
Symbiotic fixed N (average)	23.91 (10.38 CAD)	127.38 (54.77 CAD)
Nitrogen derived from the soil	190.20 (81.79 CAD)	138.56 (59.58 CAD)
N taken off with harvested grain	157.74 (66.54 CAD)	213.47 (91.79 CAD)
N taken off with harvested TDM	214.11 (92.07 CAD)	262.88 (113.04 CAD)
N taken off with vegetative material only	59.38 (25.53 CAD)	49.43 (21.25 CAD)
Soil nitrogen balance[1]	-130.20	-86.09
Net soil N balance (CAD/ha)[2]	(-56.26 CAD)	(-37.02)
Barley		
Total N taken from the soil	190.20 (81.79 CAD)	138.56 (56.58 CAD)
N taken off with harvested TDM	190.20 (81.79 CAD)	138.56 (56.58 CAD)
N taken off with harvested grain	98.90 (42.53 CAD)	87.26 (37.52 CAD)

1. Soil N balance (kg/ha) = N fixed (kg/ha) - N taken off with faba bean harvested grain (kg/ha).
2. Based on appropriate cost of fertilizer (urea), i.e., 0.43 Canadian Dollars (CAD)/kg.

depending on the environmental conditions and agronomic practices, faba bean crop can reduce the soil nitrogen status. The extent of the secondary effects of nitrogen remaining in the soil on the crop following faba bean will always depend on different factors at the site, as well as climatic conditions. Utilization of the remaining nitrogen in the crop can be very minimal (3-5%) as reported by Huber *et al.* (1987).

Acknowledgment

The authors wish to thank the International Development Research Centre (IDRC), Ottawa, Canada, for the financial assistance provided during the course of the study.

References

Bremner, J. 1965. Total nitrogen. Pages 1149-1176 *in* Methods of Soil Analysis (Black, C.A., Evans, D.D., White, J.L., Ensining, L.E. and Clark, F.S., eds). American Society of Agronomy, Madison, USA.

Candlish, E. and Clark, K.W. 1975. Preliminary assessment of small faba bean grown in Manitoba. Canadian Journal of Plant Science 55: 89-93.

Dean, R.J. and Clark, K.W. 1979. Inoculum specificity in faba bean and peas. Canadian Journal of Plant Science 59: 57-64.

Dean, R.J., Toosan, B. and Clark, K.W. 1980. *Rhizobium* strain selection for faba bean. Canadian Journal of Plant Science 60: 385-397.

El-Sherbeeny, M.H., Mytton, L.R. and Lawes, D.A. 1977(a). Symbiotic variability in *Vicia faba*. 1. Genetic variation in the *Rhizobium leguminosarum* population. Euphytica 26: 149-156.

El-Sherbeeny, M.H., Lawes, D.A. and Mytton, L.R. 1977(b). Symbiotic variability in *Vicia faba*. 2. Genetic variation in *Vicia faba*. Euphytica 26: 377-383.

Huber, R., Keller, E.R. and Schwendimann, F. 1987. Effects of biological nitrogen fixation by faba beans (*Vicia faba* L.) on the nitrogen economy of the soil. FABIS Newsletter No. 17: 14-20.

Mytton, L.R., El-Sherbeeny, M.H. and Lawes, D.A. 1977. Symbiotic variability in *Vicia faba*. 3. Genetic effects of host plant, *Rhizobium* strain and of host x strain interaction. Euphytica 26: 785-791.

Rennie, R.J., Dubetz, S., Bole, J.B. and Muendel, H.H. 1982. Dinitrogen fixation measured by ^{15}N isotope dilution in two Canadian soybean cultivars. Agronomy Journal 74: 725-730.

Rice, W.A. 1976. Nitrogen gains through biological dinitrogen fixation. Pages 191-213 *in* Nitrogen Symposium: Proceedings of the Western Canada Nitrogen Symposium, 20-21 Jan 1976, Alberta, Canada.

Richards, J.E. and Soper, R.J. 1982. N-fertilization of field grown faba beans in Manitoba. Canadian Journal of Soil Science 62: 21-30.

Sprent, J.I., Bradford, A.M., 1977. Nitrogen fixation in *Vicia faba* L. (field beans)· as affected by density, shading and its relationship with soil moisture. Journal of Agricultural Science, Cambridge 88: 303-310.

Townley-Smith, L. and Slinkard, A.E. 1984. Annual legume green manure crops in western Canada (unpublished).

تثبيت الآزوت في الفول (*Vicia faba* L.) والفائدة الاقتصادية منه في البرتا الوسطى، كندا

ملخص

أجريت دراسة لمدة سنتين في محطة بحوث ادمنتون، التابعة لجامعة البرتا بكندا، بغية تقدير الآزوت المثبّت بواسطة نبات الفول وتقييم فائدته الاقتصادية فيما يتعلق بالسماد الآزوتي. لم يكن لمعدل البذار تأثير كبير على تثبيت الآزوت في وحدة المساحة. وقد بلغ متوسط كمية الآزوت المثبّت 34.8 و 127.5 كغ آزوت/هكتار في الموسمين الزراعيين 1984 و 1985 على التوالي. ولم يلبي الآزوت المثبّت بالتعايش جميع متطلبات النبات من الآزوت بشكل تام، إذ جاءت كمية كبيرة منه من التربة. ويمكن للمزارعين قلْب المحصول في التربة بعد 29 يوما من الإزهار إذا ما أريد استعماله كسماد أخضر. كما أظهرت الدراسة أن الفائدة الاقتصادية من تثبيت الآزوت قد تتحسّن كلما تدنّت قدرة التربة على مدّ النبات بالآزوت، في الوقت الذي تزداد فيه أسعار الأسمدة، وتقل أسعار البذار.

Concentration and Uptake of N, P, and K and the Effect of Potassium Sulphate on Vicia faba L.

Mohamed M. El-Fouly, A.F.A. Fawzi and F.K. El-Baz
National Research Centre,
Botany Department,
Cairo, Dokki, EGYPT

Abstract

Field experiments were carried out to study the concentration and uptake of N, P, and K in different organs of faba bean plants at various stages of growth. The maxima for uptake for the three nutrients was reached 110 days after sowing. Removal of P_2O_5 was comparable to that reported by others, whereas it was lower for K_2O, suggesting that potassium might be a limiting factor under conditions of high yields. Adding 120 kg K_2O/ha gave considerable yield increases.

Introduction

Faba bean (*Vicia faba* L.) is the most important pulse crop in Egypt and represents a major source of protein for human nutrition (Hawtin and Webb 1982). Its average yield ranges between 2-3 t/ha. However, under proper management, yield can reach over 6 t/ha. Higher yields are correlated with higher pod set and less flower and pod drop and thus may require more available nutrients (El-Fouly 1982).

While there is general acceptance for N and P fertilization based on past research in Egypt, potassium fertilization for faba bean is still under investigation. Previous results indicated that in some governorates leaf analysis of faba beans during growth showed K deficiencies (El-Fouly 1984; El-Fouly *et al.* 1984; Fawzi *et al.* 1987). Fawzi *et al.* (1983) demonstrated that fertilizing with potassium sulphate under some conditions in Egypt can lead to increases in yield. This paper presents results obtained during the winter seasons of 1982 and 1983, on the effect of K fertilization on *Vicia faba*.

Materials and Methods

Nutrients uptake experiments

Experiments conducted in the 1982 and 1983 seasons at two different locations in Kafrel Khadra village, Monoufia Governorate, Egypt, aimed at determining the nutrient uptake by different plant organs during the growth period as well as calculating the uptake of nutrients. Soil characteristics and fertilizers added to each experiment are given in **Tables 1** and **2**, respectively. Starting 35 days after planting, plant

Table 1. Soil characteristics of the experimental sites.

	Removal experiment		Potassium experiment (average of 8)
	1981/82	1982/83	
Sand %	47.0	15.0	46.4
Silt %	26.0	40.0	26.3
Clay %	28.0	45.0	27.3
pH (1:2.5 water)	8.1	7.5	8.7
E.C. (mmhos/cm^2) (1:2.5 water)	0.6	1.0	0.3
$CaCO_3$ %	2.1	2.0	1.4
O.M. %	1.3	1.8	1.2
P mg/100g (Olsen)	0.6	1.2	0.6
K mg/100g (amonium acetate)	25.0	11.0	14.0
DTPA extractable			
Fe (ppm)	10.0	84.0	4.2
Mn (ppm)	12.0	42.0	10.1
Zn (ppm)	1.3	4.1	0.8
Cu (ppm)	2.0	2.4	1.7

Table 2. Dates of sowing, and fertilizer amounts used and application.

Fertilizer	Sowing date		
	Removal experiment		Potassium experiment
	13 Nov 81	5 Dec 82	13 Nov 82
Organic manure (m^3/ha)	50 before sowing		
P_2O_5 (kg/ha)	77 (27 Dec 81)[a]	110 (10 Jan 83)	85 (12 Nov 82)
N (kg/ha)	75 (27 Dec 81)	110 (10 Jan 83)	75 (25 Nov 82)
K_2O (kg/ha)	120 (27 Dec 81)	120 (9 Jan 83)	120 (28 Dec 82)

a. Figures in parenthesis are dates of fertilizer applications.

samples were taken at 2-3 day intervals untill ripening. Each consisted of 10 plants separated into leaves and stems and, in later growth stages into, leaves, stems, and pods. The samples were weighed and analyzed during the growing periods. At harvest, grains and pods were weighed and analyzed. Analysis results are given as the average for a mean of 10 plants (3-5 analysis).

Potassium experiment

This experiment was carried out in the 1982/83 season in Sinbellawin Dakahlia Governorate. Soil analysis and treatments are given in **Tables 1** and **2**, respectively. The experiment consisted of eight trials. Each trial had two treatments (with and without K_2O fertilization). Each treatment was replicated in four plots.

Results and Discussion

Figs. 1-3 show nutrient concentrations and uptake for the first year. Results for the second year were similar and are thus omitted. Uptake of N, P, and K increased gradually up to 70 days after sowing. In the subsequent 30-50 days (pod setting), a sharp increase occurred, which was followed by a decrease in the concentration and total amounts of these nutreints in leaves and stems, probably because of translocation to pods. About 50% of total K_2O removed was taken up during the period up to the beginning of fruit setting with a maximum of 2.8 kg/day/ha. The crop might suffer if the potassium supply is inadequate during this critical growth stage.

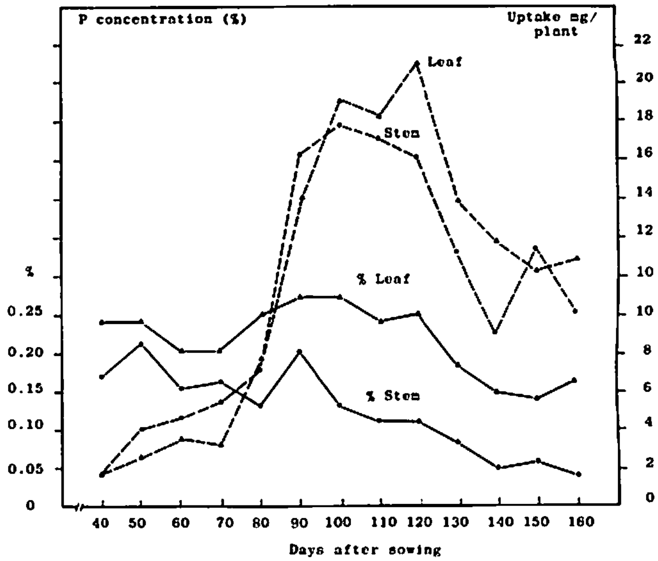


Fig. 2. Phosphorus concentration (—) and uptake (---) by Vicia faba during growth.

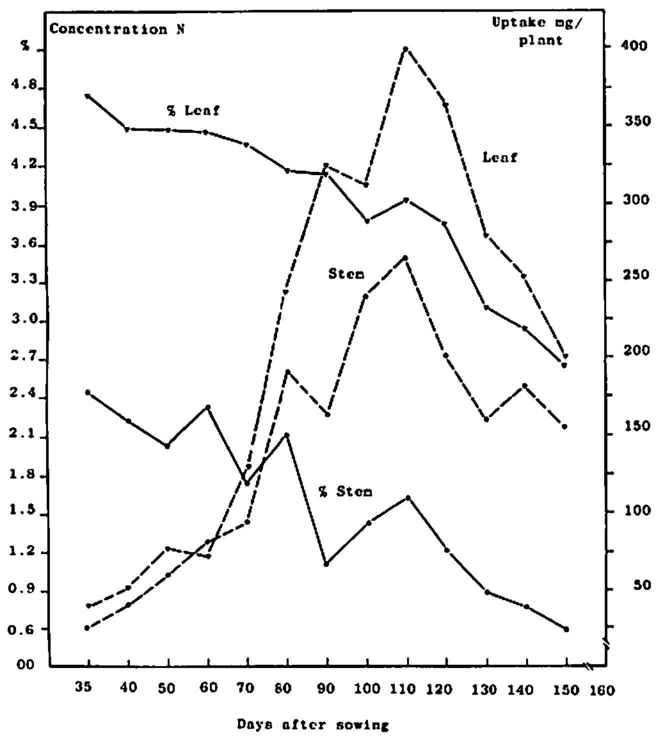


Fig. 1. Nitrogen concentration (—) and uptake (---) by different plant organs of Vicia faba during growth.

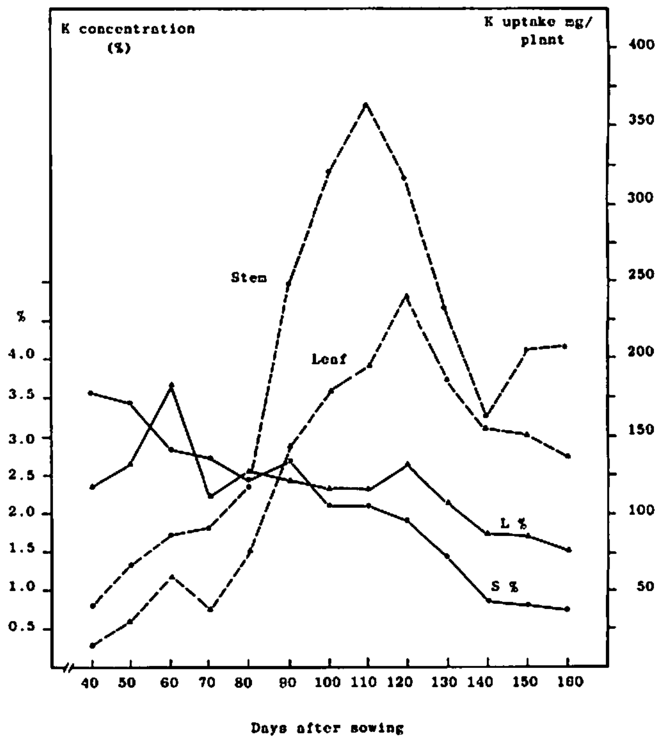


Fig. 3. Potassium concentration (—) and uptake (---) by Vicia faba during growth.

Considerable seasonal differences were obtained in the amounts of N and K_2O removed/ha due to different yields achieved in the two seasons (**Table 3**). The nutrient removal/t of each grain and straw in both years was nearly the same (**Table 4**). However, removal was generally lower in the 1981/82 season for all the nutrients except for K_2O removed by straw.

For calculation of fertilizer needs, it is necessary to know the amount of nutrients taken up by the plant to produce one ton of grain. Normally these values are somewhat higher than that actually removed from the field. **Table 5** shows those values which are very close to the figures given by Kemmler and Hobt (1985) for N and P (66.7 kg N and 18.7 kg P_2O_5), but lower for K (50 kg K_2O) though the field in the authors' experiment received 120 kg K_2O/ha. It is of interest to note that in this area potassium deficiency symptoms were detected on plants in those fields which were showing otherwise good growth and high yield potential.

Table 3. Nutrients removal by faba bean at harvest.

	Dry wt (kg/ha)	Nutrient (kg/ha)		
		N	P_2O_5	K_2O
1981/82				
Grain	6500	240	49	94
Straw	8000	165	53	164
Total	14500	405	102	258
1982/83				
Grain	5000	205	46	75
Husks	1000	12	7	42
Leaves	1250	55	9	33
Stems	3250	55	22	28
Total straw	5500	122	38	103
Total[1]	10500	327	84	178

1. Total grain + total straw.

Table 4. Removal of nutrients (kg) for t of produce.

Year	Nutrient		
	N	P_2O_5	K_2O
1981/82			
Grain	36.9	7.5	14.5
Straw	20.6	6.6	20.5
1982/83			
Grain	41.0	9.2	15.0
Straw	22.2	6.9	18.5

Table 5. Nutrients taken by the whole plant for the production of one t of grain.

Year	Nutrient		
	N	P_2O_5	K_2O
1981/82	62.3	15.7	39.7
1982/83	65.4	16.8	35.6

Table 6. Effect of potassium sulphate (120 kg K_2O/ha) applied 45 days after sowing on yield of faba bean. Average of 8 experiments.

Treatment	Yield (kg/ha)	% increase
No K fertilization	4938	
120 kg K_2O/ha	5413	9

Although there were differences between both removal experiments, the soil of the 1981/82 season contained more sand and less clay, as well as less exchangeable K. However, the amount of K taken up for the production of one ton of grain was higher. This indicates the necessity of reviewing the needs of potassium fertilizers in Egypt based on yield target.

Adding 120 K_2O/ha as potassium sulphate at 45 days after sowing (prior to the growth period of high needs) increased yield by about 5% as an average of 8 experiments (**Table 6**). Of the eight experiments, six showed an increase in yield with K application, ranging from 5% to 21%, and two had a small negative (2 and 7%) effect.

Acknowledgments

This work was carried out as a part of the NRC/GTZ Egypto-German Project "Micronutrients and other Plant Nutrition Problems in Egypt." The assistance of the Mediterranean Mission, IPI, is highly appreciated. The senior author wishes to thank the staff of Buentehof Research Station, especially Dr. H. Grimme and G. Kemmler, for their suggestions and comments, as well as the A.V. Humboldt foundation for awarding a fellowship during his stay in Buentehof.

References

El-Fouly, M.M. 1982. Flower and pod drop. Pages 177-184 *in* Faba bean improvement: Proceedings of the faba bean conference (Hawtin, G. and Webb, C., eds.), ICARDA/IFAD Nile Valley Project, 7-11 Mar 1981, Cairo, Egypt. Martinus Nijhoff Publishers, The Hague, The Netherlands.

El-Fouly, M.M. 1984. Soil testing and plant analysis for optimizing fertilizer use in field crops in Egypt. Pages 173-180 *in* Proceedings of the Colloque for Optimization of Plant Nutrition, 2-8 Sept 1984, Montpellier, France.

El-Fouly, M.M., Fawzi, A.F.A., Firgani A.H. and El-Baz, F.K. 1984. Micronutrient status of crops in selected areas in Egypt. Communications in Soil Science and Plant Analysis 15: 1175-1189.

Fawzi, A.F.A., Amberger, A. and El-Fouly, M.M. 1987. Nutrients status of field crops in the Nile valley area. Agrochimica 31: 536-542.

Fawzi, A.F.A., Firgani, A.H., Rezk, A.I., Kishk, M.A. and Shaaban, M.M. 1983. Response of *Vicia faba* to K and micronutrient fertilizers. Egyptian Journal of Botany 26: 113-121.

Hawtin, G. and Webb, C. (eds). 1982 Faba Bean Improvement: Proceedings of the faba bean conference. ICARDA/IFAD Nile Valley Project, 7-11 Mar 1981, Cairo, Egypt. Martinus Nijhoff Publishers, The Hague, The Netherlands. 398 pp.

Kemmler, G. and Hobt, H. 1985. Potash a product of nature. Kali und Salz A.G., Kassel, FRG, 112 pp.

تركيز وامتصاص الآزوت والفوسفور والبوتاسيوم وتأثير كبريتات البوتاسيوم في الفول (*Vicia faba L.*)

ملخص

أجريت اختبارات حقلية لدراسة تركيز وامتصاص الآزوت والفوسفور والبوتاسيوم في مختلف أعضاء نبات الفول، وأطوار نموه المختلفة. إذ وصل الحد الأقصى لامتصاص تلك العناصر المغذية الثلاثة بعد 110 أيام من الزراعة. وكانت إزالة P2O5 مماثلة لتلك التي ذكرها آخرون، في حين كانت بالنسبة ل K2O أقل؛ مما يوحي بأن البوتاسيوم قد يكون عاملا محدداً تحت ظروف الغلال الوفيرة، فقد أدّت إضافة 120 كغ K2O/هكتار إلى تحقيق زيادات كبيرة في الغلة.

Variation Analysis of Physiological Traits among Different Entries of Faba Bean (Vicia faba L.)

G.B. Polignano and P. Uggenti
Germplasm Institute, C.N.R.
Via Amendola, 165/A Bari,
ITALY

Abstract

Variations for plant height, leaf area, dry weight, leaf area ratio (LAR), net assimilation rate (NAR), and relative growth rate (RGR) were examined in 28 entries of faba bean (*V. faba* L. var *major*, *equina* and *minor*) at various growth stages. Significant differences among the entries were observed for leaf area and dry weight. Nonsignificant differences were observed for the LAR, NAR, and RGR. *Minor* type showed a more efficient 'leaf system'.

Introduction

Several investigators have studied the genetic variation in faba bean (*Vicia faba* L.) in recent years, but little attention was given to the genetic variation of characters linked to the biophysiological aspect of yield, i.e., photosynthesis, nitrogen fixation, accumulation and translocation of assimilates, etc. Polignano and Spagnoletti Zeuli (1985) used different faba bean populations from the world germplasm collection at the CNR-Germplasm Institute, Bari, Italy, to describe 10 quantitative morphobiological characters of interest to breeders. Several authors suggested that more efforts should be devoted to identifying "highly efficient" genotypes (Chapman and Peat 1978; Scarascia-Mugnozza and De Pace 1979; Lawes 1980). In the case of germplasm collections, it is very difficult to evaluate the genetic variation for physiological traits. However, indirect estimates of variation could be obtained by the use of more easily assessed quantitative characters (dry matter, leaf area, etc.) or by physiological indexes of growth analysis: NAR, LAR, and RGR. (Castrignano *et al.* 1987). Variations are reported in this paper for some of these characters and physiological indexes among entries of faba bean (*Vicia faba* var *major*, *equina*, and *minor*) selected in previous years for their yield potential.

Materials and Methods

Seeds of 24 entries of *V. faba*, representing the three botanical groups: *major*, *equina*, and *minor*, were sown on 15 Nov 1986 at the Experimental Farm of Bari University, Valenzano, Italy. The experimental material consisted of improved populations, cultivars, and ecotypes of Italian origin. Thirty plants of each population were grown in 3-row plots, each 3 m long and 70 cm apart. The experiment was laid out in a randomized block design with three replicates; 100 kg/ha of P_2O_5 was applied before sowing.

Three plants from each plot were sampled at 100, 131, 152, and 177 days after sowing. Data were recorded on dry weight, leaf area, and seed yield/plant.

For leaf area (LA) determination, plants were harvested by cutting at ground level, subdivided, and dried in a forced-air oven to determine the dry weight of leaf and stem tissue and total shoot dry weight (W). Leaf punches of a known total area were weighed and the average dry weight/unit area was used to estimate total leaf area (Wallace and Munger 1965).

The net assimilation rate (NAR) was estimated according to the formula of Watson (1952). Both leaf area ratio (LAR = LA/W) and relative growth rate (RGR = LAR x NAR) were derived indexes. NAR and RGR were determined by using the mean values at 131 and 152 days after sowing. Data were statistically analyzed and LSD was used to compare mean values of the three botanical groups.

Results

Analysis of variance within sampling date showed significant differences among the three botanical groups for dry weight (W) and leaf area (LA). No significant differences were obtained for plant height (PH) in all sampling dates, and for leaf area ratio (LAR) in the first three sampling dates. At 177 days after sowing, the differences among the three botanical groups for LAR were significant. Differences due to entries were highly significant for all characteristics at each sampling date.

Mean values of LA, W, and LAR for the three botanical groups at each sampling date are presented in Table 1. The *major* type showed the highest values for W and LA, whereas the *minor* type showed the lowest values. The *equina* type showed intermediate values. In contrast to the *minor* type, values of LA in the *major* and *equina* types were highly reduced when sampling was

Table 1. Mean values of leaf area (LA), total dry weight (W), and leaf area ratio (LAR) for the three botanical groups of *V. faba* at the four sampling dates.

Days from sowing	LA (cm^2)				W (g)				LAR (cm^2/g)			
	major	*equina*	*minor*	LSD	*major*	*equina*	*minor*	LSD	*major*	*equina*	*minor*	LSD
100	56.94	55.35	54.43	1.73	44.08	43.33	42.47	0.37	1.29	1.28	1.28	ns
131	78.92	72.76	72.14	3.14	60.87	56.20	56.20	2.11	1.31	1.30	1.31	ns
152	232.46	219.44	201.53	10.09	174.89	164.20	154.27	7.22	1.34	1.35	1.31	ns
177	186.71	186.11	229.42	10.82	182.11	177.40	140.12	9.61	0.98	1.02	1.42	0.16

delayed from 155 to 177 days after sowing. However, this situation was reversed with respect to dry weight.

Table 2 shows the mean values for each entry in each of the botanical groups for LA, W, LAR, NAR, and RGR at the third sampling date as well as seed yield/plant. LA and W were the only characters that showed significant differences among the three botanical groups. The entries MG 106808, MG 109758, and the cv 'Manfredini,' representing the *major*, *equina*, and *minor* types of faba bean, respectively, showed the highest values for LA, whereas the lowest corresponding values were observed in MG 106861, MG 106165,and MG 107141. Conversely, the highest values for W were recorded in the entry MG 106650 and the cvs Aguadulce and Manfredini, whereas the lowest values were observed in MG 106963, MG 107116, and cv 'Strudel'.

The simple correlation coefficients among yield/plant and physiological traits observed in the 24 entries of faba bean are listed in **Table 3**. Yield/plant was significantly correlated to dry weight

Table 2. Mean values for leaf area (LA), total dry weight (W), leaf area ratio (LAR) at 152 days after sowing, and net assimilation rate (NAR) and relative growth rate (RGR) at 131 and 152 days after sowing in 24 entries representing the three botanical groups of *V. faba* var *major*, *equina*, and *minor*.

Botanical group	Entry	Yield[1]/ plant (g)	LA (cm^2)	W (g)	LAR (cm^2/g)	NAR (g/cm^2/day)	RGR (g/g/cm^2/day)
Major	Aguadulce (2)	62.3	236.72	206.72+	1.16	34	39
	Loc Putignano (3)	35.9	233.89	167.00	1.40	37	52
	MG 107142	60.1	233.58	164.58	1.42	36	51
	MG 106609	40.5	213.74	167.91	1.31	40	52
	MG 106827	45.7	259.76	180.94	1.43	41	59
	MG 106865	37.1	217.10	155.68	1.40	39	55
	MG 106963	22.5	230.06	150.38-	1.44	34	49
	MG 106808	53.9	263.53+	174.51	1.51	37	56
	MG 109751	40.6	228.29	186.68	1.22	44	54
	MG 106951	61.9	237.28	191.18	1.25	42	53
	MG 106861	41.9	210.86-	187.59	1.26	39	49
	MG 106815	32.6	229.87	181.58	1.28	38	62
$\bar{X}$		44.6	232.89	174.56	134	39	53
Equina	Gemini (2)	31.4	244.45	161.96	1.51	31	47
	MG 107168	37.6	216.98	155.62	1.39	34	47
	MG 107140	32.1	204.77	147.82	1.38	37	51
	MG 107116	27.6	198.76	138.48-	1.43	36	51
	MG 106549	40.2	230.80	156.59	1.48	36	53
	MG 109746	34.8	198.10	154.43	1.28	39	49
	MG 106650	55.0	231.73	195.87+	1.20	48	58
	MG 109758	44.1	253.01+	198.96	1.26	45	57
	MG 106165	50.7	185.45-	168.10	1.16	41	48
$\bar{X}$		39.3	218.23	164.20	1.34	38	51
Minor	Strudel (2)	25.8	202.91	143.99-	1.41	37	52
	Manfredini (2)	40.5	205.14+	166.70+	1.23	38	47
	MG 107141	35.4	193.11-	152.05	1.27	36	46
$\bar{X}$		33.9	200.39	154.25	1.30	37	48

(1) Mean value of yield/plant obtained from the remaining plants in each plot after sampling.

(2) Cultivar.

(3) Local population.

(+) Maximum value; (-) Minimum value.

Table 3. Correlation coefficients among yield/plant and physiological traits observed in 24 entries of *V. faba* L.

Trait	LA	W	LAR	NAR	RGR
Yield/plant	0.38ns	0.72***	0.40*	0.37ns	-0.02ns
LA		0.58***	0.33ns	0.09ns	0.42*
W			0.56***	0.55***	0.21ns
LAR				-0.55***	0.18ns
NAR					0.57***

(P<0.01), and leaf area ratio (P<0.05). Leaf area was positively associated with dry weight, whereas small or nonsignificant association was observed with LAR, NAR, and RGR.

Dry weight (W) was negatively associated with LAR, but positively with NAR. High LAR was associated with low NAR. A positive association existed between NAR and RGR. Fig. 1 shows the regression of yield/plant on total dry weight/plant for all entries studied.

Discussion

It is well known that an improved plant architecture could promote better photosynthetic efficiency and consequently, improved faba bean grain yield (Scarascia-Mugnozza and De Pace 1979). The results presented here show that differences among *major*, *equina*, and *minor* types for leaf area and dry weight allow identification of genotypes having a more efficient 'leaf system.' Data on leaf area ratio seems to indicate a better photosynthetic efficiency for the *minor* type, especially at the late stages of growth. Correlation analysis showed that variations in dry weight accumulation by different entries was positively related to yield/plant, leaf area, and net assimilation rate.

Absence of significant differences among the examined entries for such physiological indexes as NAR, RGR, and LAR points to their limitation as criteria for screening genotypes. Instead, easily measurable traits like leaf area and dry weight could serve very usefully in screening large numbers of genotypes for yield improvement. Wallace and Munger (1965) reported that high initial growth rate for leaf area and high early leaf area ratio of six dry bean varieties lead to high seed yield. The same appears to be true for faba bean. Screening germplasm for these traits might be helpful in a yield improvement program for this crop.

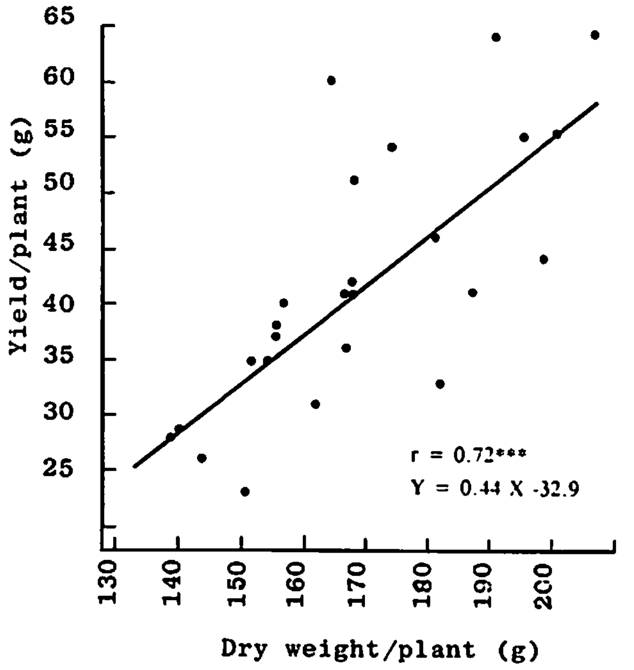


Fig. 1. Relationship between the yield/plant (Y) and dry weight/plant (X) in 24 entries of V. faba.

References

Abdalla, M.M.F. and Fischbeck, G. 1981. Potentiality of different subspecies and types of *V. faba* L. for breeding. Zeitschrift fuer Pflanzenzuechtung 87: 111-120.

Castrignano, A.M., Rubino, P., Tarantino, E. and Cilardi, A.M. 1987. Confronto tra due metodi: classico e funzionale, per lo studio dell'accrescimento del pomodoro. Rivista di Agronomia 21 (4): 282-292.

Chapman, G.P. and Peat, W.E. 1978. New concepts in breeding high yield *V. faba* L. Pages 293-302 *in*

Some Current Research on *Vicia faba* in Western Europe: Proceedings of a Seminar in the EEC Program of Coordination of Research on Plant Proteins (Bond, D.A., Scarascia-Mugnozza, G.T. and Poulsen, M.H., eds.), 27-29 Apr 1978, Bari, Italy. Commission of the European Communities, Luxembourg.

Cubero, J.I. and Suso, M.J. 1981. Primitive and modern forms of *V. faba.* Kulturpflanze 29 (Suppl.): 137-145.

Lawes, D.A. 1980. Recent developments in understanding, improvement, and use of *Vicia faba.* Pages 625-636 *In* Advances in Legume Science: Volume 1 of the Proceedings of the International Legume Conference (Summerfield, R.J. and Bunching, A.H., eds.), 31 July - 4 Aug 1978, Kew, England. Royal Botanical Gardens, Kew, England.

Polignano, G.B. and Spagnoletti Zeuli, P.L. 1985. Variation and covariation in *Vicia faba* L. populations of mediterranean origins. Euphytica 34: 659-668.

Scarascia-Mugnozza, G.T. and De Pace, C. 1979. Concepts and goals for *Vicia faba* breeding in mediterranean environment. Genetica Agraria 4: 217-244.

Wallace, D.H. and Munger, H.M. 1965. Studies of the physiological basis for yield differences. I. Growth analysis of six dry bean varieties. Crop Science 5: 343-348.

Watson, D.J. 1952. The physiological basis of variation in yield. Advances in Agronomy 4: 101-145.

تحليل الاختلاف في الصفات الفيزيولوجية بين مختلف مدخلات الفول
(*Vicia faba* L.)

ملخص

دُرست الاختلافات بين 28 مُدخلا من الفول (*Vicia faba L.* var *major, equina,* and *minor*) فيما يتعلق بطول النبات، ومساحة الورقة، والوزن الجاف، ونسبة مساحة الورقة، ومعدل التمثيل الصافي، ومعدل النمو النسبي، وذلك في مختلف أطوار نمو النبات. وقد لوحظت فروق معنوية بين المدخلات في مساحة الورقة والوزن الجاف، وأخرى غير معنوية في الصفات الثلاث الأخيرة. وأظهر الطراز *minor* نظاما ورقيا أكثر فعالية.

Plant Density Effects on the Growth and Development of Winter Faba Bean (Vicia faba L. var minor)

J. Castro Coelho and P. Aguiar Pinto
Instituto Superior de Agronomia,
Technical University of Lisbon,
Tapada Da Ajuda,
1399 Lisboa CODEX, PORTUGAL

Abstract

The effect of two plant densities (20 and 40 plants/m^2) on growth and development of a genotype of *Vicia faba* var *minor* "Tapada da Ajuda" was studied at various stages of crop growth. At final harvest, the dry-matter yield of above-ground parts was 16.1 and 26.8 t/ha at 20 and 40 plants/m^2 densities, respectively. The higher plant density had the highest crop growth rate (CGR), net assimilation rate (NAR), and photosynthetic active radiation efficiency (PAR). Towards the end of the season, the rates of senescence and pod abscission were much higher at the higher plant density.

Introduction

Literature indicates that faba bean has remarkable plasticity to variations in plant density. Significant differences were obtained between sparse populations of 20 plants/m^2 or less and plant densities of 40 plants/m^2. This study sought to determine the effect of plant density on some key growth parameters and assess their importance in affecting the final dry-matter yield.

Materials and Methods

The experiment was conducted at the Instituto Superior de Agronomia's experimental farm (Tapada da Ajuda, Lisbon) during the growing season of 1985/86. The soil of the experimental field was silty-clay with problems of poor drainage. A local genotype of *Vicia faba* var *minor* (cv "Tapada da Ajuda"), whose agronomic characteristics are presented in Table 1, was sown on 3 Dec 1985, at two densities (20 and 40 plants/m^2). The densities were randomly assigned to four 60 m^2-plots with a constant row spacing of 50 cm. Prior to sowing, the plots were fertilized with 90 kg of P_2O_5. A series

Table 1. Agronomic characteristics of the *Vicia faba* cv Tapada da Ajuda.

Flower set:	65 to 80 days after sowing
Maturation:	160 to 180 days after sowing
Seed size:	medium type (100-seed weight = 52 g)
Seed color:	light brown with black hilum
Plant height at harvest:	100 to 120 cm
Number of seeds/pod:	often 3 and seldom 2 or 4
Orobanche reaction:	very sensitive
Farming region:	Ribatejo e Oeste
Protein content:	24 to 26%

of 10 harvests, each of 10 contiguous plants, were made in each plot at 14-day intervals starting 41 days after sowing. Phenological observations were made daily on the same three randomly selected plants within each plot throughout the growing season. Insect pest control was achieved by applications of thiram, deltamethrin, and ethiofencarb; methabenzthiazuron and glyphosate were used for weed control. Leaf area was measured with a portable leaf-area meter (LI-COR model LI-3000).

Results

Fig.1 shows the accumulation of dry matter among different parts of individual plants throughout the season. In both densities, maximum stem and leaf dry weight were reached around 153 days after sowing, slightly after pod filling started. The increase of pod dry weight was greater than the loss of stem and leaf dry weight, suggesting that both remobilization and photosynthesis contributed to pod growth. Very rapid accumulation of dry matter coincided with the start of pod filling. This suggests a positive feedback of sink size on photosynthetic rate. Overall plant size was 30% greater at the low density, whereas total dry matter accumulation was greater at the high density, being 26.8 and 16.1 t/ha, respectively at 40 and 20 plants/m^2. Harvest indices were 0.49 and 0.46 respectively, and were not significantly different.

Differences in crop growth rates (CGR) between populations were not significant up to day 140 (**Fig. 2**). Thereafter, the denser crop had a CGR more than twice that of the sparse crop.

There were no significant differences in the net assimilation rates (NAR) for the two plant populations, leading to the conclusion that the greater leaf area index (LAI) of the denser crop was the main reason for the differences in crop growth rates. The values of LAI were never so large as to cause crop competition for light, explaining the non-asymptotic behavior of the dry weight accumulation curve in Fig. 1. Maximum LAIs were obtained at the start of pod filling (3.9 and 7.0 for the 20 and 40 plants/m^2 populations, respectively). Specific leaf area (SLA) decreased with leaf age.

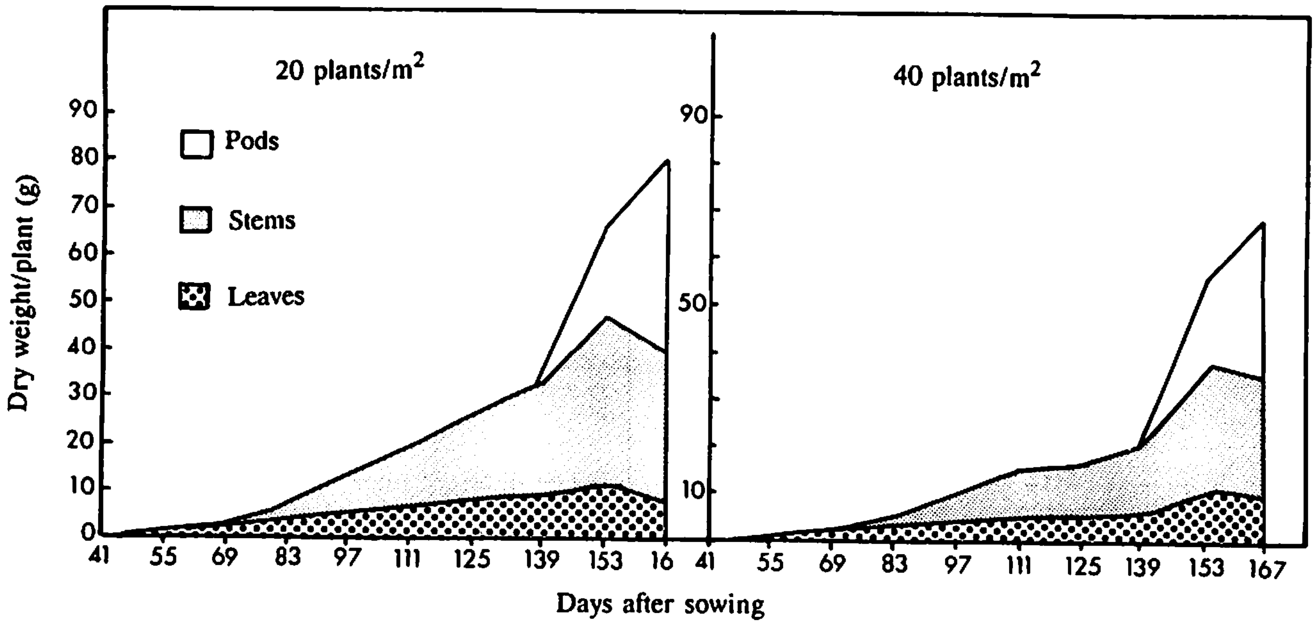


Fig. 1. Accumulation of dry matter in different plant parts of faba bean at 20 and 40 plants/m^2 densities.

The efficiency of conversion of incident photosynthetic active radiation (PAR) for the season was 2.5% for the 20 plants/m^2 population and 4.1% for the 40 plants/m^2 population. This result suggests that the level of light saturation was not reached with the highest population used in this study.

Plants of the dense population had less branching and fewer flowers and pods/plant, and were taller during the initial stages of crop growth (Fig. 3). There was a high rate of flower abscission in both plant densities (only 21.4% and 15.8% of the developed flowers gave a rise to pods at 20 and 40 plants/m^2, respectively). Such rates are common in *Vicia faba*, even in the absence of environmental stresses, and may be due to competition between various reproduction bodies for the metabolites.

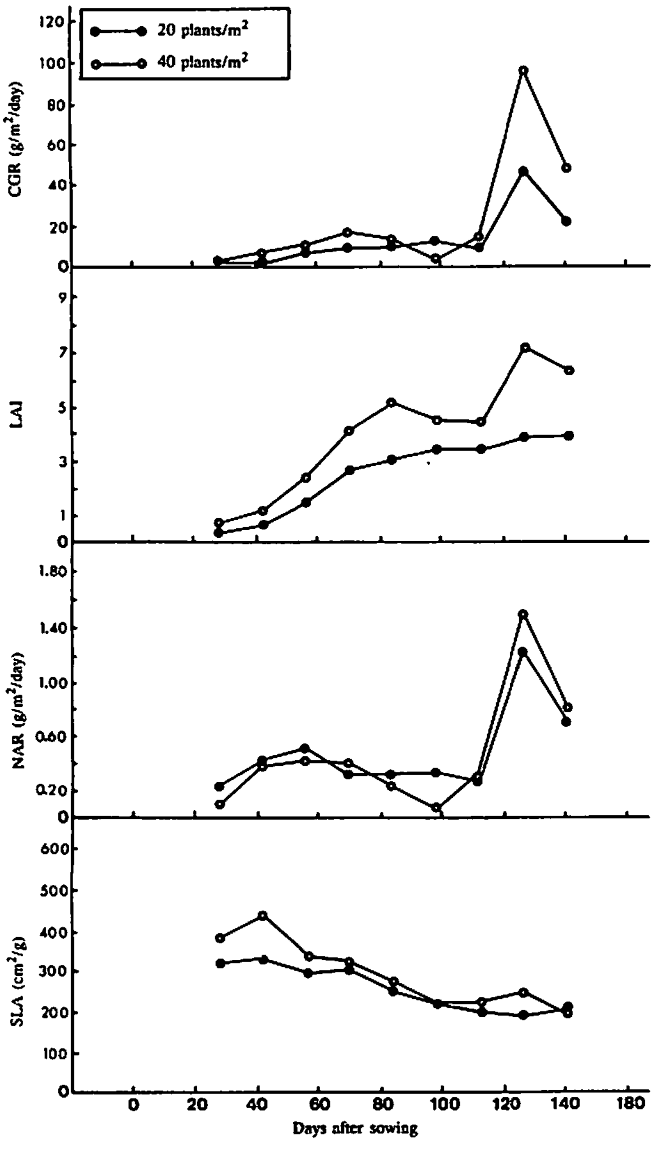


Fig. 2. Evolution of crop growth rate (CGR), leaf area index (LAI), net assimilation rate (NAR), and specific leaf area (SLA) of faba bean grown at two plant densities.

Discussion

The results obtained from this study indicated a clear positive effect of population density on crop yield. In agreement with the results of Poulin (1984) and Sprent *et al.* (1977), leaf senescence rates increased with the increase in plant density, resulting in a more rapid reduction in crop growth rate and net assimilation rate for the higher plant density. Analysis of the growth rates at maximum LAI showed no evident competition for light or nutrients, indicating that the increased leaf senescence rate in the higher plant density might be due to increased competition among individual plants for soil water towards the end of the cropping season.

The overall energy conversion efficiency for the 40 plants/m^2 population is relatively high for a C_3 leguminous species, but it is similar to the one found by Sale (1977) with a spring faba bean crop. However, maximum energy conversion efficiencies occurred during April under a set of favorable conditions, i.e., maximum LAI, high radiation, moderate air temperature, and good soil water and nutrient supply.

The reduction in branching as well as the reduction in the number of pods/plant due to increased plant density have also been observed by other workers (Hodgson and Blackman 1956; Kambal 1969; Seitzer and Evans 1973; Abo El-Zahab *et al.* 1981; Salih 1981; Plancquaert 1984; and Poulin 1984).

The number of seeds/pod did not seem to be affected by an increase in plant density. The high abscission rates observed are in agreement with Kambal (1969), Ishag (1973), Gates *et al.* (1983), Hebblethwaite *et al.* (1983), and Peat (1983) who examined abscised pods and concluded that all of them had been fertilized. The most reasonable explanation for the abscission of young pods is the high level of competition for assimilates between the numerous sinks (Peat 1983; Baker *et al.* 1984).

The different rates of pod survival at different nodes might be related to asynchronous initiation of seed development. Within the same inflorescence, the basal flower showed lower rates of abortion. Gates *et al.* (1983) hypothesized that this is caused by a more favorable position and a larger capacity of the assimilate transport.

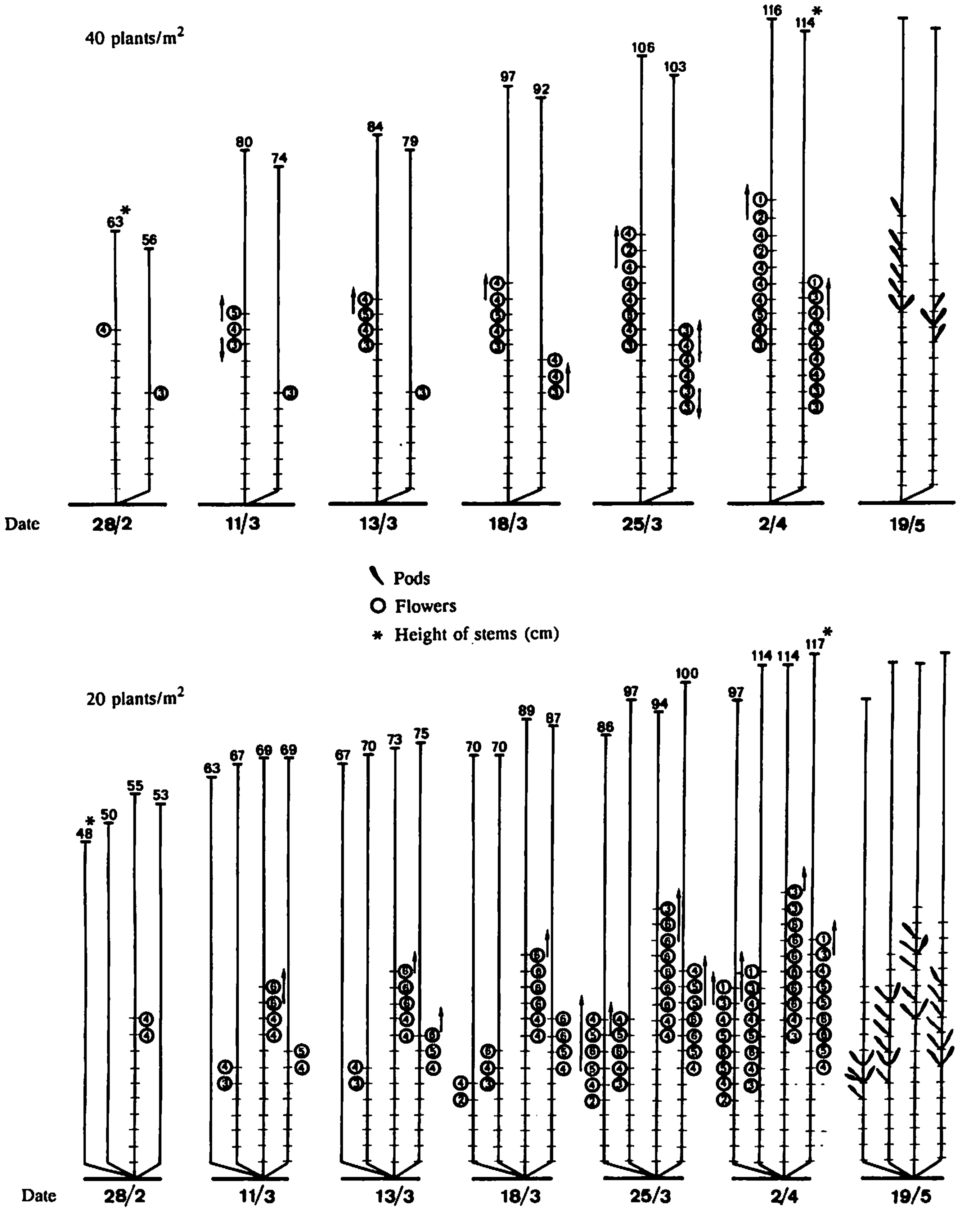


Fig. 3. Evolution of stem height, flower and pod numbers and position along the stems of faba bean grown at two population densities.

The reduction in abscission rates seems to be a promising way to increase yield through breeding. There are two possibilities worth consideration in this regard:

1. reduction in the number of pods/plant together with an increase in the number of seeds/pod;
2. breeding for determinate growth combined with a slower rate of senescence so that reproductive and vegetative parts do not compete with each other.

References

Abo El-Zahab, Al-Babawy, A.A. and Abd El-Latif, K. 1981. Density studies on faba beans (*Vicia faba* L.). II- Growth parameters. Journal of Agronomy and Crop Science 150: 303-312.

Baker, D.A., Chapman, G.P., Standish, M.J. and Bailey M.P. 1984. Growth habit in relation to assimilate partitioning and some consequences for field bean breeding. Pages 23-28 *in Vicia faba*: Agronomy, Physiology and Breeding: Proceedings of a CEC Seminar (Hebblethwaite, P.D., Dawkins, T.C.K., Heath, M.C. and Lockwood, G., eds.), 14-16 Sept 1983, University of Nottingham, UK. Martinus Nijhoff/Dr W. Junk Publishers, The Hague, The Netherlands.

Gates, P., Smith, M.L. and Boulter, D. 1983. Reproductive physiology of *Vicia faba* L. Pages 133-142 *in* The Faba Bean (Hebblethwaite, P.D., ed.). Butterworths Publisher, London.

Hebblethwaite, P.D., Hawtin, G.C. and Lutman, P.J.W. 1983. The husbandry of establishment and maintenance. Pages 271-312 *in* The Faba Bean (Hebblethwaite, P.D., ed.). Butterworths Publisher, London.

Hodgson, G.L. and Blackman, H.E. 1956. An analysis of the influence of plant density on the growth of *Vicia faba*. I- the influence of density on the pattern of development. Annals of Botany 7: 147-165.

Ishag, H.M. 1973. Physiology of seed yield in field beans (*Vicia faba* L.). I- Yield and yield components. Journal of Agricultural Science, Cambridge 80: 181-189.

Kambal, A.E. 1969. Components of yield in field beans (*Vicia faba* L.). Journal of Agricultural Science, Cambridge 72: 359-363.

Peat, W.E. 1983. Developmental physiology. Pages 103-132 *in* The Faba Bean (Hebblethwaite, P.D., ed.). Butterworths Publisher, London.

Plancquaert, P. 1984. Culture du poids et de la feverole. Perspectives Agricoles 13: 24-35.

Poulin, D. 1984. Influence of density on the growth and development of winter field bean (*Vicia faba*). Pages 151-167 *in Vicia faba*: Agronomy, Physiology and Breeding: Proceedings of a CEC Seminar (Hebblethwaite, P.D., Dawkins, T.C.K., Heath, M.C. and Lockwood, G., eds.), 14-16 Sept 1983, University of Nottingham, UK. Martinus Nijhoff/Dr W. Junk Publishers, The Hague, The Netherlands.

Sale, P.J.M. 1977. Net carbon exchange rates of field-grown crops in relation to irradiance and dry weight accumulation. Australian Journal of Plant Science 57: 401-406.

Salih, F.A. 1981. A review of the effects of seed rate and plant population, on grain yield of faba bean in Sudan. FABIS Newsletter No. 3: 44-46.

Seitzer, J.F. and Evans, L.E. 1973. response of small faba beans to seed rate and spacing. Canadian Journal of Plant Science 53: 279-283.

Sprent, J.I., Bradford, A.M. and Norton, C. 1977. Seasonal growth patterns in field beans (*Vicia faba*) as affected by population density, shading and its relationship with soil moisture. Journal of Agricultural Science, Cambridge 88: 293-301.

تأثير كثافة النبات في نمو وتطور الفول الشتوي
(Vicia faba L. var *minor)*

ملخص

تمت دراسة تأثير كثافتي نبات (20 و 40 نباتا/م2) في نمو وتطور طراز وراثي من الفول (*Vicia faba L. var minor*) ، هو "Tapada da Ajuda"، وذلك في خلال مختلف أطوار نمو المحصول. وعند الحصاد النهائي، بلغت غلة المادة الجافة للأجزاء الفوق أرضية 16.1 و 26.8 طنا/هـ للكثافتين المدروستين على نفس الترتيب السابق. وأعطت الكثافة النباتية الأعلى أفضل معدل لكل من نمو المحصول، ومعدل التمثيل الصافي، والكفاءة الإشعاعية الفعالة للتمثيل الضوئي. وقرب نهاية الموسم، كانت معدلات شيخوخة النباتات وانفراط القرون أعلى بكثيرفي الكثافة النباتية الأعلى.

Agronomy and Mechanization

المعاملات الزراعية والمكننة

Forage Productivity of Faba Bean under Various Spacings of Poplar (Poplus deltoides) Trees in an Agro-Forestry System

R.S. Dhukia[1], Shardha Ram[2] and K.S. Bangarwa[3]
1. Directorate of Extension Education
2. Department of Plant Breeding
3. Department of Farm Forestry
Haryana Agricultural University,
Hisar 125 004, INDIA

Abstract

Faba bean for forage was grown in the winter season of 1986/87 in interspaces of 5-year old poplar trees planted at various spacings. Maximum green fodder and dry matter production was obtained when faba bean was grown in interspaces of poplar trees planted at 6x6 m^2. Narrow tree spacings of 2x2 m^2 adversely effected production of both green fodder and dry matter due to shading.

Introduction

In India, faba bean (*Vicia faba* L.) is grown on small plots, mainly in the eastern parts of the country, where its yield can reach up to 5000 kg/ha (Singh *et al.* 1986). The crop is mainly consumed by humans. However, recent efforts have been started to explore the possibilities of growing this crop as a forage legume in existing agro-forestry systems (Dhukia *et al.* 1988). The objective of this investigation was to study the productivity of faba bean in an agro-forestry system of poplar (*Poplus deltoides*) trees planted at different spacings.

Materials and Methods

A field experiment was conducted on a sandy loam soil at the Haryana Agricultural University, Hisar, India, during the winter season of 1986/87, to study the productivity of faba bean under various spacings of poplar (*Poplus deltoides*) trees. Seeds of the faba bean (*Vicia faba*) cv 'local' were sown in the interspaces of 5-year old poplar trees planted at 2x2 m^2, 4x4 m^2, and 6x6 m^2 apart. The corresponding plot sizes were 19.2 m^2, 36 m^2, and 60 m^2, respectively. The faba bean crop was fertilized with 16 kg N and 70 kg P_2O_5/ha at sowing. Seeds were sown on 5 Nov 1986 at a seed rate of 75 kg/ha in rows 25-cm apart arranged in a randomized block design. The crop was harvested on 30 Mar 1987 for green fodder. Data on green fodder and dry matter yields were recorded.

Results and Discussion

Table 1 shows that faba bean planted in the interspaces of poplar trees grown at 6x6 m^2 produced maximum green fodder yield (14890 kg/ha) and dry matter yield (2580 kg/ha) which were 50.4% and 52.6% higher, respectively, than those obtained under the 2x2 m^2 spacings. The corresponding increases in green fodder and dry matter yields were 14.9 and 19.4%, respectively, over those produced under the 4x4 m^2

Table 1. Green fodder and dry matter yields of faba bean grown under 5-year old poplar plantation with different inter-tree spacings at the Haryana Agricultural University, Hisar, India, during the 1986/87 season.

Poplar spacing	Yield (kg/ha)	
	Green fodder	Dry matter
2x2 m^2	9900	1690
4x4 m^2	12960	2160
6x6 m^2	14890	2580
SE ±	2214	394

spacings. Similarly, the forage yield of faba bean under 4x4 m^2 tree spacings was higher than that obtained under the 2x2 m^2 tree spacings. As the population of poplar trees increased, the shading effect on the intercropped faba bean increased resulting in reduced yields.

The foregoing results suggest that acceptable forage yields could be obtained from faba bean grown under 5-year old poplar trees planted at 6x6 m^2 in an agro-forestry system.

Acknowledgments

The authors are grateful to the Head, Department of Farm Forestry and Director of Research, Haryana Agricultural University, Hisar, for providing the facilities for conducting this study.

References

Dhukia, R.S., Lodhi, G.P., Jatasra, D.S. and Ram, S. 1988. Productivity of forage and food crops in agro-forestry system under Shisham and Siris trees. Indian Journal of Range Management 9: 53-58.

Singh, V.P., Rao, P., Singh, R.C. and Sharma, S.C. 1986. Technology for faba bean cultivation. Indian Farming 36(3): 17, 19, 35.

الإنتاجية العلفية لنبات الفول تحت أشجار الحور (Populus deltoides) المزروع على مسافات متباينة في نظام زراعي-حرَجي

ملخص

في الموسم الشتوي 87/1986 زرع فول للإنتاج العلفي بين أشجار حور عمرها خمس سنوات، ومزروعة على مسافات متباينة. وقد تم الحصول على أعلى إنتاجية من العلف الأخضر والمادة الجافة، عندما زرع الفول بين أشجار حور مزروعة على مسافات 6 x 6 م2 . بينما أدّت المسافات الضيقة بين الأشجار 2x2 م2 إلى تأثير عكسي في إنتاج كل من العلف الأخضر والمادة الجافة، بسببالتظليل shading.

Performance of Faba Bean Genotypes under Saline Alkali Soil Condition of Soba Area, Sudan

Yousif H. Yousif and Farouk A. Salih
Shambat Research Station, Khartoum North, SUDAN

Abstract

Faba bean breeding lines were tested for yield performance under the saline alkali soil conditions of Soba, Sudan. The lines varied significantly in both their yield and some yield components during the two years of test. Poor plant stand and stunted growth were observed on the low yielding lines. Tolerant lines having good stand and growth produced the highest yield. H.72 and other new introductions seemed to be sensitive to the prevailing soil conditions and need to be replaced by other lines.

Introduction

In the Sudan, faba bean is mainly grown along the Nile in the northern region, where soil and climatic conditions are suitable for maximum production. Because faba bean production in the traditional areas (northern region) can no longer meet demand, attempts were made to introduce the crop into areas south of Khartoum, which cover about quarter of a million hectares and can be very important for the production of various crops, i.e., vegetables and fruits. The fact that this region is within the reach of the densely populated areas in and around Khartoum with the necessary infrastructure, makes it suitable for exploitation. However, soils of this region are saline and alkali.

The aim of the present work was to study the adaptability of faba bean in order to introduce the crop into the new area as a new cash crop.

Materials and Methods

This study was conducted at the experimental farm of Soba Research Station (Lat. 15^o 24", Long. 32^o 28") during the 1982/83 and 1983/84 seasons. The soil is aridisol, saline alkali in the sub surface (Table 1).

It is sandy clay loam in texture with high $CaCO_3$. The land is watered from Gezira Scheme Canal which comes from the Blue Nile.

The experiment was sown during the first week of November of each year. Seeds of different breeding lines were planted on both sides of 70-cm ridges at plant spacings of 15 cm in $50m^{-2}$ plots arranged in a complete randomized block design replicated four times. At harvest, data on yield and yield components were taken and statistically analyzed.

Results and Discussion

Season 1982/83

The trial of this season included nine breeding lines plus cv H.72 as a standard check. Significant yield differences were found among the lines, but none was significantly better than cv H.72 (**Table 2**). Mass Selection Giza 1, line RB 30/17, and line 188 x G.1 outyielded cv H.72 by 26.7%, 25.7%, and 24.1%, respectively. All the breeding lines were significantly better than Mass Selection Giza 2, which was the lowest yielder. The yield of cv H.72 surpassed the yield of Mass Selection Giza 2 by 40.5%.

Differences among the tested breeding lines in plant stand, plant height, and number of branches/plant were not significant. Mass Selection Giza 2 had the highest 100-seed weight, but that did not compensate for the low seed yield.

Season 1983/84

Two trials were conducted during this season. The first trial included two standard checks (cvs H.72 and BF 2/2), 13 breeding lines, and Mass Selection Giza 1 which was the top yielding breeding line in 1982/83. There were significant differences among the lines tested in this trial with respect to seed yield/ha, plant stand/m^2, number of seeds/pod, number of branches/plant and 100-seed weight (**Table 3**). Lines 00639, 00657, and the control cv H.72 were negatively affected by the soil and environmental conditions of Soba area and had lowest plant stand and seed yield.

Table 1. Soil properties of Soba Research Farm, Shambat, Sudan.

Soil depth (cm)	Electrical conductivity (mm hos/cm)	Anions (mg/l)			Cation (mg/l)			SAR	ESP	Exch. Na (mg/100g)	CEC (mg/100g)	pH	$CaCO_3$ (%)	Sand (%)	Silt (%)	Clay (%)
		Cl	SO	HCO	Na	Ca	Mg									
00-30	2.93	6.3	27.7	20.7	25.2	8.2	2.0	15.8	23.7	8.2	34.6	8.2	9.9	42.3	13.6	34.8
30-60	10.44	19.1	102.4	1.5	99.1	19.7	4.2	28.7	39.1	15.4	39.4	8.2	9.7	34.1	15.7	40.9
60-100	10.44	23.4	88.3	1.5	96.7	12.0	4.8	47.2	53.2	22.0	41.4	8.4	9.5	31.9	16.6	43.5

Table 2. Yield and yield components of certain faba bean breeding lines grown at Soba, Shambat Research Station, Sudan, during the 1982/83 season.

Line	Seed yield (kg/ha)	Plant stand/ m^2	No. of pods/ plant	No. of seeds/ pod	100-seed weight (g)	Plant height (cm)	No. of branches/ plant
Mass Selection Giza 1	1897	19.4	13.5	2.83	40.0	82.0	3.9
RB 30/17	1873	18.3	18.3	3.36	36.5	74.9	2.7
188 x G.1	1835	20.0	16.4	2.36	40.7	83.3	3.7
IW	1618	18.1	16.1	2.24	39.5	82.5	3.4
NEB 423	1565	20.0	16.3	2.38	49.0	81.6	3.4
NEB 428	1555	18.3	16.1	2.12	36.1	84.2	3.4
BM 9/3	1529	18.3	18.5	2.34	36.0	70.3	3.6
NEB 424	1468	19.8	16.9	1.90	42.2	75.3	3.0
Mass Selection Giza 2	827	19.7	8.3	2.02	54.7	73.9	3.7
H.72	1391	19.6	15.1	2.26	39.2	80.8	3.1
SE ±	195.7	12.3	2.2	0.15	2.3	3.5	0.3
Mean	1556	19.1	15.5	2.38	41.4	78.9	3.4

Table 3. Yield and yield components of certain faba bean breeding lines grown at Soba, Shambat Research Station, Sudan, during the 1983/84 season.

Breeding line	Seed yield (kg/ha)	Plant stand/ m^2	No. of pods/ plant	No. of seeds/ pod	100-seed weight (g)	Plant height (cm)	No. of branches/ plant
Mass Selection Giza 2	1559	17.4	9.8	3.17	41.8	60.8	3.1
00654	1496	20.9	6.6	3.30	41.8	50.2	2.4
00634	1469	20.7	6.2	3.26	52.7	49.4	2.3
Mass Selection BF 2/2	1382	17.3	8.3	3.57	41.0	55.0	2.7
Mutant LB-48	1379	24.0	7.1	2.34	36.7	47.8	1.6
00649	1337	21.8	6.5	2.15	45.0	43.8	2.5
00482	1316	20.5	7.2	2.94	45.0	51.6	4.0
00104	1167	17.8	8.1	2.86	38.3	52.2	2.4
00637	1139	20.1	8.4	2.96	38.1	51.4	2.3
00638	1014	17.9	10.8	2.80	40.6	49.8	2.5
00501	996	15.1	7.1	2.03	45.9	55.8	2.2
00657	639	7.7	8.9	3.38	44.2	63.2	3.6
00639	117	1.4	9.5	2.26	44.9	51.5	2.8
H.72	116	0.8	15.2	2.74	38.0	58.6	4.7
BF 2/2	1156	16.2	8.5	2.63	36.3	48.2	2.2
SE ±	148	1.3	1.7	1.38	3.65	3.1	0.5
Mean	1086	16.0	8.5	2.83	42.0	52.6	2.75

Table 4. Yield and yield components of a group of mutant lines of faba bean tested at Soba, Shambat Research Station, Sudan, during the 1983/84 season.

Mutant	Seed yield (kg/ha)	Plant stand/ m^2	No. of pods/ plant	No. of seeds/ pod	100-seed weight (g)	Plant height (cm)	No. of branches/ plant
W-57	1838	28.3	14.9	2.06	34.6	59.4	1.9
B-3	1315	29.0	8.2	2.14	34.1	62.9	1.3
W-54	1301	26.0	12.9	2.11	37.8	57.5	1.6
B-12	1134	29.4	6.4	2.37	31.0	51.5	1.7
B-48	1065	29.1	7.1	1.87	35.1	48.9	1.6
B-21	1065	29.6	5.1	1.94	43.5	52.7	1.7
B-50	1032	26.8	7.7	2.25	53.1	48.9	2.1
B-7	991	27.0	5.4	3.17	29.2	55.3	1.5
B-14	903	25.9	7.1	1.55	30.2	41.1	2.4
W-8	889	29.6	8.6	2.26	27.1	53.8	1.8
B-42	829	30.4	8.9	1.68	36.0	47.2	1.7
B-25	754	25.7	7.3	2.20	37.2	51.5	2.0
W-55	718	27.6	6.1	2.41	31.7	49.2	1.4
B-4	579	26.6	5.7	1.62	38.1	47.9	1.3
H.72	282	1.3	14.0	2.63	39.4	49.8	3.1
SE ±	235	1.1	2.3	0.25	4.7	4.0	0.3
Mean	980	26.1	8.4	2.15	35.9	51.8	1.8

Mutant LB-48 produced the highest number of plants/m^2, but it ranked fifth in seed yield and had the lowest number of branches/plant and 100-seed weight. Mass Selection Giza 1, as in the previous season, was the leading line in seed yield/ha. It outyielded the controls H.72 and BF 2/2 by 92.5% and 25.8%, respectively (**Table 3**).

The seven top breeding lines presented in **Table 3** were not significantly different from each other in seed yield, but their yields were significantly different from the yields of H.72, BF 2/2, and the rest of the tested lines.

In general, plants were shorter this season, thus producing fewer pods and seeds/plant and consequently lower yields.

The second trial included 14 promising mutants selected from the X-irradiated BF 2/2. Cultivar H.72 was included as a standard check. There were significant differences between the mutants themselves and between the mutants and the standard check for seed yield/ha, plant stand/m^2, number of seeds/plant, and number of branches/plant (**Table 4**).

The highest seed yield was produced by mutant W-57, which non-significantly exceeded the yields of the three mutants B-3, W-54, and B-12 by 28.4%, 29.2%, and 38.3%, respectively. The high yield of mutant W-57 was accompanied by good plant stand and a high number of pods/plant. On the other hand, cv H.72 produced the lowest seed yield due to its poorest plant stand.

The poor stand and stunted growth of some of the breeding lines reported in **Tables 1, 2,** and **3** may be attributed mainly to soil properties at Soba, i.e., poor physical condition (poor aeration, high bulk density, low hydraulic conductivity) and high concentrations of salts in the sub-surface. El-Karouri (1979) investigated the tolerance of faba bean to salts on aridisol at the Soba Research Farm. His results showed that at a soil salinity level of 10.5 mm hos/cm, dry matter production was reduced by 50%. There was a negative relationship between soil salinity and shoot dry matter yield. Faba bean could not survive when the CEC of the saturation extract approached 22 mm hos/cm.

It is evident from the results of this study that cv H.72, which was released for planting in the southern part of the northern province of the northern region of the Sudan (Yassein 1972), performed poorly under the conditions of the new area due to its sensitivity to salinity. Mass Selection Giza 1 and lines RB 30/17, 188 x G1, 00654, 00634, and W-57 produced the highest yields and were better adapted to Soba area.

Conclusions

1. Yields were affected by seasonal variations.
2. Faba bean could be produced economically under saline alkali conditions if suitable lines were used.
3. Screening of varieties and breeding lines for salt tolerance needs to be expanded further.
4. Low yields were associated with poor stand and stunted growth. However, plant stand can be improved by modified cultural practices.

References

El Karouri, M.O.H. 1979. Effects of soil salinity on broad bean (*Vicia faba* L.) in the Sudan. Experimental Agriculture 15: 59-63.

Yassein, T.S. 1972. Ful-Masri (*Vicia faba*) regional trials. Annual Report 1971. Hudeiba Research Station, Ed-Damer, Sudan.

كفاءة طرز وراثية من الفول تحت ظروف تربة قلوية مالحة في منطقة سوبا، السودان

ملخص

اختبرت سلالات تربية من نبات الفول لتحديد كفاءة غلّتها تحت ظروف التربة القلوية المالحة في سوبا بالسودان. وخلال سنتي الاختبار تباينت السلالات بشكل معنوي فيما بينها، من حيث الغلة وبعض مكوناتها. ولوحظت كثافة نباتية قليلة، ونمو متقزم في السلالات المنخفضة الغلة. وقد أعطت السلالات المتحملة ذات الكثافة النباتية والنمو الجيدين أعلى غلة، وظهر أن H. 72 ومدخلات جديدة أخرى حساسة لظروف التربة السائدة، وثمة حاجة لاستبدالها بسلالات أخرى.

Rate of Cross-Fertilization Between Single Plants and Between Plots

Wolfgang Link and Ernst von Kittlitz
University of Hohenheim, Postfach 70 05 62, 7000 Stuttgart 70, FEDERAL REPUBLIC OF GERMANY

Abstract

In field trials, the cross-fertilization between single plants and between small plots was studied in *Vicia faba* L. var *minor* using black-seeded marker-gene. The rate of cross-fertilization between single plants (42%) was about twice the rate between plots (22%). The results show that cross-fertilization is too frequent to be ignored.

Introduction

Faba bean (*Vicia faba* L.) is a partially allogamous species, a fact that renders its breeding difficult. Multiplication of genotypes in the open field causes problems of impurity in the genotypes for subsequent test trials, unless adequate isolation is provided. The problems that arise from this practice are:

1. A given genotype cannot be properly maintained.

2. Genotypes show different degrees of cross-fertilization. Therefore, even stocks with an equal coefficient of inbreeding will produce progenies with differing coefficient of inbreeding. This creates differences between the productivity of these progenies which are found at the homozygous level, thus decreasing the validity of the results.

3. The contamination with pollen from the whole nursery reduces the genetic variation between the stocks, and subsequently the heritability and the gain from selection.

To minimize these disadvantages, breeders often discard seeds from the border rows. Hawtin and Omar (1980) found, that harvesting the center of a plot (size of 15 m^2 or 30 m^2) instead of the borders, reduced contamination from outside the plots by 3 to 5%. Omar and Hawtin (1981) found a difference of about 6% between the samples from the border and from the central part of a plot; the difference was somewhat more pronounced when the experiment was located in the center of the field than when at the edge. Dietrich *et al.* (1979) reported from repeated experiments that their four-row-plots produced about 28% of the progeny pollinated from outside the plot, whereas single-row-plots produced 38%. However, Xanthopoulos *et al.* (1986) reported a rate of cross-fertilization within rows of 48% compared to only 8% between rows using single row plots with a row spacing of 0.7 m. Robertson and Cardona (1986) suggested, that neighboring plots of *Brassica napus* L. potentially reduced bee activity in the faba bean plots; however the rate of inter-plot outcrossing was not significantly reduced.

Pope and Bond (1975) found that an isolation distance of 0.9 m resulted in 17% contamination with 20 m^2 plots. However, contamination was reduced to 3% at 23 m, to 2% at 46 m, and to less than 1% at 138 m distance to the source of foreign pollen. Similarly, Hawtin and Omar (1980) reduced contamination from 7% (at plot spacings of 10-40 m) to less than 2% (at plot spacing of 200 m) with 6.25-m^2 plots. Also, they found that contamination was reduced as the plot-size increased.

The objective of the present work was to determine the rate of cross-fertilization between plants (i.e., within plots) and between small plots at different levels of heterozygosity of the faba bean genotypes at Hohenheim, Stuttgart, Germany.

Materials and Methods

Four experiments were conducted in the open field at Hohenheim, Stuttgart, Germany, during the 1985-1987 seasons to study the rate of cross-fertilization in faba bean (*Vicia faba* L. var *minor*). Nine genotypes of faba bean expressing the recessive buff seed color were used: three homozygous lines (line 03 from the variety Diana, line 20 from Herz Freya, and line 43 from Kleine Thueringer), along with the three possible F_1s and the corresponding F_2s.

The rate of cross-fertilization was measured with a top cross by examining the offspring in the topcross-test. The topcross-tester was a bulk of 16 lines, homozygous for the dominant black seed-color. The flowering period of the topcross-tester covered the flowering period of the nine genotypes.

In the topcross-test-generation the progeny of the nine buff-seeded genotypes was sown and number of black seeded and buff seeded progenies was counted. The rate of cross-fertilization (RCF) in the four experiments was calculated as follows:

$$RCF = \frac{\text{No. of black-seeded progenies}}{\text{Total no. of scored progenies}} \times 100(1+R)$$

where R is the relation of buff-seeded plants to black seeded plants (topcross-tester) during the flowering period in the topcross-generation.

Experiments 1 - 3

Experiments 1 and 2 included all the nine genotypes, whereas experiment 3 included only the three lines. The topcross-generations of the experiments were grown in 1985 (exp. 1), 1986 (exp. 2), and 1987 (exp. 3) at different fields. The genotypes were randomized in two blocks. Each plot consisted of 10 buff-seeded plants, surrounded by eight plants of the topcross-tester. The resulting plant density was 20 plants/m^2 with all plants equally spaced. An average of 1495 offsprings/genotype and experiment were scored in the respective topcross-test.

Experiment 4

The topcross-generation of experiment 4 was grown in 1987 at the same field as exp. 3. The buff-seeded genotypes were planted as whole plots (2x0.9 m^2 size) with three rows and 60 plants/plot. The relation of "black" plots to "buff" plots was 3 : 1 (**Fig. 1**). The "buff" plot were harvested in three parts: the two border rows (treatment 1), the five border plants of each side of the central row (treatment 2), and the center of the central row (treatment 3). An average of 486 offsprings/genotype and treatment were scored in the topcross-test.

"Total rate" of cross-fertilization was estimated in experiments 1 - 3, whereas in exp. 4, the rate of cross-fertilization between plots was estimated ("rate between plots"), i.e., the part of progeny which is fertilized by pollen from plants of neighboring plots. The "rate between plots" is the "total rate" minus the cross-fertilization between plants within the same plot.

Results and Discussion

A summary of the rate of cross-fertilization in experiments 1 - 4 is shown in **Table 1**. There was a strong negative influence of the degree of heterozygosity on the rate of cross-fertilization, and the mean of the F_2s was nearer to the mean of the parental lines than to the mean of the F_1s.

There were clear differences between experiments 1 - 3 and exp. 4. The "rate between plots" was, on average, about half of the "total rate," indicating that approximately half of the cross-fertilization occurred between plants within the same plot. These results are at variance with those of Xanthopoulos *et al.* (1986).

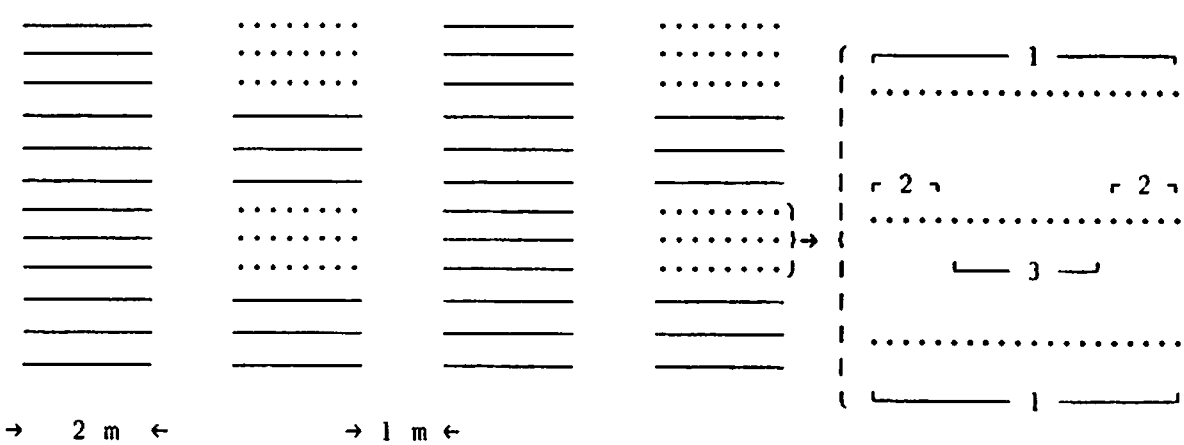


Fig. 1. Field design of experiment 4 (the solid lines symbolize a row of black-seeded plants and a dotted line symbolizes a row of buff-seeded plants; 1, 2, 3 correspond to treatments 1, 2, and 3.

Table 1. Rate of cross-fertilization faba bean genotypes (experiments 1 - 4) grown at Hohenheim, Stuttgart, Germany, during the 1985-1987 seasons.

Experiment	Generation /genotype									Mean
	P			F_2			F_1			
	03	20	43	03x20	03x43	20x43	03x20	03x43	20x43	
Exp. 1	57.3	42.6	51.7	49.2	53.2	41.9	37.1	26.3	11.7	41.2
Exp. 2	57.8	50.5	64.7	46.0	52.3	46.1	25.5	30.8	11.7	42.8
Exp. 3	64.1	58.1	40.4							
Mean[a]	59.7	50.4	52.3	47.6	52.8	44.0	31.3	28.6	11.7	
Mean		54.1			48.1			23.8		
Exp. 4										
Treat. 1	36.5[d]	38.4	35.0	30.9	22.9	30.0	18.4	14.1	4.8	25.7[c]
Treat. 2	38.5	30.9	30.3	25.0	29.9	22.3	10.2	12.1	6.2	22.8
Treat. 3	29.9	23.4	28.1	17.9	24.7	14.6	10.8	10.5	10.2	18.9
Mean[b]	35.0	30.9	31.1	24.6	25.8	22.3	13.2	12.2	7.1	22.5
Mean	32.3			24.2			10.8			

a. LSD (0.05) for comparison of genotypes: 11.5
b. LSD (0.05) for comparison of genotypes: 6.2
c. LSD (0.05) for comparison of treatments: 2.8
d. LSD (0.05) for comparison of genotypes within treatments: 6.6

In exp. 4, only small differences were detected between buff-seeded plants harvested from the center of the plot and those harvested from the border of the plot. Nevertheless, the influence of the treatments was significant. These results agree with the work of Omar and Hawtin (1981).

The effect of cross-fertilization on the coefficient of inbreeding of the stocks is shown in **Table 2**. Consider the self-pollinated progeny of a single, heterozygous plant, giving an F_2-plot as in exp. 4. The F_2-plants produced 48% of its progeny by cross-fertilization. However, only 24% was traced back to pollinators from other plots and subsequently were not inbred (coefficient of inbreeding of 0.00), whereas the remaining 24% was pollinated by F_2-plants within the same plot (coefficient of inbreeding of 0.50). Consequently, 52% of the progeny resulted from self-fertilization (coefficient of inbreeding of 0.75). The average inbreeding coefficient of the entire progeny is then 0.51 (**Table 2**). Harvesting only the plants from the center of the plot did not markedly improve the coefficient of inbreeding, especially when compared with a coefficient of inbreeding of 0.75, achievable in bee-proof conditions.

Table 2. Average coefficient of inbreeding of the progeny of lines, F_2's and F_1's harvested from the whole plot or from the central part only.

Harvested area	Generation		
	P	F_2	F_1
Whole plot	0.68	0.51	0.38 (0.45)[a]
Central part	0.73	0.54	0.38 (0.45)

a. If all F_1-plants in the plot have the same genotype.

Generally, it can be concluded that the rates of cross-fertilization between plots were too large to be neglected. A single row at each side of a plot is a weak shelter against foreign pollen and does not diminish the rate of cross-fertilization within the plot. Thus, to reduce contamination with foreign pollen, additional sheltering rows should be planted from seed of the respective genotypes harvested from the open field at the previous year. The "inner" plot with true-bred seed will then yield a less contaminated progeny for larger trials.

References

Dietrich, M., Kaestner, H.F. and Steuckardt, R. 1979. Der anteil der selbst- und fremdbefruchtung bei der ackerborhne (*Vicia faba* L.) nach ergebnissen mehrjaehriger versuche mit weiss sowie farbig bluehenden genotypen. Tag.-Ber. Akad. Landw. -Wiss. 175: 97-109.

Hawtin, G. and Omar, M. 1980. Estimation of out-crossing between isolation plots of faba beans. FABIS Newsletter No. 2: 28-29.

Omar, M. and Hawtin, G. 1981. Effect of plot-to-plot distance on the percentage of intercrossing between faba bean plots. FABIS Newsletter No. 3: 27.

Pope, M. and Bond, D.A. 1975. Influence of isolation distance on genetic contamination of field bean (*Vicia faba* L.) seed produced in small plots. Journal of Agricultural Science, Cambridge 85(3): 509-513.

Robertson, L.D. and Cardona, C. 1986. Studies on bee activity and outcrossing in increase plots of *Vicia faba* L. Field Crops Research 15(2): 157-164.

Xanthopoulos, F., Roupakias, D.G. and Tsaftaris, A.S. 1986. Inter- and intravarietal cross-fertilization in faba beans (*Vicia faba* L.). Zeitschrift fuer Pflanzenzuechtung 96: 371-375.

Acknowledgments

The results of this work could not have been brought about without the collaboration of Mrs. Beate Devezi and Mrs. Sabine Frey. We are very grateful to Prof. Dr. B. Allison, Hohenheim, for critically reading the English text.

معدل الإخصاب الخلطي بين نباتات منفردة، وفيما بين قطع تجريبية

ملخص

ضمن تجارب حقلية على الفول، تمت دراسة الإخصاب الخلطي بين نباتات منفردةوبين قطع تجريبية صغيرة، وذلك باستخدام مورث علام ذي بذرة سوداء. وكان معدل الإخصاب الخلطي فيما بين النباتات المنفردة (42٪) حوالي ضعف ما هو عليه بين القطع التجريبية (22٪). وهذه النتائج تظهر أن الإخصاب الخلطي كان شديد التكرار بحيث لا يمكن تجاهله.

DOCUMENT COLLECTION

With the financial support of the International Development Research Centre (IDRC), ICARDA is building up its document collection on faba bean. The collection will be used to supply needed documents to scientists in developing countries.

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

FABIS
ICARDA
Box 5466
Aleppo, Syria

Pests and Diseases

الآفات والأمراض

Plant Characteristics of Faba Bean (Vicia faba L.) Cultivars Associated with Broomrape (Orobanche crenata Forsk.) Attack in a Naturally Infested Field

A.J. Karamanos and C.E. Avgoulas
Laboratory of Crop Production
The Agricultural University
118 55 Athens, GREECE

Abstract

Plant and crop characteristics of 12 faba bean (*Vicia faba* L.) cultivars were examined against broomrape (*Orobanche crenata* Forsk.) attack in a naturally infested field. The number of broomrape spikes on a plant basis differed significantly among cultivars, indicating different degrees of susceptibility. The late appearance of the parasite (by mid-podding stage) permitted the consideration of most characteristics as independent variables in relation to the degree of attack. The number of stems and seeds/plant, as well as the total plant dry weight, exhibited the highest negative correlations with the degree of attack. Furthermore, the ratio of leaf area integral after anthesis over seed yield, used as an index of the availability of assimilates to the parasites, exhibited high positive correlations with broomrape attack. In most cases, the relations between plant characteristics and broomrape attack were expressed better by parabolic than by linear regressions.

Introduction

Orobanche crenata Forsk. (crenate broomrape) is one of the major constraints to faba bean production in the Mediterranean basin. Yield losses between 5 and 100% have been reported (Sauerborn and Saxena 1986). These are attributed to the severe competition between the parasite and the host for water, nutrients, assimilates and other growth substances (Whitney 1972; Ponce de Leon *et al.* 1974; Cubero 1983). The consequences of parasitism to faba bean are reductions in plant height, number of leaves, flower- and pod-setting, as well as number and weight of seeds/plant (Kadry *et al.* 1959). Considerable attention is being paid to the chemical control of the parasite (Cubero 1983), but the application cost and possible undesirable effects to normal development of the faba bean crop limit the use of chemicals. Thus, several cultural techniques (e.g., delayed sowing) also have been suggested (Zahran 1982).

In addition, the search for genetic resistance of faba bean to broomrape attack is very active, resistant cultivars (e.g., Giza 402, BPL 2210, etc.) have been developed (Nassib *et al.* 1982). Very little is known, however, about the plant characteristics responsible for resistance to the parasite. Cubero (1973 and 1983) gave special emphasis to factors associated mostly with the form and function of the root system of the host. Evidence is still restricted and confusing concerning morphological and other characteristics of the above-ground part of the plants. For example, the greater susceptibility of large-seeded varieties (Ciccarone and Piglionica 1979) is not valid anymore, at least on a per plant basis (Cubero 1983).

The aim of the present work was to find easily detectable plant characteristics that could be associated with variations in resistance to broomrape attack. A trial of 12 faba bean cultivars of different origins provided a wide range of plant characteristics that could be examined for this *purpose*. The late appearance of the attack permitted the observed variation in most characteristics (e.g., stem, pod and seed numbers/plant, maximum leaf area, etc.) to be considered as independent of infection. Consequently, it was possible to consider various plant parameters as independent variables in regard to the degree of attack, expressed as number of inflorescences/plant.

Materials and Methods

The experiment, part of the European Economic Community (EEC) Joint Faba Bean Trials with 12 winter-type cultivars for 1985/86, was established on organic silty clay loam soil in a field previously cultivated with cotton at the Athens Agricultural University at Kopaida, about 100 km northern of Athens. The experiment was laid out in a randomized block design with three replications. The examined cultivars were mainly winter-type, with one spring cultivar ('Troy') which was included as control. The origins and classifications of the cultivars are shown in **Table 1.** The field was ploughed three days before sowing. Then, 100 kg P_2O_5/ha was broadcast in the form of superphosphate fertilizer (20% P_2O_5), and incorporated by harrowing. Sowing was on 6 Dec 1985 in rows 40 cm apart using seeds treated with Vitavax (20% carboxin + 40% maneb) at the rate of 225 g a.i./kg of seed. Spacing of seeds within rows differed among the cultivars according to their seed size: 9-10 cm for Polycarpi, N. 312, R.29.T, Alto, Chiaro T.L. and Troy (average density 35 seeds/m^2); 12 cm for Gemini, PAM-1, Palacio, and Brucul (density of about 30 seeds/m^2); 16 cm for Vt-1 (22 seeds/m^2); and 18 cm for ILB 1814 (20 seeds/m^2). Plot size was 15.6 m^2 (4x4.4 m) and included 11 rows. Pre-emergence weed control was performed on 11 Dec using Tribunil (70% methabenz-thiazuron) at a rate of 3 kg a.i./ha. The remaining weeds, especially *Galium aparine*, were controlled in mid-March by hoeing. The bean plants started to emerge 12 days after sowing. The first signs of *O. crenata* attack (first visible attachments on the roots) were observed on 17 Apr 1986 when all cultivars were at the early podding stage (132 days from sowing). The crop was harvested on 19 June 1986, when all pods were dark.

Plant growth (dry weight and leaf area) was determined at approximately 15-day intervals on three plants/plot randomly selected on each occasion. Leaf area/plant was determined with an electronic planimeter. Leaf area index was calculated by using the average plant area in each plot and the corresponding plant density determined at 75 and 98 days after sowing. The final density was 20 plants/m^2 for ILB 1814; 22 plants/m^2 for Vt-1; 30 plants/m^2 for Gemini, PAM-1, Palacio, and Brucul and; 35 plants/m^2 for the remaining cultivars. The different stages of reproductive development (appearance of inflorescences, anthesis and maturation) were also determined on the sampled plants and expressed according to the key proposed by Stuelpnagel (1984) and von Kittlitz *et al.* (1984). This permitted an accurate method for determining the days to 50% anthesis and the days to 50% pod darkening for each cultivar.

Crop yield was determined by harvesting 5 m^2 from the center of each plot on 19 June 1986 (195 days after sowing). Yield components (total number of stems and number of fruiting stems/plant, number of pods and seeds/plant, and the average seed weight) were determined on 10 randomly chosen plants/plot. Plant height was also measured on the same day.

Table 1. The origin and classification (according to Higgins *et al.* 1981) of the faba bean cultivars tested in this experiment. The letters in brackets indicate the symbol for each cultivar used in Figs. 1, 2, and 3.

Cultivar		Origin	Var
Polycarpi	(P)	Legume and Forage Crops Institute, Larissa, Greece	*minor*
N. 312	(N)	Laboratory of Plant Breeding University of Thessaloniki, Greece	*equina*
Alto	(A)	University of Dijon, France	*minor*
R.29.T	(R)	INRA, Rennes, France	*minor*
ILB 1814	(I)	ICARDA, Aleppo, Syria	*major*
Chiaro T.L.	(C)	University of Napoli, Italy	*minor*
Troy	(T)	University of Hohenheim, W. Germany	*minor*
Vt-1	(V)	University of Tuscia, Viterbo, Italy	*major*
Gemini	(G)	University of Palermo, Italy	*major*
PAM-1	(PA)	University of Palermo, Italy	*major*
Palacio	(PL)	Superior Technical School of Agronomy, Cordoba, Spain	*equina*
Brucul	(B)	Superior Technical School of Agronomy, Cordoba, Spain.	*equina*

O. crenata inflorescences were counted on the harvested area on 19 June 1986. The results were converted to a per plant basis using the average plant density in each plot.

Results and Discussion

The intensity of broomrape attack, expressed as the number of emerged *O. crenata* inflorescences/plant, varied significantly (P< 0.01) among cultivars (Table 2). Troy was the most susceptible cultivar, whereas Chiaro T.L. was the least susceptible. Troy differed significantly from all the other cultivars, while Chiaro T.L. was significantly inferior even to the second most susceptible cultivar (ILB 1814). The remaining nine cultivars did not differ significantly from each other.

The association between seed yield of the host plants and numbers of emerged *O. crenata* spikes was weak (r = -0.23, p > 0.05). This may be due to the late appearance of the attack, when plants were about to reach the 50% podding stage. In addition, the intensity of attack was poor on the average, i.e., less than one spike/plant, a value which is expected to cause a yield reduction of less than 12.4% (Mesa-Garcia and Garcia-Torres 1984). Thus, the effects of broomrape attack may be masked by other factors responsible for similar or even higher yield variation among plots.

Table 2. Intensity of broomrape attack, expressed on a per plant basis, among the examined cultivars. Each value is the mean of three replicates.

Cultivar	No. of inflorescences/ plant[1]
Troy	1.34a
ILB 1814	0.78b
Gemini	0.63bc
R.29.T	0.62bc
Alto	0.55bc
Vt-1	0.52bc
Palacio	0.47bc
Brucul	0.46bc
PAM-1	0.42bc
Polycarpi	0.38bc
N.312	0.35bc
Chiaro T.L.	0.23c

1. Different letters indicate significant differences at the 5% level of probability according to the Duncan's multiple range test.

Several plant characteristics were correlated with the numbers of emerged *O. crenata* spikes. **Table 3** shows the coefficients of determination of both linear and quadratic regressions obtained between the characteristics and the number of *O. crenata* inflorescences/plant.

Plant height was not correlated with broomrape attack despite the wide range of heights among cultivars (76 to 101 cm) **(Table 3)**. A lack of correlation between stem height and broomrape attack was also noted by Mesa-Garcia and Garcia-Torres (1982). A negative curvilinear relation was detected between total plant dry weight and broomrape attack **(Fig. 1)**. This observation contradicts the findings of Aalders and Pieters (1986, 1987) who noted that broomrape attack is positively correlated with the vigor of the host. Troy, the most heavily attacked cultivar, had the lowest above-ground biomass throughout its life span. The same was true for other cultivars with low biomass production (e.g., R.29.T., N.312). No correlation was found between earliness, expressed either to anthesis or to ripeness and the intensity of attack, although the variation among cultivars was considerable. The time to 50% anthesis ranged between 115 to 131 days, whereas the corresponding range for 50% ripeness (pod darkening) was 166 to 184 days.

Among the yield determinants, the number of stems/plant exhibited the highest quadratic correlation with the number of broomrape spikes/plant **(Fig. 2)**. An equally high coefficient of determination was also found between the number of pod-bearing stems/plant and

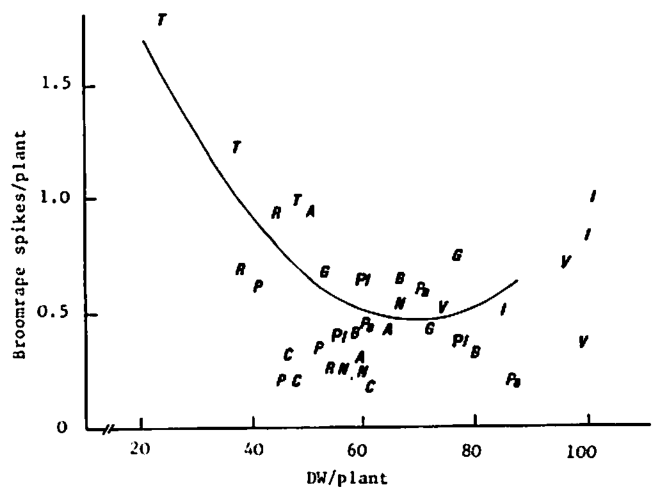


Fig. 1. The relation betweeen the total dry weight/plant and the number of emerged broomrape spikes/plant. The curve indicates the fitted parabolic regression ($Y = 2.91 - 0.07X + 0.0005X^2$; $r^2 = 0.49$). The letters show the points for the different cultivars (see **Table 1**).

the number of broomrape spikes/plant. Considering these correlations, one could ascribe the lower number of *O. crenata* spikes in the more profusely tillering genotypes to the existence of a greater number of seeds/plant, which act as sinks for metabolites and compete with the parasite. This view is also supported by the fact that the number of seeds/plant exhibited a weak but significant negative correlation with the number of spikes (Table 3, and Fig. 3). On the other hand, no significant correlation was found between the average seed weight and the degree of attack. This contradicts the findings of other investigators (Cubero 1973; Cubero and Moreno 1979; Ciccarone and Piglionica 1979). The wide range of the average seed weights in the present experiment (0.29 to 1.71 g), due to the inclusion of *minor*, *equina* and *major* varieties, lead to the conclusion that seed size is of little importance when considering genotype resistance to *O. crenata*.

Table 3. The coefficients of determination (r^2) of both linear and quadratic regressions between various plant growth parameters and the number of broomrape inflorescences/plant.

Independent variable	r^2	
	Linear	Quadratic
Plant height	0.06	0.11
Total plant dry weight	0.06	0.49
Days to 50% anthesis	0.08	0.12
Days to 50% ripening	0.07	0.13
Pods/plant	0.14	0.14
Seeds/plant	0.25*	0.26
Average seed weight	0.08	0.08
Stems/plant	0.05	0.63
Pod bearing stems/plant	0.11	0.57
∫LA anth.-maturity	0.03	0.02
∫LA/yield/plant	0.28*	0.36
∫LA/no. of seed/plant	0.14	0.15

* = $P < 0.05$ in the linear regression only.

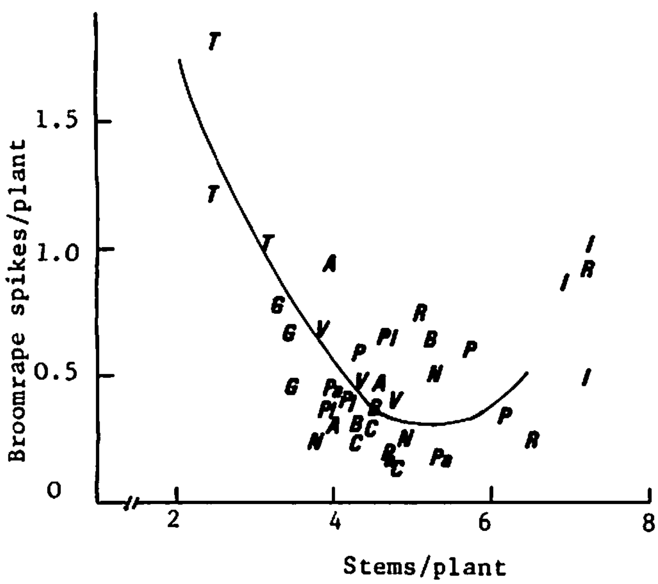


Fig. 2. The relation between the number of stems/plant and the number of broomrape spikes/plant. The line indicates the fitted parabolic regression ($Y = 4-1.41\ X + 0.135X^2$; $r^2 = 0.63$). The letters show the points for different cultivars (see Table 1).

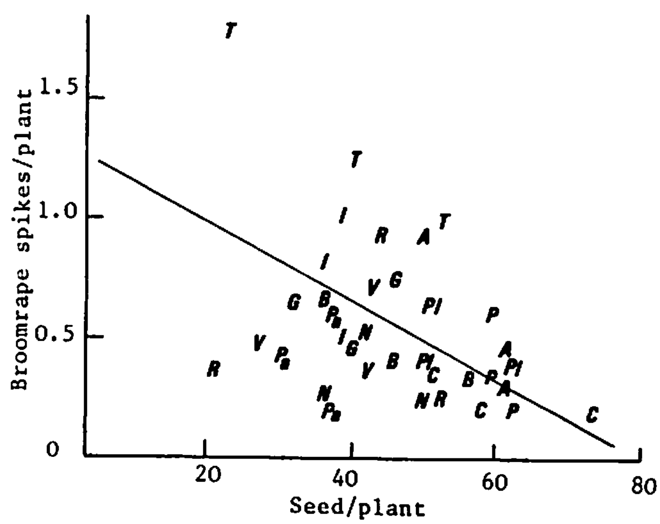


Fig. 3. The relation between the number of seeds/plant and the number of broomrape spikes/plant. The line indicates the fitted linear regression ($Y = 1.25 - 0.015X$; $r^2 = -0.50$; $p < 0.05$). The letters show the points for different cultivars (see Table 1).

The supply of assimilates and water are important to the growth of the parasite (Whitney 1972; Cubero 1983). Special attention has been given to the transfer of sucrose (the main product of current photosynthesis) to the parasite (Aber *et al.* 1983). Given that both fruits and parasites are the main assimilate sinks in fruit-bearing infested plants, an attempt was made to correlate the time integral of the assimilating area from anthesis onwards, as well as the ratios of the assimilating area over the seed yield and seed number/plant with the number of *O. crenata* spikes. The statistically significant positive linear correlation between the time integral of the assimilating area over the seed yield and the number of broomrapes (Table 3) indicates that the greater the amount of photosynthates available to sinks other than the seeds, the greater was the degree of attack.

A correlation of emerged spikes/m^2 of land with crop density was virtually absent ($r = 0.10$, $P > 0.05$). This may be due to the narrow range of densities (17 to 30 plants/m^2) used in this experiment. A negative correlation between crop density and broomrape attack was observed when a wider range of densities (17 to 50 plants/m^2 was used (Pieters and Aalders 1986).

Although no characteristics of the root system were examined, it was concluded that some other plant characteristics could be used as indices of genotype resistance to broomrape attack. Special attention should be given to parameters associated with the use (number of seeds/plant) or the availability of assimilates to the parasites (time integral of post-anthesis leaf area over seed yield). The ability of the plants to produce secondary stems also proved to be quite important.

References

Aalders, A.J.G. and Pieters, R. 1986. Plant vigor as a misleading factor in the search for resistance in broad bean to *Orobanche crenata*. Pages 140-149 *in* Biology and Control of *Orobanche*: Proceedings of a Workshop (Borg, S.J. ter, ed.), LV/VPO, Wageningen, The Netherlands.

Aalders, A.J.G. and Pieters, R. 1987. Resistance in *Vicia faba* to *Orobanche crenata*: true resistance versus hidden susceptibility. Euphytica 36: 227-236.

Aber, M., Fer, A. and Salle, G. 1983. Etude du transfert des substances organiques de l'hote *(Vicia faba)* vers le parasite (*Orobanche crenata* Forsk.). Zeitschrift fuer Pflanzenphysiologie 112: 279-308.

Ciccarone, A. and Piglionica, V. 1979. Attempts to control *Orobanche* in Southern Italy. Pages 87-102 *in* Some Current Research on *Vicia faba* in Western Europe: Proceedings of a Seminar in the EEC Program of Coordination of Research on Plant Proteins (Bond, D.A., Scarascia-Mugnozza and Poulsen, M.H., eds.), 27-29 Apr 1978, Bari, Italy. Commission ofthe European Communities, Luxembourg.

Cubero, J.I. 1973. Resistance to *Orobanche crenata* Forsk. in *Vicia faba* L. Pages 205-217 *in* Proceedings of the European Weed Research Council Symposium on Parasitic Weeds, 11-13 Apr 1973, Malta. Malta University Press, Malta.

Cubero, J.I. 1983. parasitic diseases in *Vicia faba* L. with special reference to broomrape (*Orobanche crenata* Forsk.). Pages 493-521 *in* The Faba Bean (Hebblethwaite, P.D., ed.), Butterworths, London.

Cubero, J.I. and Moreno, M.T. 1979. Agronomic control and sources of resistance in *Vicia faba* to *Orobanche* sp. Pages 41-80 *in* Some Current Research on *Vicia faba* in Western Europe: Proceedings of a Seminar in the EEC Program of Coordination of Research on Plant Proteins (Bond, D.A., Scarascia-Mugnozza and Poulsen, M.H., eds.), 27-29 Apr 1978, Bari, Italy. Commission of the European Communities, Luxembourg.

Kadry, A.R., Omar, A.A. and Salama, S.A. 1959. A study on the effect of parasitism of *Orobanche* sp. on some agronomic characters of *Vicia faba* L. Annals of Agriculture Science, Cairo 4: 73-78.

Kittlitz, von E., Kries, von A., Meier, U., Stuetpnagel, R. and Wittstock, I.M. 1984. Entwicklungsstadien der Fababohne. Biologische Bundesanstalt fuer Land- und Forstwirtschaft Merkblatt 27(10): 1-11.

Mesa-Garcia, J. and Garcia-Torres, L. 1982. Broomrape-faba bean competition. FABIS Newsletter No. 4: 36-38.

Mesa-Garcia, J. and Garcia-Torres, L. 1984. A competition index for *Orobanche crenata* Forsk. effects on broad bean (*Vicia faba* L.). Weed Research 24: 379-382.

Nassib, A.M., Ibrahim, A.A. and Khalil, A.S. 1982. Breeding for resistance to *Orobanche*. Pages 119-206 *in* Faba Bean Improvement: Proceedings of the Faba Bean Conference (Hawtin, G. and Webb, C., eds.), ICARDA/IFAD Nile Valley Project, 7-11 Mar 1981, Cairo, Egypt. Martinus Nijhoff Publishers, The Hague, The Netherlands.

Pieters, R. and Aalders, A.J.G. 1986. The effect of *Vicia faba* sowing density on broomrape attack. FAO Plant Protection Bulletin 34: 209-211.

Ponce de Leon, J.L., Royo, A. and Cubero, J.I. 1974. El jopo de las habas (*Orobanche crenata* Forsk.): estructura y biologia de las poblaciones del parasito. Anales Instituto Nacional de

Investigaciones Agronomicas 4: 213-237.

Sauerborn, J. and Saxena, M.C. 1986. A review on agronomy in relation to *Orobanche* problems in faba bean (*Vicia faba* L.). Pages 160-165 *in* Biology and Control of *Orobanche*: Proceedings of a Workshop (Borg, S.J. ter, ed.). LV/VPO, Wageningen, The Netherlands.

Stuelpnagel, R. 1984. Proposal of a growth stages key for *Vicia faba*. Pages 9-14 *in Vicia faba*: Agronomy, Physiology and Breeding: Proceedings of a Seminar in the CEC Program of Coordination of Research on Plant Protein Improvement (Hebblethwaite, P.D., Dawkins, T.C.K., Heath, M.C. and Lockwood, G., eds.), 14-16 Sept 1983, University of Nottingham, United Kingdom. Martinus Nijhoff/Dr W. Junk Publishers, The Hague, The Netherlands.

Whitney, P.J. 1972. The carbohydrate and water balance of beans (*Vicia faba* L.) attacked by broomrape (*Orobanche crenata*). Annals of Applied Biology 70: 59-66.

Zahran, M.K. 1982. Weed and *Orobanche* control in Egypt. Pages 191-198 in Faba Bean Improvement: Proceedings of the Faba Bean Conference (Hawtin, G. and Webb, C., eds.), ICARDA/IFAD Nile Valley Project, 7-11 Mar 1981, Cairo, Egypt. Martinus Nijhoff Publishers, The Hague, The Netherlands.

الخصائص النباتية لأصناف الفول (*Vicia faba L.*) المرافِقة للإصابة بالهالوك المفرْض (*Orobanche crenata*) في حقل مصاب طبيعيا

ملخص

دُرِست الخصائص النباتية والمحصولية لاثني عشر صنفا من الفول (*Vicia faba L.*)، من حيث الإصابة بالهالوك المفرْض (*Orobanche crenata Forsk.*) في حقل مصاب طبيعيا. وقد اختلف عدد نورات الهالوك على النبات الواحد بصورة معنوية بين الأصناف، مما يشير إلى وجود درجات متفاوتة من الحساسية له. وقد أدى ظهور هذا النبات الطفيلي في وقت متأخر(منتصف طور تشكل القرون) إلى اعتبارمعظم الخصائص كمتغيرات مستقلة فيما يتعلق بدرجة الإصابة. وأبدت خصائص عدد الفروع رالبذور/ النبات، فضلا عن وزن النبات الجاف الإجمالي، أعلى قيم ارتباط سالب بدرجة الإصابة. علاوة على ذلك، أظهرت نسبة مساحة الورقة باكملها بعد تفتح الأزهار على الغلة البذرية، المستخدَمة كدليل على وجود السوائغ assimilates للطفيليات، قيمَ ارتباط موجب عالٍ بالإصابة بالهالوك. وفي معظم الأحوال تم التعبير عن الخصائص النباتية والإصابة بالهالوك بشكل أفضل بواسطة قيم انحدار مكافئي أكثر مما هو خطي.

Vicia faba Lines Resistant to the Giant Race of Stem Nematode (Ditylenchus dipsaci (Kuehn) Fil.)

G. Caubel and D. Leclercq
Institut National de la Recherche Agronomique,
BP 29,
35650 Le Rheu,
FRANCE

Abstract

Laboratory tests are useful for detecting resistance to the stem nematode in *Vicia faba*. Two criteria, namely plant symptoms and multiplication rate of nematodes, were used to classify several lines and cultivars from ICARDA and INRA for their reactions to the giant race of stem nematode (*Ditylenchus dipsaci*). Plant tissues swelled from the third week after inoculation, and scoring for symptoms was easy between 4 and 6 weeks. The percentages of swollen plants varied from 0 to 100%, depending on plant material. Large differences in multiplication rates also occurred. Good correlation was observed between these two criteria. Of the material tested, line INRA 29 H proved resistant to *D. dipsaci*, whereas ICARDA lines BPL 1696 and 1827, as well as FLIP 84-154 and 84-186 showed an intermediate level of resistance.

Introduction

Genes resistant to stem nematode are known in several important crops such as lucerne, oats, red and white clovers. Only a few studies have been conducted in *Vicia faba*. Sturhan (1975) reported the existence of several faba bean lines with low multiplication rates of some stem nematode populations. Ait Ighil (1983) found resistance in some lines from ICARDA and INRA. Hanounik *et al.* (1986) screened 200 ICARDA lines by scoring swollen plants and indicated that 12 lines were less infected and swollen, but did not give details on the abundance of *Ditylenchus dipsaci* in these plants. It is essential to assess both plant symptoms and nematode multiplication because the effect of the host on nematode reproduction is an important criterion for resistance. The purpose of this study was to investigate potential sources of resistance to the giant race of stem nematode using plant symptoms as well as nematode multiplication rate.

Materials and Methods

Seven different experiments, designated A to G, were conducted using lines and cultivars of faba bean listed in Table 1.

Preliminary tests showed that some cultivars, such as Diana and Ad 23 F, allowed multiplication of the nematode while others, like INRA 29 H, proved resistant. The latter was used as a control in some tests.

Stem nematodes were reared on *Vicia faba* plants and maintained in dry tissues in the laboratory. Suspensions with the second-stage larvae of the giant race were prepared from these tissues. The experiments were carried out under controlled conditions in a greenhouse or growth chamber at temperatures between 15 to 25°C. The young plants were inoculated individually with a small droplet of water containing 100 to 300 active nematodes. The rate of multiplication was assessed by extracting nematodes from the plants and counting them in aliquots.

Results and Discussion

The artificial inoculation of *Vicia faba* was easily achieved under laboratory conditions as the percentage of plants remaining free of nematodes was very low two months after inoculation (Table 2).

The percentages of plants remaining free of nematodes were higher in the accessions BPL 1698, BPL 1827 and INRA 29 H, and thus were resistant to nematode. Swelling, the typical symptom induced by the giant race of *D. dipsaci*, occurred on infested plants, sometimes only three weeks after inoculation. However, swollen plants were easily observed four weeks after

Table 2. Percentages of plants without nematodes about two months after inoculation.

	Tests			
Cultivar	**A**	**B**	**C**	**D**
Ad 23 F				0
Ascott			2	
BPL 538			2	
BPL 628				0
BPL 1682				7
BPL 1698				14
BPL 1827				17
Diana	0	0		
INRA 29 H	9	10	9	10

Table 1. List of accessions of *Vicia faba* tested for resistance to *D. dipsaci* in different tests.

Accession	Test	Pedigree	Origin
1. Ad 23 F	D,F,G	Pure line	France (F)
2. Alfred	F	Synthetic	Commercial (F)
3. Ascott	C	Synthetic	Commercial (F)
4. BPL 538	C	Pure line	ICARDA
5. BPL 628	D	Pure line	ICARDA
6. BPL 1682	D	Pure line	ICARDA
7. BPL 1698	D	Pure line	ICARDA
8. BPL 1827	D	Pure line	ICARDA
9. Diana	A,B,G	Synthetic	Commercial (F)
10. FLIP 83-42	E	Breeding material	ICARDA
11. FLIP 84-154	E	Breeding material	ICARDA
12. FLIP 84-162	E	Breeding material	ICARDA
13. FLIP 84-186	E	Breeding material	ICARDA
14. FLIP 84-213	E	Breeding material	ICARDA
15. FLIP 84-216	E	Breeding material	ICARDA
16. INRA 29 H	A,B,C	Pure line	INRA (F)

inoculation, and became particularly clear after six or eight weeks (Fig. 1). The percentages of swollen plants varied with the lines and cultivars tested (Table 3).

Three groups of lines with low, high, or intermediate numbers of swollen plants were observed. The multiplication rate of nematodes in plant tissues strongly varied among lines, with a mean of 60 nematodes/plant in INRA 29 H, to about 45000 in Ad 23 F. Only few lines showed an intermediate multiplication rate. The two criteria used to assess resistance, i.e., percentages of swollen plants and nematode counts, were well correlated. Three groups of accessions could be distinguished when the percentages of swollen plants were plotted against final nematode populations (Fig. 2).

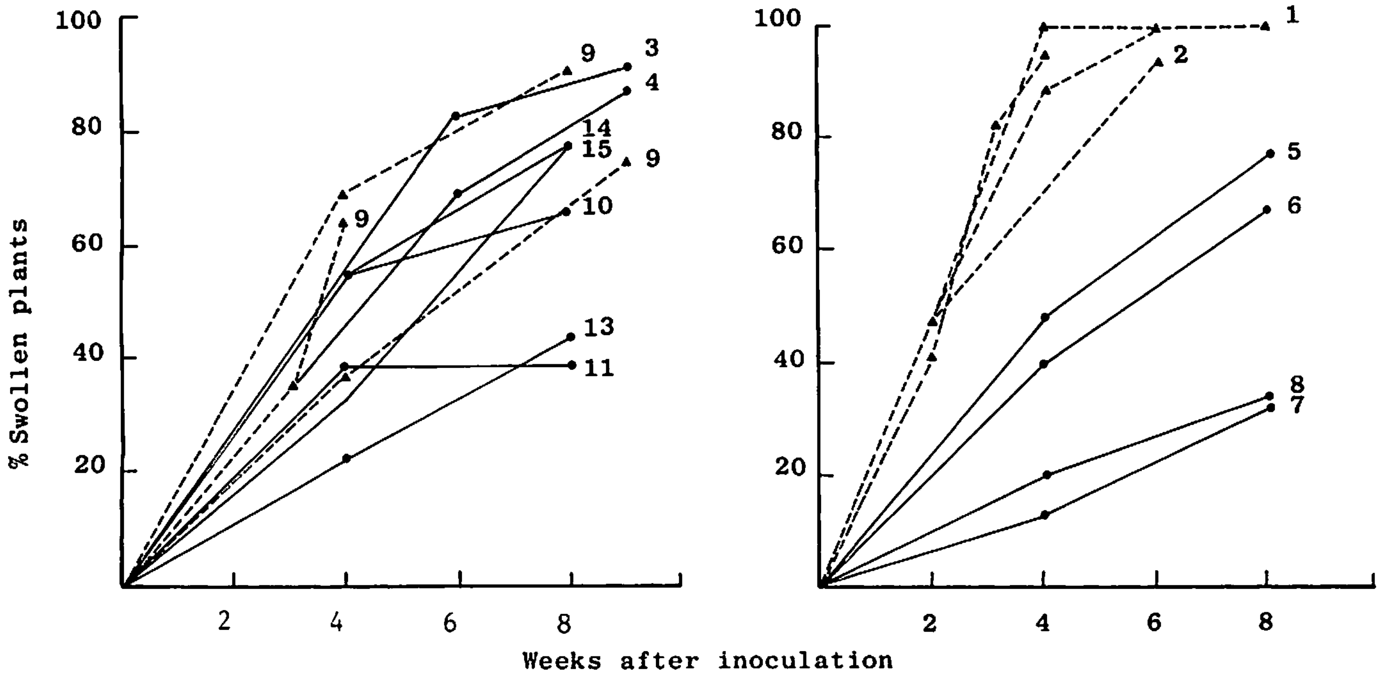


Fig. 1. Evolution of the percentages of swollen plants 2 to 9 weeks after artificial inoculation in different accessions of faba bean; see Table 1 for details on accessions.

Table 3. Percentages of swollen plants and final mean population of stem nematode in different lines of *V. faba* about two months after inoculation.

Line* no.	Test	Number of plants	Swollen plants (%)	Mean number of nematodes/plant
1	D	28	100	45330
4	C	80	93	10980
3	C	79	92	37890
9	A	57	92	44500
5	D	30	77	14460
9	B	122	74	9420
6	D	27	67	30780
7	D	30	33	1550
8	D	28	32	3380
16	A	63	0	1300
16	B	120	0	60
16	C	45	0	70
16	D	30	0	70

* See Table 1 for details on different lines.

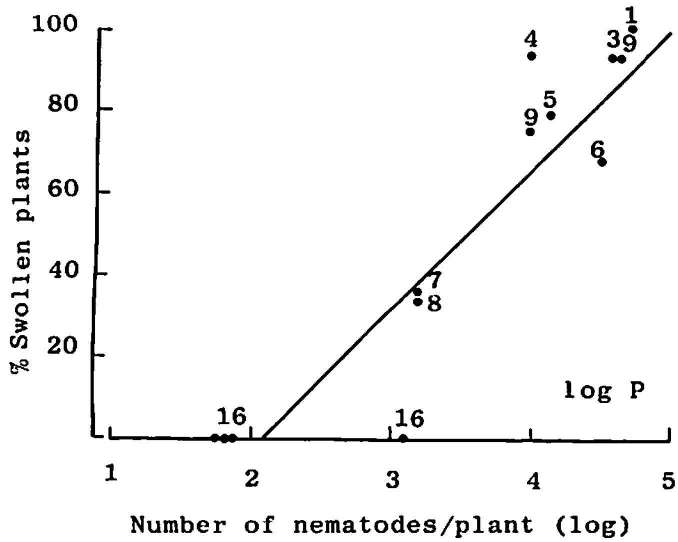


Fig. 2. Relation between percentages of swollen plants and mean number of nematodes/plant in different accessions of faba bean; see Table 1 for details on accessions.

Because resistance is the result of the interaction between plant and nematode, it was essential in this study to consider the reactions exhibited by faba bean plants. Responses within a line were not similar and percentages of swollen plants varied greatly for the same accession. Final nematode populations observed in plants differed strongly depending on the genotype. These responses were reproducible in different experiments.

Line INRA 29 H, which is resistant to *Ascochyta fabae* (Tivoli *et al.* 1987) showed a high level of resistance to stem nematode. Preliminary results also suggest that narbon vetch (*Vicia narbonensis*), which is resistant to *Botrytis fabae*, is also resistant to *D. dipsaci* (Caubel, unpublished).

It can be concluded from the results of this study that both the rates of nematode multiplication and percentages of swollen plants should be considered in screening for resistance to stem nematode with artificial inoculation under controlled conditions. It will also be desirable to test the level of resistance of the laboratory-selected lines under field conditions.

Acknowledgment

The authors wish to thank Drs M.C. Saxena (ICARDA), J. Leguen and B. Berthelem (INRA - Le Rheu) for providing the seeds used in this study.

References

Ait Ighil, M. 1983. Variabilite physiologique de deux races, normale et geante, de *Ditylenchus dipsaci* (Kuehn, Fil.) parasites de *Vicia faba* L. These Ingenieur-Docteur - ENSA, Rennes, France. 106 pp.

Caubel, G. 1984. Nematodes des proteagineux. Journee Nationale sur les Proteagineux (Paris): 218-223.

Hanounik, S.B., Halila, H. and Harrabi, M. 1986. Resistance in *Vicia faba* to stem nematodes *Ditylenchus dipsaci*). FABIS Newsletter No. 16: 37-39.

Sturhan, D. 1975. Untersuchung von *Vicia faba* Sorten auf Resistenz gegenueber strengelaelchen (*Ditylenchus dipsaci*). Mededelingen van de Faculteit Landbouarwetenschappen Rijksuniversiteit Gent 40: 443-450.

Tivoli, B., Reynaud, B., Maurin, N., Berthelem, P., and Le Guen, J. 1987. Comparison of some methods for evaluation of reaction of different faba bean genotypes to *Ascochyta fabae*. FABIS Newsletter No. 17: 35-38.

سلالات فول مقاومة للسلالة العملاقة من نيماتودا الساق (*Ditylenchus dipsaci* (Kuehn) Fil.)

ملخص

تعتبر الاختبارات المخبرية مفيدة في الكشف عن مقاومة الفول لنيماتودا الساق. وبغية تصنيف عدة سلالات وأصناف فول من ايكاردا و INRA من حيث تفاعلها مع السلالة العملاقة من تلك الآفة، استخدم معياران هما: الأعراض النباتية، ومعدل تكاثر الآفة. وقد انتفخت الأنسجة النباتية المصابة بدءا من الأسبوع الثالث من العدوى، وكان تسجيل درجات الأعراض سهلا بين الأسبوعين الرابع والسادس. وتراوحت النسب المئوية للنباتات المنتفخة من 0 إلى 100 ٪ بحسب نوع النبات، كما ظهرت فروق كبيرة في معدلات التكاثر. ولوحظ ارتباط جيد بين هذين المعيارين. ومن بين الأصول الوراثية المختبرة، أثبتت السلالة INRA 29 H مقاومتها لتلك الآفة، في حين أظهرت السلالات الواردة من ايكاردا: BPL 1696,1827 وكذلك FLIP 84-154,84-186 مستوى متوسطا من المقاومة.

Contributors' Style Guide

Policy

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

Style

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

Disclaimers

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

Manuscript

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

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

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

Examples of common expressions and abbreviations

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

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

References

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

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

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

Submission of articles

Contributions should be sent to FABIS, ICARDA, P.O. Box 5466, Aleppo, Syria.

NEWS

أخبار

Forthcoming Events

أحداث مرتقبة

Third International Seed Technology Course and Workshop

This course will be given at the National Institute of Agricultural Botany, Cambridge, UK, 2-13 July 1990. The course will be divided into two parts. The first will be allocated to seed certification and the second to seed testing. A third optional part that deals with seed pathology or tetrazolium testing procedures will be offered after the completion of the first two. Proficiency in English is required. A certificate of attendance will be presented to those delegates who complete the course.

For more information write to:

P.T. Nelson
National Institute for Agricultural Botany
Huntingdon Road
Cambridge, UK

Fax: 44 223 277707; Telex 817455 NIAB G.

Statistics in Agricultural Climatology

This course will be given at the University of Reading, Whiteknight, UK, 11-19 July 1990. The broad aim of this course is to provide a foundation for using statistical climatology in operational situations to help improve and stabilize agricultural production.

For further information write to:

Mrs Alison Ansell
Statistical Services Center,
Department of Applied Statistics,
University of Reading,
Whiteknights, P.O. Box 217,
Reading RG6 2AN, UK

Fax: Reading (0734) 314404
Telex: 847813 A/B RULIB G
(marked CENTER APPSTAT).

Course on Training of Trainers for Agricultural and Rural Development

The course, organized by the University of Illinois International Program for Agricultural Knowledge Systems (INTERPAKS), will be held 4-29 June 1990 at the University of Illinois, USA. The short course is designed to provide participants with an opportunity to strengthen their competencies to design and implement training programs for staff and clientele in a variety of organizational settings. The focus will be on the process which supports participants' subject matter concerns. It is expected that the course will enable participants abilities to do the following:

1. Understand the nature of effective training to help staff members to perform better;
2. Use innovative teaching methods for groups and individuals;
3. Develop course outlines and lesson plans;
4. Prepare printed and audiovisual teaching aids and materials.

The four-week course is designed specifically for the following people: i) training directors of agricultural extension and national and international research organizations, ii) principals, head masters, and senior trainers of extension training institutes, iii) training scientists at international agricultural research centers, and iv) teachers of adult or extension education at colleges and universities. Certificates will be awarded to participants who successfully complete the course.

For participation, apply by letter, telex, or cable to:

John W. Santas
Training Officer, INTERPAKS
University of Illinoise
113 Mumford Hall
1301 West Gregory Drive
Urbana, Illinoise 61801 USA

Telex: 206957: Cable: INTSOY.

International Course on Plant Protection

The course, organized by the International Agricultural Center in collaboration with several departments of the Agricultural University at Wageningen, Research Institutes, Experimental Stations, and the Protection Service, will be held 16 April-27 July 1990 at Wageningen, The Netherlands. The course intends to update the knowledge of the participants and to provide information and skills on an integrated approach of pest, disease, and weed management. It has been designed for university-trained plant protection and advisory officers who are engaged in advising farmers on all aspects of plant protection, as well as for lecturers in general plant protection at agricultural colleges, and those engaged in applied plant protection research. Participants should hold a B.Sc. degree or equivalent in agriculture or biology with at least a 3-year experience in plant protection or closely related subjects.

For application write to:

The Director,
International Agricultural Center (IAC),
P.O. Box 88, 6700 AB Wageningen,
The Netherlands

Fax: 08370 18552; Telex: 54888 INTAS NL.

Legumes in Cropping Systems of the Tropics and Subtropics

The course will be held in summer 1990, Stuttgart, Germany. The primary objective of the course is to discuss the principles of legumes and point out the issues, benefits and possibilities of their integration into tropical or subtropical cropping systems. Minimum requirements for application are: A university degree or equivalent in Agriculture and, as the course is conducted in English, proficiency in English.

For additional information write to:

The course coordinator
Centre for Agriculture in the Tropics & Subtropics
University of Hohenheim
P.O. Box 70 05 62
7000 Stuttgart
Federal Republic of Germany

Telex: 72 29 50; Fax: 711/45 92 785

Statistics in Agriculture

This course will be given at the University of Reading, Whiteknight, UK, 11-19 July 1990, with the aim to review the most widely-used techniques for agricultural applications, starting from basics but moving quickly to matters of real professional interest. Participants will be introduced to the use of computers for data management and analysis. Methods of collecting agricultural data are considered critically, and appropriate data management and statistical techniques to analyze such data are explained. Practical assistance will be offered with the special problems faced in developing countries. There are no formal qualifications for entry to the course. A certificate of attendance will be provided, but the course itself does not provide an academic qualification.

For further information write to:

Mrs Alison Ansell
Statistical Services Center,
Department of Applied Statistics,
University of Reading,
Whiteknights, P.O. Box 217,
Reading RG6 2AN, UK

Fax: Reading (0734) 314404
Telex: 847813 A/B RULIB G
(marked CENTER APPSTAT).

International Conference on Genetic Engineering and Biotechnology

The conference, organized by the Nepal Biotechnology Association (NBA), will be held in Kathmandu, Nepal, 9-13 Sept 1990, with the aim to create awareness about genetic engineering and biotechnology and to provide Nepalese scientists the opportunity to interact with scientists working in various areas of biotechnology. There will be invited speakers, contributed papers, as well as poster sessions.

For more information write to:

Secretary General
ICGEB Conference Organizing Committee
NBA
P.O. Box 2128
Kathmandu, Nepal

Telex: 2492 MURARKA NP; Cable: RLABB, Kathmandu
Tel. 977-1-522-900.

Second International Food Legume Research Conference
12 - 16 April 1992, Cairo, Egypt

The First International Food Legume Research Conference (IFLRC-I) on pea (*pisum sativum*), lentil (*Lens culinaris*), faba bean (*Vicia faba*), and chickpea (*Cicer arietinum*) was held at Spokane, Washington, U.S.A. in 1986. It was a resounding success with over 500 registrants from 50 countries. The program consisted of 91 papers coauthored by 202 contributors from 40 countries. The Conference Proceedings was published as: Summerfield, R.J. (ed.). World Crops: Cool Season Food Legumes. 1988. Kluwer Academic Publishers, Dordecht, The Netherlands.

The success of IFLRC-I has prompted development of the Second International Food Legume Research Conference (IFLRC II) on 1992 in Cairo, Egypt. Recent success in development of low neurotoxin lines of grass pea (*Lathyrus sativus*) has resulted in the addition of this promising cool seasean food legume to the list of species covered.

The objectives of IFLRC-II are to 1) review and assess recent results from national and international research programs on cool season food legumes and 2) develop strategies for increasing production per unit area and increasing use of these cool season food legumes in various cropping systems. Both basic and applied research will be addressed and multidisiplinary research efforts will be emphasized.

The organizing committee is developing the program and details will be available in the Second Announcement. The primary function of this First Announcement is to alert everyone to the time and date so they can make plans to attend. In addition the organizing committee wishes to develop an updated mailing list of interested food legume researchers and those involved in technology transfer of these research results.

For further information regarding reservation for 1992 IFLRC-II, Cairo, Egypt, please contact:

Dr. A.E. Slinkard
Crop Development Centre
University of Saskatchewan
Saskatoon
Saskatchewan, S7N OWO
Canada

Editors' Note

FABIS Newsletter has published many articles which use data from a variety trial grown at only one location and in one year. The data are usually analyzed for genetic and phenotypic variation, heritability, genetic advance and correlations between characters. We, the Editors, feel that there is little merit in adding to the literature more articles of this type. To this end we will only consider publishing articles which discuss the results of a variety trial sown in a single environment under exceptional circumstances (i.e. when the number of entries or genetic diversity is particularly high or when an unusual trait is discussed).

Need More Information ?

للمزيد من المعلومات

Need More Information on ICARDA Publications and Services ?

Free Catalog of ICARDA Publications
Request your list of all currently available publications from the Communication, Documentation and Information Unit (CODI).

ICARDA Information Brochure
ICARDA's historical background and research objectives are outlined in English and Arabic. For your copy, contact CODI

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

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

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

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

Field Guide to Major Insect Pests of Wheat and Barley (Arabic)
This field guide in Arabic covers fungal, bacterial, viral, and physiological diseases, as well as insects and nematodes, that attack wheat and barley crops in the Middle East and North Africa. Forty-four insects and diseases are discussed and illustrated with 72 color photos. For your copy, write Cereals Improvement Program.

Introduction to Food Legume Physiology
This comprehensive 105-page technical manual is designed for food legume scientists and their support staff. It covers several areas of food legume physiology in a practical way, with examples whenever possible. The book contains four chapters covering the following: plant structure and physiological functions; mineral nutrition; photoperiodism, vernalization, crop canopy and radiation, and growth analysis; and physiology and crop improvement. For your copy, write Training Coordination Unit.

ICARDA's Food Legume Improvement Program
In English and Arabic, the 24-page illustrated information brochure briefly describes research projects on lentil, faba bean, and chickpea treated either as single crops or as a group. For your copy, write FLIP.

Screening Chickpeas for Resistance to Ascochyta Blight A Slide-tape Audio-tutorial Module
This slide-tape audio-tutorial module is the first in the food legume training series. It is designed for the use of legume trainees during the training courses at ICARDA as well as for scientists and their support staff in the various national programs. This module is

also useful educational material for universities and training departments in national research systems. For your copy of this publication or package, write Training Coordination Unit.

Checklist of Journal Articles from ICARDA 1978 - 1987
This checklist, compiled to bring information to the attention of the scientific community, consists of references of articles by ICARDA research scientists submitted to refereed scientific journals as of 1978. Each reference includes within year of publication: author, primary title, volume number, issue number, pagination, language code of the article and/or summary when necessary, and AGRIS reference number. For your copy write CODI.

Opportunities for Field Research at ICARDA
This brochure is intended primarily to assist Master of Science candidates, who are enrolled at national universities within ICARDA region and selected for the Graduate Research Training Program. It explains to them the opportunity they have to conduct their thesis research work at ICARDA research sites under the supervision of distinguished international scientists. For your copy, write GRI Program, Training Coordination Unit.

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, write Training Coordination Unit.

TO OBTAIN PUBLICATIONS:
Address requests for publications to the specific department or service cited above, at: ICARDA, P.O. Box 5466, Aleppo, Syria.

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

Mailing List

We are having many items of correspondence returned, due to those on our mailing list having changed their addresses or left their place of employment without notifying us. Obviously this represents a considerable waste of money to the FABIS service.

We request that those who currently receive FABIS should inform us of any change in their address or position in good time to allow us to maintain an efficient service.

ARE YOU MOVING ?

If you are moving, please let us know your new address as soon as possible.
Send it to:

FABIS
ICARDA
Box 5466
Aleppo, Syria

MAJOR FABA BEAN PRODUCING COUNTRIES

Area, yield, and production of faba bean (*Vicia faba* L.) in the major faba bean producing countries ranked on 1987 production.

Country	Area (1000 ha)					Yield (kg/ha)					Production (1000 MT)				
	1979-81	1982-84	1985	1986	1987	1979-81	1982-84	1985	1986	1987	1979-81	1982-84	1985	1986	1987
China	2267	1855	1700	1700	1700	1162	1315	1353	1353	1362	2633	2438	2300	2300	2316
Egypt	103	126	140	140	136	2135	2291	2193	2214	3666	219	288	307	310	499
Ethiopia	328	354	350	350	360	1453	1328	1429	1429	1333	476	472	500	500	480
Germany FR	5	7	14	28	54	3224	3390	3872	3838	3617	15	23	55	106	195
Italy	161	148	136	134	120	1277	1268	1327	1331	1290	205	125	180	179	156
France	23	58	40	41	37	3070	3034	3283	2976	3750	70	176	130	122	138
Morocco	165	150	212	159	211	589	813	916	1264	603	97	122	194	201	127
Turkey	30	41	42	44	44	1751	1816	1738	1818	1818	53	73	73	80	80
Australia	11	16	17	19	38	533	604	639	1526	1816	6	10	11	29	69
Spain	79	52	52	50	49	992	984	1158	1040	1265	78	118	61	52	62
Sudan	15	16	18	20	30	2521	2236	1944	2000	1667	38	34	35	40	50
The Netherlands			2	6	10			4749	5175	4712			12	30	48
Brazil	146	122	142	142	142	278	307	317	317	317	41	38	45	45	45
Mexico	35	32	30	30	30	1771	1348	1333	1333	1333	62	42	40	40	40
Algeria	46	48	70	78	75	594	470	357	449	533	27	23	25	35	40
Tunisia	69	64	83	48	50	682	786	512	604	694	47	50	43	29	35
Czechoslovakia	39	19	14	14	13	1641	1833	2080	1453	2257	64	33	28	21	30
Peru	23	24	32	27	32	911	934	936	943	938	21	22	30	25	30
Canada		17	19	25	25		792	789	800	800		14	15	20	20
Portugal	36	31	23	26	24	586	614	709	635	779	21	20	17	17	19

Source: FAO Production Yearbooks.

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

Region	Area (1000 ha)					Yield (kg/ha)					Production (1000 MT)				
	1979-81	1982-84	1985	1986	1987	1979-81	1982-84	1985	1986	1987	1979-81	1982-84	1985	1986	1987
Africa	733	765	882	804	872	1245	1303	1262	1398	1423	913	996	1113	1124	1241
North Central America	63	81	84	90	88	1244	940	987	977	952	79	76	83	88	84
South America	200	176	201	198	208	459	539	540	549	537	92	94	109	109	112
Asia	2319	1912	1758	1763	1764	1172	1328	1362	1366	1374	2717	2538	2394	2408	2425
Europe	354	332	294	310	318	1751	1574	1727	1778	2111	477	474	507	551	572
World total	3680	3282	3235	3182	3288	1164	1292	1303	1349	1400	4283	4237	4216	4291	4603

Source: FAO Production Yearbooks.

تعليمات النشر باللغة العربية

سياسة النشر :

تهدف هذه النشرة العلمية الى نشر نتائج البحوث الجديدة بالسرعة الممكنة . والغاية من هذه التعليمات مساعدة الباحثين على صياغة بحوثهم بالشكل الذى يسهل تبادل المعلومات فيما بينهم على اختلاف أمصارهم ومشاربهم العلمية . وهذه المطبوعة تعني بنشر الاوراق العلمية والبحوث المختصرة والمقالات المكتوبة بلغة واضحة واسلوب علمي . والمطبوعة بمسافات مزدوجة بين السطور على ورق أطواله 21 x 28 سم على وجه واحد فقط . ترسل نسخة أصلية عن البحث وتعنون جميع المراسلات الى عنوان النشرة . ويشترط في المادة المرسلة للنشر الا تقدم الى أى جهة أخرى . ولا تعبر نتائج البحوث المنشورة الا عن وجهة نظر أصحابها . كما أن استعمال الاسماء التجارية لا يعني بالضرورة أن ايكاردا تحبذ استعمال أى من هذه المنتجات مقارنة بمثيلاتها التجارية .

منهج الكتابة :

تكتب وترتب البحوث بالشكل التالي : 1) عنوان مناسب لا يزيد على 70 حرفا ، يليه اسم وعنوان الباحث/ الباحثين . 2) ملخص بالعربية يتألف من فقرة واحدة لا تزيد على 200 كلمة توجز العمل ، والنتائج المتوصل اليها ، بأقصر وأوضح طريقة ممكنة . 3) مقدمة وتبرز أهمية موضوع البحث وتستعرض بشكل نقدى الاعمال والبحوث السابقة المتعلقة بذلك . 4) المواد والطرق وتشمل المعلومات الخاصة بموقع تنفيذ التجربة ، والمواد والطرق المستعملة ، مع تحديد تصميم التجربة المتبع . 5) النتائج والمناقشة وتظهر المعلومات والبيانات التي حصل عليها الباحث ، ومدى أهميتها . 6) التوصيات ان وجدت فتكتب بفقرات محددة ومرقمة . 7) كلمة الشكر عند اللزوم . 8) ملخص بالانكليزية مترجم عن العربية بأسلوب علمي ينسجم مع روح اللغة الانكليزية . 9) المراجع ويتم العزو اليها في النص بكتابة كنية المؤلف وعام النشر بين قوسين ، واذا كان للمرجع أكثر من ثلاثة مؤلفين تكتب كنية الاول وتضاف اليها كلمة "وآخرون " اذا كان المرجع بالعربية أو et al. اذا كان المرجع بالاجنبية . أما عن ترتيب المراجع في نهاية المطبوعة فيتم هجائيا وبصورة مستقلة لكل من المراجع العربية والاجنبية . تستثنى المقالات من الترتيب السابق : مقدمة ومواد وطرق ... انما يكتفى بوضع ملخص لها بالعربية وآخر بالانكليزية ، يضاف الى ذلك ضرورة تقسيمها الى فقرات تحمل كل منها عنوانا مناسبا . وينصح هنا بالرجوع الى آخر أعداد هذه النشرة للتعرف الى طريقة اعداد المخطوطة وترتيب المراجع .

الجداول والاشكال والصور :

تفضل الجداول الصغيرة على الكبيرة ، والبسيطة على المعقدة . ويجب أن يحمل كل جدول رقما معينا حسب وروده في النص ، مع عنوان مناسب . وتستعمل الصور (الابيض والاسود فقط) والاشكال والرسوم الاصلية وليس صورا عنها ، على أن تكون في عمود واحد (8.6 سم) أو عمودين (17.7 سم) ويشار الى مكانها المناسب في النص ، ويراعى فيها أن تكون واضحة المعالم ، وتحمل عنوانا وأرقاما متسلسلة حسب ورودها في البحث .

الارقام ووحدات القياس :

تستعمل في جميع مطبوعات ايكاردا الارقام العربية Arabic figures (1 ، 2 ، 3 ، ..... 9) ، ووحدات القياس الدولية SI Units مثل : طن/هـ ، كغ ، غ ، م ، كم ، مم ، م2 .

الاختصارات والرموز :

5 غ ، 325 مم ، 300 م2 ، عام 1983 ، موسم 89/1988، موسما 1987-1989 ، مواسم 1986 - 1989 ، 20 م2 ، الجدول 1 ، الشكل 5 ، الفاو (منظمة الاغذية والزراعة) ، ف م ع (الفرق المعوَّل عليه LSD) .

ICARDA publications deposited at AGRICULTURAL libraries

ICARDA is inviting many of the AGRICULTURAL libraries to accept all its publications in English and French and to make these available to other libraries under normal inter-library loan and photocopy procedures.

Libraries that have accepted to do so are listed here:

Libraries Division
Agriculture Canada
Ottawa K1A 0C5
CANADA

Telex 533283 canagric ott

Library
Agricultural University
Postbus 9100
6700 HA Wageningen
NETHERLANDS

Telex 45015 blhwg nl

Helsinki University
Library of Agriculture
Viikki
SF-00710 Helsinki
FINLAND

Telex 122 352 hymk sf
Telefax (90)708 5011

John Hjeltnes
Head Librarian
The Library of the Agricultural University of Norway
P.O. Box 12
N-1432 Aas-NLH
NORWAY

Telex (56) 77125 nlhbi n

J-F. Giovannetti
Chef du Service Central IST
Avenue du Val de Montferrand
BP 5035
34032 Montpellier Cedex
FRANCE

Telex 480 762f

اعلان الى العلماء والباحثين العرب الكرام

يسر المركز الدولي للبحوث الزراعية في المناطق الجافة (ايكاردا) ، اعلامكم بان مركز بحوث التنمية الدولية (IDRC) في أوتاوا بكندا ، قد وافق على تقديم دعم مالي لمشروع فابس FABIS مدته ثلاث سنوات اعتبارا من بداية عام 1987 ولغاية 1989 ، علما بان ادراج اللغة العربية ضمن النشره الاخباريه للفول يشكل أحد أهم أهداف هذا المشروع .

وبمزيد من السرور تعلن اسرة تحرير " FABIS " للباحثين العرب العاملين في مجال تحسين محصول الفول أنها تصدر نشرتها العلمية باللغتين العربية والانكليزية . لذا فيرجى من الاخوة العلماء الراغبين في نشر بحوثهم باللغة العربية التفضل بارسالها الى العنوان التالي : نشرة " فابس " ، ايكاردا ــ قسم التوثيق ، ص.ب. 5466 حلب ــ سورية .

ملاحظة :

تتم كتابة البحث بلغة عربية واضحة ، وفق الترتيب التالي :

1) الملخص ويكتب باللغتين العربيه والانكليزية .
2) المقدمة .
3) المواد والطرق .
4) النتائج .
5) المناقشة ويمكن دمجها مع النتائج وتصبح (نتائج البحث والمناقشة) .
6) المراجع .

المعاملات الزراعية والمكننة

الفيزيولوجيا والاحياء الدقيقة

التربية والوراثة

مقالة عامة

فابس

مشروع المعلومات المتخصصة عن الفول

فابس ، نشرة علمية 25 ، كانون الأول 1989

المحتويات

ايكاردا والمجموعة الاستشارية للبحوث الزراعية الدولية

يتمثل الهدف العام للمركز الدولي للبحوث الزراعية في المناطق الجافة (ايكاردا) في زيادة الانتاجية الزراعية والموارد الغذائية المتاحة في المناطق الريفية والحضرية بهدف تحسين الوضع الاجتماعي والاقتصادي لشعوب البلدان النامية وخاصة في شمال أفريقيا وغرب آسيا . ويركز ايكاردا اهتماماتها بصورة رئيسية على المناطق التي تعتمد في زراعتها على الامطار السنوية التي تتراوح من 200-600 مم سنويا . وعندما تستدعي الضرورة تمتد دائرة بحوثها لتغطي مناطق تتسم بروية او ذات أمطار موسمية .

ويضطلع المركز بمسؤولية عالمية في تحسين الشعير والعدس والفول ، وبمسؤولية اقليمية في تحسين القمح والحمص والنظم الزراعية والثروة الحيوانية والمراعي والمحاصيل العلفية . كما ويعتبر تدريب وتأهيل الباحثين الزراعيين في البلدان النامية . وتبادل نتائج البحوث معهم أحد أهم الانشطة التي تقوم بها ايكاردا .

وقد ساهمت المجموعة الاستشارية للبحوث الزراعية الدولية (CGIAR) بتأسيس ايكاردا في سورية عام 1977 كمركز للبحوث لا يتوخى الربح . أما المجموعة الاستشارية للبحوث الزراعية الدولية فهي هيئة غير رسمية من المتبرعين تضم حكومات ومنظمات ومؤسسات خاصة . وتدعم البحوث الزراعية في جميع انحاء العالم بهدف تحسين الانتاج الغذائي في البلدان النامية . وذلك من خلال شبكة مؤلفة من ثلاثة عشر مركزا دوليا للبحوث من بينها ايكاردا . وتغطي أعمال الشبكة بحوثا على أنظمة المحاصيل والثروة الحيوانية التي تسهم في تأمين ثلاثة ارباع الغذاء في البلدان النامية .

فابس

تصدر ايكاردا نشرة " فابس FABIS " العلمية ثلاث مرات في السنة بدعم مالي من مركز بحوث التنمية الدولية (IDRC) في اوتاوا بكندا . وهي نشرة علمية متخصصة بالفول . وتعتبر وسيلة اتصال لتبادل نتائج البحوث حول هذا النبات . وتضم النشرة بحوثا مختصرة تهدف الى ايصال المعلومات بسرعة . اضافة الى بعض المقالات العامة التي تدعو اليها أسرة التحرير بشكل منتظم وتتناول مجالات معينة من بحوث الفول . كما تضم النشرة بعض الاعلانات . وتقدم النشرة المعلومات حول بحوث الفول دون مقابل من خلال قوائم الاستجواب والتصوير النسخي (الفوتوكوبي) وجمع الوثائق العلمية المتعلقة بالفول .

الاشتراكات

توزع نشرة " فابس " العلمية دون مقابل للباحثين المهتمين بنبات الفول . وللاشتراك فيها يرجى الكتابة الى :

FABIS/Documentation Unit/ICARDA, P.O.Box 5466
Aleppo, Syria

هيئة التنسيق

كندا : الدكتور س. بريتيه . قسم علوم النبات . جامعة مانيتوبا . وينبج . مانيتوبا R3T 2N2
مصر : الدكتور عبد الله نصيب . معهد المحاصيل الحقلية . مركز البحوث الزراعية . الجيزة 12619
اليابان : الدكتور ك. كوجي . كلية الزراعة . جامعة كاجاوا 2393 Ikenobe. Miki-tyo. Kagawa-Ken
السودان : الدكتور ف. آ. صالح . هيئة البحوث الزراعية . محطة بحوث شمباط . ص.ب. 30 خرطوم شمال .
سورية : الدكتور م. ساكسينا . برنامج تحسين البقوليات الغذائية . ايكاردا . ص.ب. 5466 . حلب .
البرازيل : الدكتور هـ. ايدار . المركز الوطني لبحوث الرز والفاصولياء BR-153, km 4-Gionia, Anapolis
Caixa Postal 179, 74.000-Goiania, Goias
فرنسا : الدكتور ج. بيكارد 4 Rue du 8 Mai. 36. 100 Neuvy-Pailloux.
ايطاليا : البروفسور سي دو باسه . معهد التيولوجيا الزراعية . جامعة بوليا . فيرنو .
اليابان : الدكتور ج.ي. كوبيرو . المدرسة الفنية العليا للهندسة الزراعية . قسم الوراثة . ص.ب. 3048 . قرطبة .
المملكة المتحدة : الدكتور د. آ. بوند . معهد تربية النبات . ماريس لين . ترومبينجتون . كامبردج .

هيئة التحرير

الدكتور موهان ساكسينا/محرر علمي
الدكتور حبيب ابراهيم/مساعد محرر علمي
السيد نهاد مليحة/محرر
السيدة مليكة عبد العالي مارتيني/مساعدة
الدكتور وليد سراج والسيد خالد الجبيلي/الملخصات العربية

صورة الغلاف : صنف من الفول محدود النمو مصاب بالهالوك المفرض (*Orobanche crenata* Fork.)

فابِس

نشرة علمية متخصصة بالفول

العدد 25 كانون الأول/ديسمبر 1989

المركز الدولي للبحوث الزراعية في المناطق الجافة
ايكاردا
ص. ب. 5466 ، حلب ، سورية