Status of diseases of faba bean in the Mediterranean region and their control

Honounik S.B., Bisri M.

in

Cubero J.I. (ed.), Saxena M.C. (ed.).
Present status and future prospects of faba bean production and improvement in the Mediterranean countries

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 10

1991
pages 59-66

Status of diseases of faba bean in the Mediterranean region and their control

S.B. HANOUNIK*
M. BISRI**
*INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS (ICARDA)
P.O. BOX 5466, ALEPPO, SYRIA
**INSTITUTE AGRONOMIQUE ET VETERINAIRE HASSAN II
B.P. 6202, RABAT, MOROCCO

SUMMARY - Faba bean are attacked by a wide range of pathogens. The most important faba bean diseases in the Mediterranean region are chocolate spot (*Botrytis fabae*), broomrape (*Orobanche crenata*), stem nematode (*Ditylenchus dipsaci*), and rust (*Uromyces fabae*). Although each of these diseases is quite destructive, when two or more interact on the same plant, their combined effect becomes greater. This situation is complicated further by the presence of several physiological races. The present commercial cultivars are susceptible to all of these diseases. This paper discusses the present status and control of faba bean diseases in the Mediterranean region with a special emphasis on disease resistance.

RESUME - "Situation actuelle et contrôle des maladies de la fève dans la région méditerranéenne". La fève est attaquée par une grande variété de pathogènes. Dans la région méditerranéenne, les maladies les plus importantes de la fève sont: Botrytis fabae, Orobanche crenata, *les nématodes de la tige (*Ditylenchus dipsaci*) et la rouille (*Uromyces fabae*). Bien que chacune de ces maladies soit très destructive en soi, quand deux ou plus interagissent sur la même plante, leur effet combiné est encore plus nuisible. Cette situation devient encore plus sérieuse lorsqu'il existe plusieurs races physiologiques. Les cultivars commerciaux actuels sont susceptibles à toutes ces maladies. Cet article examine la situation et le contrôle actuels des maladies de la fève dans la région méditerranéenne, en particulier en ce qui concerne la résistance aux maladies.*

Introduction

Faba bean (*Vicia faba* L.) is one of the most important grain legumes in the Mediterranean region. It is grown on approximately 0.68 million ha, with a total production of about 0.83 million metric tons annually (Hebblethwaite, 1983). Although faba bean, in this region, is attacked by more than 100 pathogens (Hebblethwaite, 1983), it is widely accepted that chocolate spot (*Botrytis fabae* Sard.), broomrape (*Orobanche crenata* Forsk.), stem nematode (*Ditylenchus dipsaci* (Kuhn) Filipjev), and rust (*Uromyces viciae fabae* (Pers.) Schroet.), are the most important limiting factors which cause great annual losses and sometimes complete crop failures (Cubero, 1983; Djerbi *et al.*, 1979; Hanounik, 1979; Hanounik and Sikora, 1980; Hanounik, 1982; Hashim, 1979; Hebblethwaite, 1983; Ibrahim *et al.*, 1979; Lamberti, 1981; Mengistu, 1979; Mohamed, 1982; Schreiber, 1977).

The use of resistant cultivars is the least expensive and most practical method of disease control. Attempts in the past to identify useful sources of resistance (Elliot and Whittington, 1979) resulted in the detection of a few genes which were not effective enough to develop acceptable disease–resistant cultivars. However, recent collaborative efforts between the International Center for Agricultural Research in the Dry Areas (ICARDA) and the national programs in the region, have resulted in the detection of durable as well as multiple disease–resistant sources to major pathogens (Hanounik and Maliha, 1986; Hanounik *et al.*, 1986; Hanounik and Robertson, 1988; ICARDA, 1987). Genes from these sources have already been used, and the release of faba bean cultivars with disease resistance and stable yield is under way. This paper discusses the status and control of faba bean diseases in the Mediterranean region, with a special emphasis on disease resistance.

Chocolate spot *(Botrytis fabae* Sard.)

When a virulent pathogen and susceptible host are brought together in an environment that favours disease development, severe losses often occur. Such losses occurred when the 1977 chocolate spot epidemic in Syria forced several faba bean growers to abandon their crops (Hanounik and Hawtin, 1982). The disease occurs almost anywhere faba bean is grown. It is devastating in Europe (Wilson, 1937), the Middle East (Hanounik, 1979) and North Africa (Djerbi *et al.,* 1978). In Egypt it causes an estimated 5–20% loss in faba bean production annually, but losses as high as 50% have been reported under epiphytotic conditions (Ibrahim *et al.,* 1979). The disease has been reported from Tunisia, Algeria, Morocco, Libya, Ethiopia, England, Spain, Norway, Germany, Scotland, Russia, Japan, China, Canada, North and South America, and Australia (Abdelmonem, 1981; Conner, 1967; Hebblethwaite, 1983; Ikata, 1933; Mengistu, 1979; Sardiña, 1929; Tupenevich and Kotova, 1970; United States Dept. of Agri., 1960). Losses caused by chocolate spot are due mainly to a decreased number of pods per plant (Williams, 1978). However, crop damage seems to be related to plant age at the time of infection. In Syria, losses varied from as little as 0.7% with three week–old to as high as 60% with seven week–old plants in the field (Hanounik and Hawtin, 1982). Other workers showed that faba bean leaves approaching maturity are more susceptible than the younger ones (Deverall and Wood, 1961; Mansfield and Deverall, 1974). Early chocolate spot symptoms occur mainly on leaves. However, stem, flower and pod tissues may also become infected. Two stages of the disease are observed. The non–aggresive stage known by the small circular and discrete reddish spots with darker margins; and the aggressive stage where the small spots merge and coalesce to form irregular larger dark–brown lesions involving the entire leaf surface. Under optimum conditions the disease causes severe defoliation, flower drop, stem collapse, tissue necrosis and finally plant death. The pathogen sporulates abundantly during the aggressive stage on blackened tissue only. *B. fabae* is often confused with *B. cinerea* on faba bean, but separation between the two is always possible, as *B. fabae* is more virulent (Leach, 1955; Mansfield and Widdowson, 1973), has larger conidia, shorter conidiophores and smaller sclerotia (Harrison, 1983; Sundheim, 1973) compared to *B. cinerea*. The mild stage of chocolate spot could be produced by both fungi, but *B. fabae* is more pathogenic and generally associated with the aggressive stage (Deverall and Wood, 1961; Leach, 1955).

Although the perfect stage of some species of *Botrytis* was reported in the genus *Botryotinia* of the class *Ascomycetes* (Bergquist and Lorbeer, 1968; Drayton, 1937), the perfect stage of *B. fabae* has not been identified yet. More attention is needed in this area to help understand the large cultural and pathogenic variabilities of *B. fabae* (Hanounik *et al.,* 1984; Hutson and Mansfield, 1980; Vedie *et al.,* 1983) in the region. The sclerotial and mycelial stages of *B. fabae* were found in infected seeds and plant debris (Harrison, 1978; Sode and Jorgensen, 1974). However, the sclerotial stage is more important than the mycelium in the survival of the pathogen from one season to another (Harrison, 1978). In Syria, conidia obtained from one year–old refrigerated sclerotia of *B. fabae* were more virulent than those obtained from naturally infected faba bean leaves (Hanounik, 1982). These sclerotia produce conidia which could induce primary infection (Harrison, 1979). Sporulation of primary lesions may lead to chocolate spot epiphytotics under suitable conditions (Moore and Leach, 1968). Although disease severity is favoured between 92–100% relative humidity and 15–20 °C (Harrison, 1980 and 1984), other factors including inoculum density, waterlogging, high plant density, and host physiology (Griffiths and Amin, 1977; Ingram and Hebblethwaite, 1976; Moore and Leach, 1968) have been shown to be closely related with disease development. In Syria, increase in plant age, inoculum density, incubation per-

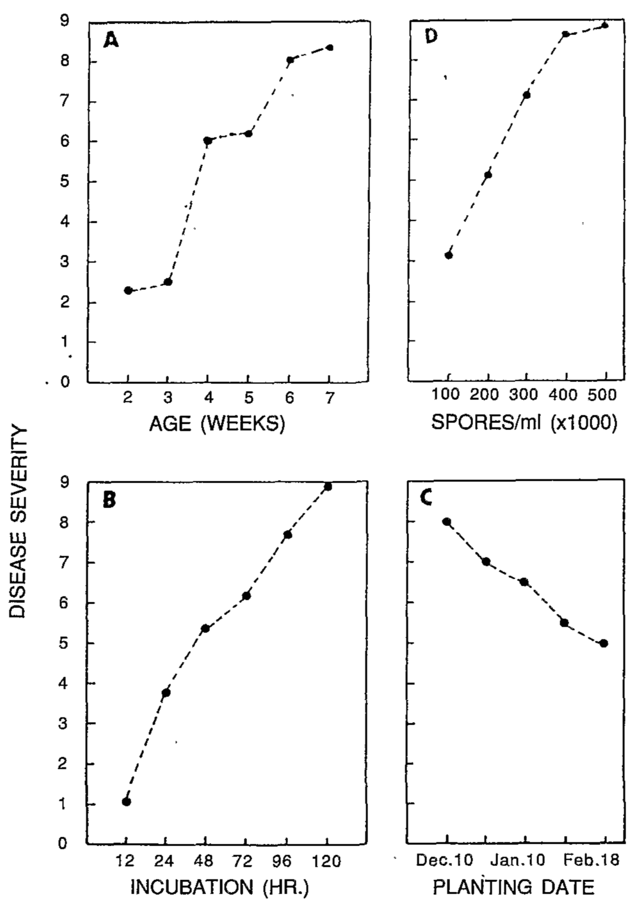

Fig. 1. Severity of chocolate spot on the faba bean line ILB 1814, as affected by plant age (A), incubation period at 89% relative humidity and 18 °C (B), date of planting (C), and spore density of *Botrytis fabae* (D). Disease severity was rated on ICARDA's 1–9 scoring scale where 1=no necrosis and 9=100% necrosis.

iod at 98% relative humidity and 18 °C, as well as advancing the planting dates from February to December, were all associated with a corresponding increase in disease severity (Fig. 1). Differences in the susceptibility of different plant organs seemed to affect severity of chocolate spot in the region. In general plant organs were found to be less susceptible to *B. fabae* at the 10% podding than at the 100% podding stage, and that at both stages, leaf tissue was more susceptible than either stem or pod tissues (Fig. 2).

Modified cultural practices and fungicides provide partial crop protection only, and therefore, effective disease management should include resistance as a major component. The use of low seeding rates (Ingram and Hebblethwaite, 1976), and the choice of the planting date to avoid extended periods of wet weather conditions (Hanounik and Hawtin, 1982; Wilson, 1937), elimination of plant debris that may harbor hyphae or sclerotia of *B. fabae* (Hanounik and Hawtin, 1982; Harrison, 1979), rotating faba bean with non–host crops such as cereals, to reduce sclerotial population and chances of primary infections (Harrison, 1979), can play an important role in reducing disease severity. Fungicides may be useful only when faba bean is grown early in the season to take advantage of high prices. In Syria, the use of vinclozoline (Ronilan 50 wp) as a foliar spray, once every two weeks (total eight applications), controlled chocolate spot, and increased faba bean yield by 58% over untreated plots (Hanounik, 1981). Recently two antagonistic fungi, *Penicillium citrinum* and *P. cyclopium,* were isolated from the phyllosphere of the resistant faba bean line BPL 1179, grown under field conditions, in the coastal area of Syria. Cultural filtrates of these antagonists suppressed spores of *B. fabae* and reduced disease development, equally well as did the widely used fungicide vinclozoline (Fig. 3).

The massive local and international screening program organized by ICARDA resulted in the identification of durable sources of resistance to *B. fabae* (Hanounik and Hawtin, 1982; Hanounik and Maliha, 1986; Hanounik and Robertson, 1988). Three faba bean lines BPL 1179, 710 and 1196 were consistently rated as resistant over the past eight years at more than 30 locations in Syria, Egypt, Qatar, Ethiopia, Tunisia, Morocco, Algeria, UK, France, Germany, The Netherlands, Canada, and China. These sources are being utilized to stabilize faba bean production, especially in the Mediterranean region where pathogenic variability (Hanounik *et al.*, 1984; Hosni *et al.*, 1981; Hutson and Mansfield, 1980; Vedie *et al.*, 1983) and virulent races in *B. fabae* exist (Hanounik and Maliha, 1986).

Although chocolate spot is individually quite destructive, damage due to its interaction with rust, bean yellow

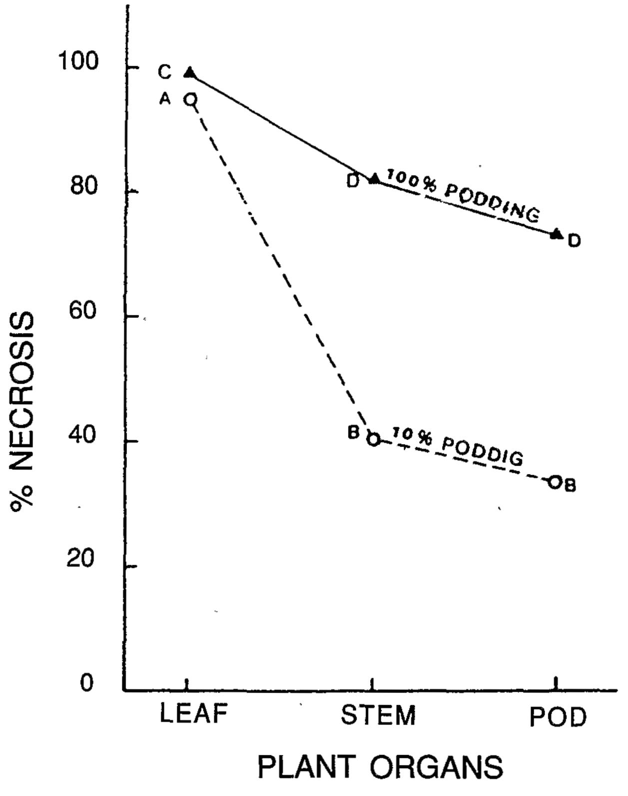

Fig. 2. Susceptibility of different plant organs of faba bean to *Botrytis fabae* at the 10% and 100% podding stage in the field. Means followed by different letters are significantly different at p<0.01 according to Duncan's multiple range test.

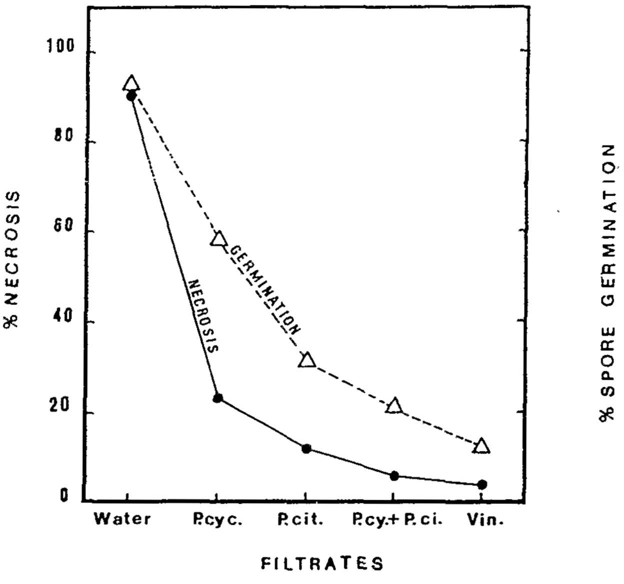

Fig. 3. Effects of cultural filtrates of *Penicillium cyclopium, P. citrinum* and the fungicide vinclozoline on spore germination of *Botrytis fabae* and chocolate spot development on the susceptible faba bean line R40.

mosaic or bean leaf roll viruses (Bekhit *et al.,* 1970; Mansour *et al.,* 1975; Omar *et al.,* 1985) can be even greater. Genes for resistance to different diseases were, therefore, combined and progenies tested under artificial conditions. These efforts resulted in the development of the faba bean lines L82009, L82007, and L82011 with a combined resistance to chocolate spot, rust, and alternaria spot.

Broomrape (*Orobanche crenata* Forsk.)

The broomrape (*Orobanche crenata* Forsk.) is one of the most important limiting factors in faba bean production throughout the Mediterranean region (Cubero, 1983). The parasite causes great annual losses and sometimes complete crop failure.

Broomrapes, as populations, are generally similar to other root–infecting agents such as fungi and nematodes. Efficiency of broomrapes, as parasites, pertains to their ability to germinate upon stimulation (Hiron, 1973), penetrate into host tissue (Privat and Andari, 1973), develop haustorium (Dorr and Kollman, 1974), establish connection through xylem fusion (Cubero, 1983), use available food (Whitney, 1972), then grow, reproduce, and persist in the soil as dormant seeds. Seed production and population growth of the parasite depends on host suitability, with respect to the availability and quality of stimulants, inhibitors, (Hiron, 1973) and food (Whitney, 1972). In general, broomrapes reproduce and build up greater populations on good compared to poor hosts. However, with non–host, there is no reproduction at all, whereas with resistant host there is a range of restricted reproduction, and with susceptible host there is an abundance of seed production. Therefore, host status can be determined, as being resistant or susceptible, by the reproductive potential of the parasite on the host.

Although these principles govern a wide range of similar host–parasite interactions, their application to explain the epidemiology of broomrape–induced diseases received little attention in the past. This was probably due to the fact that this group of diseases has rarely been investigated from a pathological point of view. In general, the initial inoculum density, available at the beginning of the season, and the rate of its reproduction during the season, determine the amount of disease or damage at the end of the season. Based on these principles, an attempt was made at ICARDA, to identify *O. crenata*–resistant faba bean lines, which could suppress the rate of reproduction of the parasite. Resistance was evaluated, in an artificially infested soil (10 seeds of *O. crenata*/1cc soil) in the field, by measuring the rate of reproduction (r) of the parasite, and also the number (n) and weight (w) of its shoots per host plant. The variable r was determined from the ratio Fi/Ii, where the final (Fi) and the initial (Ii) inoculum densities represented the number of *O. crenata* seeds per 1 cc soil, at the end and the beginning of the season, respectively. Of the 889 germplasm lines from ICARDA, and the 98 breeding lines from Cordoba (Spain), only seven (three germplasm lines and four breeding lines), were rated as resistant (Fig. 4). The variables r, n and w were significantly lower on resistant compared to susceptible lines.

The differences between resistant and susceptible faba bean lines in this study was based on the performance of *O. crenata* (Fig. 4). The rate of reproduction (r) of the parasite was greater than one (r = 6.525>1) on the local faba bean line ILB 1814, and therefore, it was regarded as a good or susceptible host. This type of host provides a suitable substrate for the reproduction of the parasite. On the other hand, the rate of reproduction of

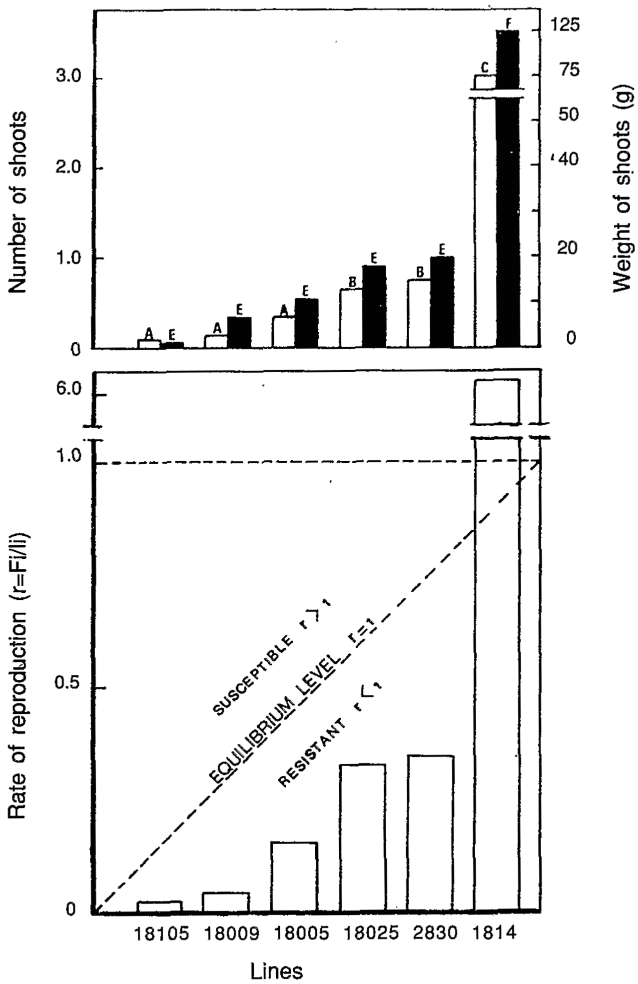

Fig. 4. Resistance in *Vicia faba* to *Orobanche crenata* (Fi and Ii are the final and initial inoculum densities of the parasite, as seeds/1 cc soil). Numbers and weights of *Orobanche* shoots/host plant, marked by different letters, are significantly different at the 1% (L.S.D.=0.39) and the 5% (L.S.D.=2.18) levels, respectively.

O. crenata was less than one (r < 1) on the faba bean lines 18105, 18009, 18035, 18025 from Cordoba and BPL 2830, from ICARDA, and hence they were considered as resistant hosts.

Because the variable r measures the rate of inoculum increase, and because the amount of damage to the host is closely related to the amount of inoculum, the use of the variable r to identify resistance is epidemiologically more meaningful than either n or w.

Stem nematode (*Ditylenchus dipsaci* (Kuhn) Filipjev)

The stem nematode *Ditylenchus dipsaci* (Kuhn) Filipjev is a destructive seed and soil–borne pathogen of faba bean in many parts of the temperate region (Hanounik and Sikora, 1980; Hanounik, 1982; Hashim, 1979; Hooper, 1971). Infested seeds play an important role in the survival and dissemination (Hooper, 1971) of the nematode. This is probably why *D. dipsaci* has a very wide geographical distribution (Hebblethwaite, 1983).

Although several biological races have been reported in stem nematode (Seinhorst, 1957), the 'giant race' is generally more common in the Mediterranean region (Hanounik and Sikora, 1980; Hashim, 1979; Lamberti, 1981) compared to the 'oat race' in Europe (Hebblethwaite, 1983). The 'giant race' is responsible for more damage and greater percentage of infested seeds, compared to the 'oat race' (Hooper and Brown, 1975). Yield losses as high as 67.8%, with 20% of the seeds infested have been reported from experimental plots, with 650 larvae of the 'giant race' per 100 cc soil, in Syria (Hanounik, 1983). The first sign of infection is a slight swelling of the young stem and distortion and twisting of petioles and leaves. As the plant matures, the swollen areas on the stem enlarge and turn dark brown to black. The host epidermis becomes characteristically thin and papery. Pods also become infected and this leads to seed infestation. *D. dipsaci* can survive for several years in infested plant debris and seeds (Hebblethwaite, 1983). In Syria, the 'giant race' of *D. dipsaci* survived for a longer period of time in stored seeds, at room temperature (20 °C + 2), than in stems buried at a depth of 10 cm in the field (Fig. 5). Seed–borne, and stem–borne larvae remained pathogenic to faba bean after three years of seed storage at room temperature, and 6 months of stem burial in the field. Therefore, the recurrence of the stem nematode disease in the field might in part be due to the re–utilization of infected seeds, and also to the survival of the nematode from one season to another in infected stems in the field. The 'giant race' apparently has a limited host range (Hebblethwaite, 1983). However, the weeds *Lamium amplexicaule* in Syria, *L. album* and *L. purpureum* in England, have recently been reported as

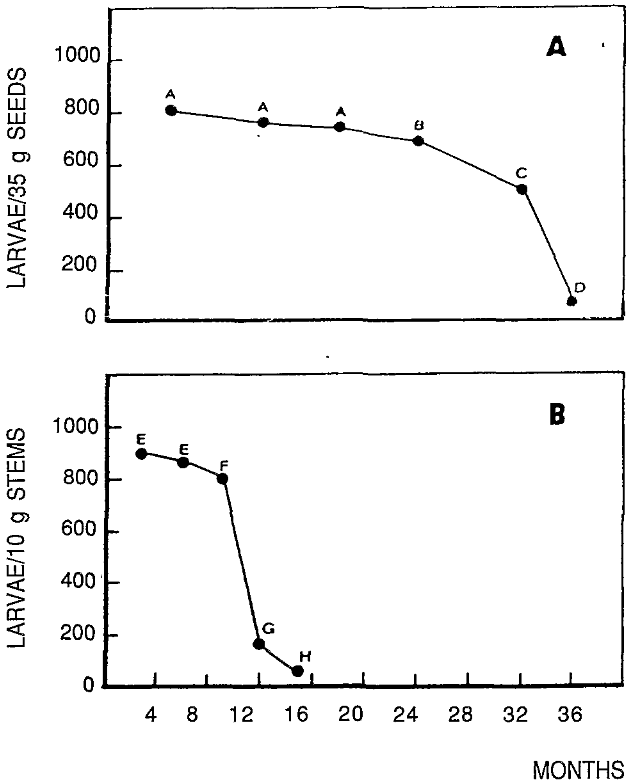

Fig. 5. Longevity of *Ditylenchus dipsaci* in stored faba bean seeds (A) and stems (B). Means followed by different letters are significantly different at p<0.01 according to Duncan's multiple range test.

wild hosts for this nematode (Clayden and Hooper, 1982; Weltzein and Weltzein, 1980).

Losses due to *D. dipsaci* can be reduced by the use of healthy seeds, destruction of wild hosts, and elimination of infected plant debris after harvest. Methyl bromide is highly effective against free living larvae of *D. dipsaci*, but dosages needed for complete eradication of nematodes from infected seeds çause substantial decrease in germination (Powell, 1974). Evaluation of ICARDA's pure line collection of faba bean in 1981 and 1982 in artificially infested soil in Syria resulted in the detection of 12 faba bean lines with resistance to *D. dipsaci*. Resistance in these lines was confirmed in Tunisia in 1984 (Hanounik *et al.*, 1986).

Rust (*Uromyces viciae fabae* (Pers.) Schroet)

Rust caused by *Uromyces viciae fabae* (Pers.) Schroet, is one of the most widely distributed diseases of faba bean around the world (Guyot, 1975; Hebblethwaite, 1983). The pathogen has been reported from all over West Asia and North Africa (Hawtin and Stewart, 1979). In general, rust appears late in the season and causes an estimated 20% loss in faba bean production (Bekhit *et al.,* 1970; Mohamed, 1981). However, these losses could go up to 45% if severe infections occur early in the season (Williams, 1978). Rust appears first on leaves as very small round, slightly raised, cream colored spots. As the spots enlarge the epidermis ruptures, releasing masses of brown urediospores. Although aeciospores can readily be detected, teliospores are produced in increasing numbers on stems and petiols towards the end of the season. The pathogen is autoecious and therefore, completes its life cycle on the same host. However, it can infect many species in the genera *Vicia, Lathyrus, Lens,* and *Pisum* (Conner and Bernier, 1982). Urediospores are short–lived, but the teliospores can survive in plant debris from one season to another (Hebblethwaite, 1983). Germination of teliospores takes place between 17 and 22 °C, at the start of the next season, producing basidiospores which start new infection cycle (Prasad and Verma, 1948). The basidial stage and initiation of primary infections are not fully understood. The disease is favoured by high humidity and cloudy and rainy weather conditions. Disease development in the field is favoured between 20 °C and 22 °C (Webb and Hawtin, 1981).

Rust occurs mostly late in the season and therefore, chemical control may not be economical. However, when rust occurs with chocolate spot in the same field, Mancozeb (Dithane–M45) can be used (Mansour *et al.,* 1975). Removal of infected plant debris (Prasad and Verma, 1948), destruction of other host species and rotating faba bean with non–host crops (Conner and Bernier, 1981), should play an important role in reducing chances of survival and primary infections in the field. Several rust–resistant lines have been reported. The faba bean lines BPL 1179, 261, 710, 8, 406, 417, and 484 have been found to be resistant in Syria, Egypt and Canada. The faba bean lines L82009, L82007, L82011 and L82010 have been rated as resistant to both rust and chocolate spot (ICARDA, 1987).

References

ABDELMONEM, A.M. (1981): Studies on chocolate spot of broadbean in Libya. Ann. Agr. Sci. Mosh. *16:*119–131.

BEKHIT, M.R., RIZK, Z., MANSOUR, K., ABD–EL–MONEIM, A., KAMEL, B. and BOSHRA, S. (1970): Study of the effect of spraying with some fungicides at different dates and different intervals on the control of chocolate spot and rust of field beans. Agr. Res. Rev. Cairo *48:*37–63.

BERGQUIST, R.R. and LORBEER, J.W. (1968): Production of the perfect stage of *Botryotinia (Botrytis) squamosa* under controlled conditions. Phytopath. *58:*398.

CLAYDEN, I. and HOOPER, D.J. (1982): New weed hosts for the giant race of *Ditylenchus dipasci* (Kuhn) Filipjev. Plant Pathol. *30*:251–252.

CONNER, I.L. (1967): An annotated index of plant diseases in Canada. Canada Dept. of Agric. Publication 1251.

CONNER, R.L. and BERNIER, C.C. (1981): Host range of *Uromyces viciae fabae*. Phytopathology *72:*687–689.

CONNER, R.L. and BERNIER, C.C. (1982): Race identification in *Uromyces viciae fabae*. Canadian Journal of Plant Pathology *4*:157–160.

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, U.K.

DEVERALL, B.L. and WOOD, R.K.S. (1961): Infection of bean plants (*Vicia faba* L.) with *Botrytis cinerea* and *B. fabae*. Ann. Appl. Biol. *49:*461–472.

DJERBI, M., MLAIKI, A. and BOUSLAMA, M. (1979): Food legume diseases in North Africa. Pages 103–105 *in* Food Legume Improvement and Development (Hawtin, G.C. and Chancellor, G.J., eds.). ICARDA/IDRC, Ottawa, Canada.

DORR, I. and KOLLMAN, R. (1974): Structural features of the parasitism of orobanche. 1, Growth of the haustorial cells within the host tissue. Protoplasma *80:*245–259.

DRAYTON, F.L. (1937): The perfect stage of *Botrytis convoluta.* Mycologia *29:*305–318.

ELLIOT, J.E. and WHITTINGTON, W.J. (1979): An Assessment of varietal resistance to chocolate spot (*Botrytis fabae*) infection of field beans (*Vicia faba*) with some indications of its heritability and its mode of inheritance. J. Agric. Sci. Camb. *93:*411–418.

GRIFFITHS, E. and AMIN, S.M. (1977): Effects of *Botrytis fabae* infection and mechanical defoliation on seed yield of field beans (*Vicia faba*). Ann. Appl. Biol. *86*:359–367.

GUYOT, A.L. (1975): Les Ureudinées (ou rouilles des végétaux) III. Uromyces. Encycl. Mycol. *29*:505–554.

HANOUNIK, S.B. (1979): Diseases of major food legumes in Syria. Pages 98–102 *in* Food Legume Improvement and Development (Hawtin G.C. and Chancellor, G.J., eds.). ICARDA/IDRC, Ottawa, Canada.

HANOUNIK, S.B. (1981): Influence of "Ronilan" on the severity of chocolate spot and yield of faba bean. FABIS Newsletter *3*:50–51.

HANOUNIK, S.B. (1983): Effects of aldicarb on *Ditylenchus dipsaci* in *Vicia faba.* Page 1194 *in* Proc. of the 10th International Congress of Plant Protection. The Lavenham Press Limited, Lavenham, Suffolk, U.K.

HANOUNIK, S.B., HALILA, H. and HARABI, M. (1986): Resistance in *Vicia faba* to stem nematodes (*Ditylenchus dipasci*). FABIS Newsletter *16*:37–39.

HANOUNIK, S.B. and HAWTIN, G.C. (1982): Screening for resistance to chocolate spot caused by *Botrytis fabae*. Pages 243– 250 *in* Faba Bean Improvement (Hawtin, G.C. and Webb, C., eds.). Martinus Nijhoff Publishers, The Hague, The Netherlands.

HANOUNIK, S.B. and MALIHA, N. (1986): Horizontal and vertical resistance in *Vicia faba* to chocolate spot caused by *Botrytis fabae.* Plant Disease *70*:770–773.

HANOUNIK, S.B., MALIHA, N., SOLH, M. and SAAD, A. (1984): Pathogenic and cultural variability in *Botrytis fabae*. FABIS Newsletter *10*:21–24.

HANOUNIK, S.B. and ROBERTSON, L.D. (1988): New sources of resistance in *Vicia faba* to chocolate spot caused by *Botrytis fabae*. Plant Disease 72:696–698.

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

HARRISON, J.G. (1978): Role of seed borne infection in epidemiology of *Botrytis fabae* on field beans. Trans. Br. Mycol. Soc. *70*:35–40.

HARRISON, J.G. (1979): Overwintering of *Botrytis fabae*. Trans. Br. Mycol. Soc. 72:389–394.

HARRISON, J.G. (1980): Effects of environmental factors on growth of lesions on field beans by *Botrytis fabae*. Ann. Appl. Biol. *95*:53–61.

HARRISON, J.G. (1983): Distinguishing between lesions caused by *Botrytis fabae* and *Botrytis cinerea* on field beans. Trans. Br. Mycol. Soc. *81*:663–664.

HARRISON, J.G. (1984): Effect of humidity on infection of field bean leaves by *Botrytis fabae* and germination of conidia. Trans. Br. Mycol. Soc. *82*:245–248.

HASHIM, Z. (1979): The Stem Nematode Eelworm, *Ditylenchus dipsaci*, on Broad Bean. F.A.O. Plant Protection Bulletin *27*:97.

HAWTIN, G.C. and STEWART, R. (1979): The development and problems of faba bean (*Vicia faba*) in West Asia and North Africa. Faba Bean Improvement Services. FABIS Newsletter *1*:7–9.

HEBBLETHWAITE, P.D. (ed.) (1983): The Faba Bean. Butterworths, London, U.K., 573 pp.

HIRON, R.W.P. (1973): An investigation into process involved in germination of *Orobanche crenata* using a new bio–assay technique. Pages 76–88 *in* Proc. Eur. Weed Res. Coun. Symp. Parasitic Weeds. Malta University Press, Malta.

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

HOOPER, D.J. and BROWN, G.J. (1975): Stem nematode *Ditylenchus dipsaci*, on field beans. Pages 183–84 *in* Rothamsted Exp. Sta. Rept. 1974, Part 1.

HOSNI, A.M., ZEID, N.A. and HABIB, W.F. (1981): Variation within the fungus *Botrytis fabae* Sard. FABIS Newsletter *3*:49–50.

HUTSON, R.A. and MANSFIELD J.W. (1980): A genetical approach to the analysis of mechanisms of pathogenicity in *Botrytis–Vicia faba* interactions. Physiol. Pl. Pathol. *17*:309–317.

IBRAHIM, A.A., NASSIB, A.M. and EL–SHERBEENY, M. (1979): Production and improvement of grain legumes in Egypt. Pages 39–46 *in* Food Legume Improvement and Development. (Hawtin, G.C. and Chancellor, G.J., eds.). ICARDA/IDRC, Ottawa, Canada.

ICARDA (1987): Faba Bean Pathology Progress Report 1986–1987. Food Legume Improvement Program, ICARDA, Aleppo, Syria.

IKATA, S. (1933): Studies on red spot disease of *Vicia faba*. Rep. Agr. Expt. Sta. Okayamaken 38, 28 pp.

INGRAM, J. and HEBBLETHWAITE, P.D. (1976): Optimum economic seed rates in spring and autumn sown field beans. Agric. Prog. *51*:27–32.

LAMBERTI, F. (1981): Plant nematode problems in the Mediterranean region. Helminthological Abstracts, Series B, Plant Nematology *50*:145–166.

LEACH, R. (1955): Recent observations of the *Botrytis* infection of beans. Trans. Brit. Mycol. Soc. *38*:171.

MANSFIELD, J.W. and WIDDOWSON, D.A. (1973): The metabolism of wyerone acid (a phytoalexin from *Vicia faba* L.) by *Botrytis fabae* and *B. cinerea*. Physiol. Pl. Pathol. *3*:393–404.

MANSFIELD, J.W. and DEVERALL, B.J. (1974): The rate of fungal development and lesion formation in leaves of *Vicia faba* during infection by *Botrytis fabae*. Ann. Appl. Biol. *79*:77–89.

MANSOUR, K., RISKY, Z. and FOUAD, W. (1975): Studies on the control of chocolate spot and rust of horse beans. Agr. Res. Rev. Cairo *53*:89–95.

MENGISTU, A. (1979): Food legume diseases in Ethiopia. Pages 106–108 *in* Food Legume Improvement and Development, (Hawtin, G.C. and Chancellor, G.J., eds.). ICARDA/IDRC, Ottawa, Canada.

MOHAMED, H.A.R. (1982): Major disease problems of faba beans in Egypt. Pages 213–225 *in* Faba Bean Improvement (Hawtin, G.C. and Webb, C., eds.). Martinus Nijhoff Publishers, The Hague, The Netherlands.

MOORE, K.G. and LEACH, R. (1968): The effect of 6–benzylami–nopurine (benzyladenine) on senescence and chocolate spot (*Botrytis fabae*) of winter beans (*Vicia faba*). Ann. Appl. Biol. *61*:65–76.

OMAR, S.A.M., CHAPMAN, G.P. and BAILTSS, K.W. (1985): Interaction between virus and *Botrytis fabae* in *Vicia fabae* L. *In* Proceedings of the 8th *Botrytis* Symposium. Quad. Vitic. Enol. Univ. Torino, Italy, 243 pp.

POWELL, D.F. 1974. Fumigation of field beans against *D. dipsaci*. Plant Pathol. *23*:110–113.

PRASAD, R. and VERMA, U.N. (1948): Studies on lentil rust *Uromyces fabae* (Pers.) de Bary in India. Indian Phytopathology *1*:142–146.

PRIVAT, G. and ANDARI, C. (1973): Considération sur les relations histologiques hôte–parasite chez l'orobanche du lierre (*Orobanche hederae* Duby). Pages 99–105 *in* Proc. Eur. Weed Res. Coun. Symp. Parasitic weeds. Malta University Press, Malta.

SARDIÑA, J.R. (1929): Una nueva especie de *Botrytis* que ataca a las habas. Real Sociedad Española de Historia Natural Memorias *15*:291–295.

SCHREIBER, E.R. (1977): Lebenweise, Bedeutung und Bekampfungs–moglichkeiten von *Ditylenchus dipsaci* (Kuhn) Filipjev an Ackerbohnen *Vicia faba* L. in Marokko. Dissertation der Technischen Universitat Berlin D83 Nr. 79, 150 pp.

SEINHORST, J.W. (1957): Some aspects of the biology and ecology of stem eelworms. Nematologica 2:355–361.

SODE, J. and JORGENSEN, J. (1974): Correlation between the incidence of disease on seed of horse beans, on the plants in the field and in the harvested seeds. Berten Statsfr. Denmark *103*:99–106.

SUNDHEIM, L. (1973): *Botrytis fabae*, *B. cinerea* and *Ascochyta fabae* on broad bean (*Vicia faba* L.) in Norway. Acta. Agr. Scan. *23*:43–51.

TUPENEVICH, S.M. and KOTOVA, V.V. (1970): Biological features of the causal agent of bean brown patch. Trudy veses. Inst. Zashch. Rast. *29*:143–150.

UNITED STATES DEPTARTMENT OF AGRICULTURE (1960): Index of plant diseases in the United States. Agricultural Handbook *165*:275–276.

VEDIE, R. ADAM, T. and NORMAND, M. (1983): Some aspects of the variability of the pathogenicity of *Botrytis fabae*. Agronomie *3*:92.

WEBB, C. and HAWTIN, G.(eds.) (1981): Lentils. Commonwealth Agricultural Bureaux, London, U.K., 216 pp.

WELTZIEN, M. and WELTZIEN, H. (1980): *Lamium amplexicaule* L. as host of the stem nematode *Ditylenchus dipsaci* in Syria. FABIS Newsletter *2*:50.

WHITNEY, P.J. (1972): The carbohydrate and water balance of beans (*Vicia faba*) attacked by broomrape (*Orobanche crenata*). Ann. Appl. Biol. *70*:59–66.

WILSON, A.R. (1937): The chocolate spot disease of beans (*Vicia faba* L.) caused by *Botrytis cinerea* Pers. Annl. Appl. Biol. *24*:258–288.

WILLIAMS, P.F. (1978): Growth of broad beans infected by *Botrytis fabae*. J. Hort. Sci. *50*:415–424.