Fababean diseases in Saskatchewan in 1973

D.L. McKenzie and R.A.A. Morrall[1]

A survey of fababean [*Vicia faba]*, involving 28 commercial fields in widely separated parts of the Province and experimental plots at three localities, was done throughout the 1973 growing season. Quantitative data were collected at the end of the season and isolations were made from seed samples collected after harvest. The major diseases were powdery mildew, ascochyta blight *[Ascochyta fabae]*, and fusarium and rhizoctonia root and foot rots. Powdery mildew in experimental plots at Saskatoon was identified as *Microsphaera penicillata* var. *ludens*, apparently a new record for this fungus on *V. faba*. Specimens of *Uromyces viciae-fabae* from similar plots appear to be a new biotype of the rust.

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En 1973, pendant toute la saison de vegetation, une enquête sur les maladies de la féverole (*Vicia faba)* a ete realisee dans *28* champs de producteurs bien répartis dans la Province et dans des champs experimentaux situés a trois endroits differentes. A la fin de la saison, les donnees quantitatives ont ete recueillies et après la récolte on a fait des isolements a partir des echantillons de graines. Les maladies les plus importantes ont ete le Blanc. l'Ascochytose *(Ascochyta fabae)* et les pourritures par *Fusarium* et *Rhizoctonia*. L'Oidium dans les champs experimentaux a Saskatoon a ete identifie comme *Microsphaera penicillata* var. *ludens,* apparemment signalé pour la premiere fois sur *V. faba*. Les echantillons d'*Uromyces viciae-fabae* dans d'autres champs experimentaux a Saskatoon semblent être un biotype nouveau de cette rouille

The diseases of several specialty crops in Saskatchewan have been studied for several years in our laboratory by means of field surveys (10,12). Fababean (*Vicia faba* L.) has been of particular interest since it was first grown in the Province in 1972. This crop was introduced to Canada about 4 years ago and several phytopathological problems have already been reported (5,7,10). The present paper deals with an extensive survey conducted in Saskatchewan in 1973. Substantial detail is presented because of the potential importance of fababean as a new protein crop in Canada, even though some aspects of the work are incomplete.

In 1972 about 500 acres of fababean were grown in Saskatchewan and a limited disease survey was done late in the season (10). The acreage was estimated to have increased to 2700 in 1973 and considerable fresh importation of seed into the province occurred. Disease surveys were begun early in the season in order to record seedling and other diseases which might not have been apparent later on. Sequential surveys of the same fields also permitted some study of the progression of disease with time.

The weather in much of Saskatchewan, especially during the early part of the growing season, appeared to be quite conducive to infection by foliar pathogens. In June at Saskatoon there were 17 days when at least some precipitation occurred (15). Many showers were followed by long periods of cool (10-15°C) temperatures and overcast skies. The late season weather at Saskatoon consisted of warm days and cool nights, with only occasional showers (15), but substantially more rainfall occurred in other parts of the province, including those where fababean was grown.

[1] *Department of Biology. University of Saskatchewan, Saskaroon, Saskatchewan, S7N* ***OWO.***

Methods

Twenty-eight fields representing about 30% of the total commercial acreage in Saskatchewan were surveyed. The majority were localized in either the irrigation area at Outlook (60 miles S of Saskatoon) or on dryland in the Laird district (40 miles N of Saskatoon). Other smaller 'groups' of fields on dryland occurred in the Kindersley district (120 miles WSW of Saskatoon), the Tisdale district (130 miles NE of Saskatoon) and in SE Saskatchewan. Thus, five separate districts of cultivation were recognized in the survey of commercial fields. In addition, visits were made to experimental plots at Saskatoon, Bellevue, and Nipawin.

Qualitative surveys were done throughout the growing season. Many fields and plots were visited three times, at about 1-month intervals; others were visited only once or twice (Table 1). At the end of the season quantitative data were collected in the fields; these surveys were done as nearly as possible just before swathing when the plants were still green.

Qualitative survey

The presence and approximate levels of diseases in the fields and plots were recorded. Additional information on variety, stage of crop development, weeds, insect pests, and soil moisture was noted. The observations were made while walking about 300 metres in a semicircular fashion through the crop. Normally only one area of a field was examined except where the topography was uneven; then both the high and low areas were examined. Isolations were always made from diseased plant material when the causal organism was unknown. Isolation routines included surface sterilization in 10%

Table 1. Summary of qualitative survey data from fields

District	Date	No. of fields examined	No. of fields where foliage diseases were present*				No. of fields where root, stem, and other diseases were present		
			Ascochyta blight	Lesions yielding *Alternaria* spp.	Powdery mildew †	Other	Fusarium root rot	Root lesions yielding *Coniella pulchella*	Other
Laird	14/6	2	0	0	0	0	0	0	0
	317	8	1	3	0	0	2	1	h
	16/8	9	7	9	3	a §	2	3	i
Kindersley	2616	4	0	1	0	b	2	0	0
	31/7	4	0	4	0	c	2	0	j
	1318	4	3	4	0	a	3	0	k
Outlook	2916	9	0	9	0	d	6	4	l
	2617	9	0	9	0	e	2	5	0
	2918	8	0	8	8	f	5	1	m
Tisdale	11/7	2	0	1	0	g	0	0	0
	419	2	1	2	0	0	1	1	n
SE Sask.	2018	4	2	4	3	0	2	1	o

* Diseases indicated were all present in trace levels except "other" on 16/8/73 at Laird, when the level was severe, and powdery mildew on 29/8 at Outlook when the level ranged from trace to moderate.

† For causal organism of powdery mildew, see text.

§ a-o Indicate the types of disease. or the organisms isolated, or both; the no. of fields to which each pertains follows in brackets:

a = herbicide injury (1);
b = chocolate spot (*Botrytis cinerea*) (1) & *Coniella pulchella* (1);
c = *Cladosporium* sp. (1);
d = herbicide injury (2), *Cladosporium* sp. (1), *Coniella pulchella* (3) & *Cephalosporium* sp. (1);
e = *Colletotrichum* sp. (1), *Cladosporium* sp. (3), *Coniella pulchella* (3) & *Cephalosporium* sp. (1);
f = rust (*Uromyces viciae-fabae*) (1);
g = *Coniella pulchella* (1);
h = root rot (*Verticillium* sp.) (1);
i = "yellows" (*Coniella pulchella, Fusarium* spp. & *Pullularia* sp., isolated from roots) (2), root rot (bacteria) (3), stem rot (*Sclerotinia sclerotiorum*) (2);
j = root rots (bacteria) (2), *Cephalosporium* sp. (1), *Pestalotia* sp. (1);
k = root rots (bacteria) (1), (*Pullularia*) (1). "yellows" (*Verticillium* sp., *Fusarium* sp., bacteria isolated from roots) (2);
l = root rots (*Scytalidium*) (1), (*Cephalosporium* sp.) (1);
m = root rots (*Rhizoctonia*) (4), (*Fusarium* & *Rhizoctonia* spp.) (4), (*Pythium* sp.) (1), (*Cephalosporium* sp.) (2), "yellows" (*Cephalosporium* sp. & *Verticillium* sp., isolated from roots (1);
n = stem rot (*Sclerotinia sclerotiorum*) (2);
o = unidentified fungi (2).

Javex (active ingredient 6% NaOCl), rinsing in sterile distilled water, and plating on potato dextrose agar (PDA).

Quantitative survey

Two areas, each about 150 metres from the edge of the crop, were sampled in each field. At each sample area 100 plants in a randomly chosen row were scored for root and stem diseases and the plants with symptoms were collected for making isolations. One leaf and one pod were picked about midway down the plant stem from each of the 100 plants and taken to the laboratory. These were used in the assessment of percentage leaf and pod area with lesions by means of assessment keys, as described in a previous paper (10).

Isolation from seeds

Samples of harvested seed were collected from many growers. Fifty seeds from each sample were surface sterilized for 5 min in 10% Javex, then rinsed in sterile distilled water and plated on PDA. Another group of 50 seeds from each sample was plated directly on PDA. The plates were incubated for 10 days at room conditions of temperature and light before examination and identification of fungi that had grown. One sample of seed imported for planting in 1973 was obtained from a grower and plated in the same manner.

Results

Eight distinct diseases were found (Tables 1-4). Powdery mildew and fusarium and rhizoctonia root/foot rots were prevalent, while ascochyta blight, rust, chocolate spot, herbicide injury, and sclerotinia stem blight were present at relatively low levels. Also found were root rots from which various fungi and bacteria were isolated, and leaf spots from which *Alternaria* spp., *Cladosporium* spp., and *Coniella pulchella* Hohnel were the primary isolates (Table 1). Furthermore, plants with thick, brittle, chlorotic leaves were conspicuous in several fields. However, the precise etiology of these last three diseases is unclear.

Foliar diseases

Powdery mildew was observed late in the season in 14 of 27 fields (Table 1). Infection was greatest in the Outlook district, where the mean percentage leaf area diseased was 11.1 (Table 2) and the disease was present in all fields (Table 1). In other districts infection was very slight (Table 2) and there was no evidence of pod infection anywhere at the times of the survey. The causal organism of this disease is in doubt. Initially, it was believed that *Erysiphe polygoni* DC ex Mérat was the pathogen (3,10), although cleistothecia were not observed on infected leaves when surveys were made. However, a powdery mildew fungus collected in September on fababean in experimental plots at the University of Saskatchewan was subsequently identified as *Microsphaera penicillata* (Wallr. ex Fr.) Lev. var. *ludens* (Salm.) W.B. Cooke on the basis of its perfect state. By the time the identification was made, it was too late to check the identity of the fungus observed in commercial fields.

Ascochyta blight [*Ascochyta fabae* Speg.] was first observed on July 3 in the Laird district (Table 1). Pycnidia containing mature conidia were present in some of the leaf lesions. The disease was not found in other fields until late in the season, when 13 out of 27 fields were found to have at least trace amounts. The variety 'Erfordia' seemed more susceptible than others (Table 4); in one field lesions were prominent on the leaves, pods, and stems. However, it must be recognized that the sample size was small.

The rust fungus found in one field in the Outlook district was identified as *Uromyces viciae-fabae* (Grev.) de Bary. A second collection of rust was made in experimental plots in late August at the University of Saskatchewan, where two lines had severe infection of the lower leaves. This collection proved to be a new biotype of *U. viciae-fabae,* characterized by larger uredospores and the presence of amphispores in the uredosori (D.B.O. Savile, personal communication).

Botrytis cinerea Pers. was isolated from the leaves of one plant in a field in the Kindersley district early in the season but was not found later in any fields. No isolates of *B. fabae* Sard. were obtained at all from foliage, despite the fact that this pathogen has been reported to have been introduced to Canada (7). However, one isolate of *B. fabae* was obtained from seed samples (see below).

The leaf lesions from which *Alternaria* spp., *Cladosporium* spp., and *Coniella pulchella* were the prevalent isolates were found in most fields during all survey trips (Table 1). The lesions were distinct in morphology; they ranged in size from 0.1 to 1.0 cm and were oval to irregular in shape. The color varied from tan to brown to black, and there were usually brown, red-brown, or chlorotic margins. Further work on the isolates from these lesions is in progress.

Herbicide injury was observed in several fields in the Outlook district early in the season. However, during the final surveys it was found in only one field in the Laird district, where 27.5% of the plants were affected. The herbicide 'Dalapon' had been applied to the crop. Symtoms included puckering of the young leaves, browning of the adaxial side of older leaves, and severe stunting.

Root, stem, and other diseases

Root rots were the predominant diseases (Tables 1,3). Fusarium root rot was found throughout the season, and in 14 out of 27 fields at the end of the season. It was especially prevalent in the Outlook fields. *Rhizoctonia* sp. was isolated from root rot lesions only from the Outlook district late in the season, while a third fungus, *Coniella pulchella* was isolated relatively frequently in several districts throughout the season. However, the pathogenicity of *C. pulchella* and the other organisms isolated from roots (Table 1) remains to be established.

Sclerotinia stem rot was found in trace amounts in four fields late in the season. This constitutes a new Saskatchewan record for the causal organism, *Sclerotinia sclerotiorum* (Lib.) de Bary.

An abnormality entitled 'yellows' in Tables 1 and 3 was found late in the season. The symptoms included general chlorosis, thickened and turgid leaves, and occasionally browning of the vascular tissue of the taproot. The various organisms isolated from the taproot tissue included *Coniella pulchella, Fusarium* spp., *Verticillium* spp., *Cephalosporium* sp. and bacteria. No organisms were isolated from taproots that were not discoloured. Some of the symptoms suggest a viral, a mycoplasmal, or even a vascular wilt infection. Descriptions of pea leaf roll on fababean in Britain (8,16), and aster yellows in Alberta (C. Hiruki, personal communication) resemble the conditions of the affected plants in Saskatchewan fields. On the other hand, the occasional browning of vascular tissue in the taproot may indicate a wilt infection, although it could be part of a disease complex, or even the result of secondary invasion by the saprophytic soil microflora.

Table 2. Intensity of leaf and pod diseases in late season by district*

	Percent area diseased							
	Powdery mildew on leaves		Ascochyta on leaves		Ascochyta on pods		Other leaf spots†	
District	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Outlook	11.1	1.4-19.3	0		0		0.04§	0.01-0.08
Laird	0.9	0 - 5.2	0.15	0-0.36	0.01	0-0.08	0.25	0.10-0.40
Kindersley	0		0.03	0-0.07	0		0.85	0.26-1.33
Tisdale	0		0.04	0-0.08	0		0.28	0.26-0.29
SE Sask.	0.5	0 - 0.9	0.03	0-0.06	< 0.01	0-0.01	0.12	0.12-0.24
Mean	2.5	0 -19.3	0.05	0-0.36	< 0.01	0-0.08	0.31	0.01-1.33

* See Table 1 for occurrence of diseases in fields and for sampling dates in each district.

† Miscellaneous leaf lesions from which ***Alternaria*** spp., ***Cladosporium*** spp., and ***Coniella pulchella*** were isolated.

§ Includes a trace of rust.

Table 3. Incidence of root, stem, and other diseases in late season by district*

	Percentage of plants infected							
	Fusarium root rot		Other root rot†		"Yellows"		Sclerotinia stem rot	
District	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Outlook	1.8	0-3.5	2.2		0.1	0-1.0	0	
Laird	0.2	0-1.0	0.4		0.4	0-0.1	0	
Kindersley	0.5	0-1.5	0.1		1.1	0-4.0	0	
Tisdale	0		0		0		1.0	0.5-1.5
SE Sask.	0.9	0-2.0	1.4		0		0	
Mean	0.8	0-3.5	0.8		0.4	0-4.0	0.2	0 -1.5

* See Table 1 for occurrence of diseases in fields and for sampling dates in each district.

† For organisms isolated, see Table 1.

Seed isolations

The prevalent seed-borne flora, as indicated in Table 5, comprised species of *Alternaria, Cladosporium, Penicillium,* and bacteria. *Ascochyta fabae* was isolated from four samples, three from the Laird district and one from the Tisdale district. Three of the samples of the variety 'Erfordia' were highly infected. All four of the samples came from fields that had the greatest amount of ascochyta blight. *Botrytis cinerea* was isolated at low frequencies from a large number of the samples (Table 5) and only seed from the Outlook district was entirely free of the fungus. Seed of the variety 'Erfordia' showed no infection with *B. cinerea* although there was a relatively high amount of contamination. *Botrytis fabae* was isolated from only one sample and only from surface-disinfected seed; the mean percentage of infected seeds in the sample was very low. This was a sample of the variety Thuringer from the Laird district.

The sample of imported seed showed 4% *Ascochyta fabae* in plating of non-surface-disinfected seed and 8% in surface-disinfected seed; the seed from the subsequent generation showed amounts of 2% and 34% respectively. In addition, this progeny seed was very severely discolored, and had a high rate of infection and contamination with *Aspergillus* sp. (near *Eurotium pseudoglaucum* (Blochwitz) Malloch & Cain), and *Penicillium cyclopium* Westling.

Discussion

The increase in acreage of fababean in Saskatchewan from 1972 to 1973 was accompanied by a significant increase in the number of diseases. In 1972 only fusarium and rhizoctonia root rots, powdery mildew, and leaf and pod spots of uncertain etiology were found (10). In 1973 several new diseases were found, including three caused by potentially destructive pathogens, *Ascochyta fabae, Uromyces viciae-fabae,* and *Sclerotinia sclerotiorum.* Thus, while diseases have not yet caused serious losses on fababean in Saskatchewan, our results, and those of other workers (5,7, and C.C. Bernier, personal communication) indicate that the cultivation of fababean in Canada will be marked by several pathological problems from the outset. This is undoubtedly partly the result of inadequacies in past plant quarantine practices in Canada, a subject that we have discussed elsewhere (11). Over the past few years substantial quantities of fababean seed were imported to Canada from Europe with virtually no inspection and certainly no testing. Most of the diseases known for a long time on fababean in Europe are now well established in Canada.

The intensity of several diseases in 1973 appears to have been controlled by both inoculum loads and environmental factors. For example, in 1972 when fababean was first grown in Saskatchewan, powdery mildew was found at low levels in the Outlook irrigation district (10). In 1973 powdery mildew had greatly increased in this district, while in other districts it was present at lower levels, comparable to those in 1972 at Outlook. In 1973 more primary inoculum at Outlook may have effected a greater infection in the district. However, the intensity of powdery mildew on dryland crops may never be as great as that on the Outlook crops because of the higher humidity and greater crop density with irrigation. On the other hand, the sprinkler system of irrigation may serve to curb powdery mildew (14,18).

The original powdery mildew inoculum may have been introduced with seed, or more likely, have come from a local source, since both *Microsphaera penicillata* var. *ludens* and *Erysiphe polygoni* have been reported on native *Vicia* spp. (3). The latter species parasitizes a large number of different plants including such common species in Saskatchewan as rapeseed and pea. Whatever the origin of the inoculum, the identity of the fungus is a matter of some interest. Our record of *M. penicillata* var. *ludens* appears to be the first on *Vicia faba,* at least for North America, but whether this is the species that was widely found in the survey remains to be determined. One of the present authors (R.A.A.M.) has regularly observed heavy powdery mildew infections on broad bean in his garden over the last 4 years; the causal organism has always been tacitly assumed to be *E. polygoni* and careful checks were not made. If two species of powdery mildew fungus do occur on *V. faba* in Saskatchewan, both may have to be accounted for in future breeding for disease resistance, thereby making the programs more complicated.

The presence of rhizoctonia root rot only in the Outlook district in both the 1972 and 1973 surveys may be related to the buildup of soil inoculum due to the alternate cultivation of rhizoctonia-susceptible crops. The field of fababean with the highest amount of rhizoctonia root rot in 1973 was planted in 1972 to potatoes which had abundant rhizoctonia infection (unpublished data). In other districts the major alternate crops are cereals and rapeseed, on which rhizoctonia infections are not as common. The low levels of ascochyta blight in both the four dryland, and the Outlook irrigation district were probably due to environmental effects and lack of inoculum respectively. In the dryland districts (particularly Laird) inoculum was obviously present, and, had the same been true at Outlook, some field infections would certainly have been noticed there too. Elsewhere, although the cool wet spring weather may have been conducive to primary infection, the relatively warm, dry summer and early autumn weather probably retarded extensive secondary spread. The variation of intensity of the disease in the Laird fields, shown by foliage lesions (Table 4) and seed infections, was probably mainly due to variations in the amount of initial seed-borne primary inoculum. However, the role of varietal differences in susceptibility, suggested *(inter alia)* by some observations in experimental plots at Nipawin, cannot be ruled out.

It is more difficult to speculate about some of the other diseases that were found in the survey. *Uromyces viciae-fabae* has been reported previously from Sas-

Table 4. Occurrence of ascochyta blight and powdery mildew by fababean variety

Variety and no. of fields examined	Powdery mildew			Ascochyta blight		
	No. of fields infected	Percentage leaf area diseased		No. of fields infected	Percentage leaf area diseased	
		Mean	Range		Mean	Range
Diana (11)	8	8.1	0-19.3	3	0.02	0 -0.08
Erfordia (2)	1	0.3	0- 5.2	2	0.33	0.29-0.36
Ackerperle (3)	1	0.2	0- 0.6	2	0.04	0 -0.10
Thuringer (3)	1	0.7	0- 2.0	3	0.17	0.08-0.23
Topas (2)	0			2	0.02	0.02-0.02
Maris Bead (1)*	0			0		
Unknown (5)	3	0.4	0- 0.9	2	0.03	0 -0.07

* Field had severe herbicide injury.

Table 5. Seed-borne organisms on seed* from commercial fields

Organism	Not surface disinfected		Surface disinfected	
	% of total samples of occurrence	Mean % of seeds contaminated or infected	% of total samples of occurrence	Mean % of seeds infected
Ascochyta fabae	12.5	0.5	16.7	3.3
Botrytis cinerea	25.0	1.3	33.3	0.8
Botrytis fabae	0.0	0.0	4.2	0.1
Alternaria spp.	95.8	64.0	95.8	18.9
Cladosporium spp.	95.8	19.4	75.0	4.9
Penicillium spp.	95.8	13.0	33.3	1.9
Aspergillus spp.	4.2	4.1	4.2	1.6
Fusarium spp.	58.3	2.3	12.5	0.3
Arthrinium sp.	41.6	1.9	29.2	1.1
Stemphylium sp.	8.3	0.3	12.5	0.3
Gliocladium sp.	4.2	0.1	0.0	0.0
Cephalosporium sp.	4.2	0.1	0.0	0.0
Nigrospora sp.	8.3	1.2	16.7	0.5
Epicoccum sp.	37.5	3.1	12.5	0.4
Chaetomium sp.	4.2	0.1	12.5	0.7
Paecilomyces sp.	4.2	0.3	4.2	0.1
Trichoderma sp.	8.3	0.3	0.0	0.0
Pestalotia sp.	0.0	0.0	4.2	0.1
Pullularia sp.	0.0	0.0	4.2	0.1
Thamnidium sp.	4.2	0.?	0.0	0.0
Bacteria	70.8	4.4	79.2	8.8

* 24 samples; 50 seeds plated/treatment/sample.

katchewan on native and cultivated plant species (2,3) but there may be a relatively low level of inoculum due to natural stabilization processes. Furthermore, the prevalent biotypes of the fungus may not be virulent on some fababean varieties. The origin of the new biotype found in plots at Saskatoon is enigmatic, since the two lines infected had both been imported and grown at Saskatoon in 1972, although no infection was noticed until 1973. However, the severity of infection of plants of the two lines (and the strict confinement of the rust to the two lines) suggests that careful attention will have to be paid to the disease in future. As for chocolate spot, *Botrytis cinerea* has also been previously reported in Saskatchewan on native and cultivated plant species (2,3,10,12) and inoculum of the fungus was obviously present in many of the crops (Table 5). Little infection occurred probably because this fungus is a weak pathogen of fababean (1,4). *B. fabae,* the more vigorous incitant of chocolate spot, had not previously been recorded in Saskatchewan. Hence, the trace of seed infection and lack of foliar infection probably indicates that an extremely low amount of inoculum was introduced with the seed. Yet it is surprising that no foliar infection was found since the disease required climatic conditions similar to ascochyta blight. Little can be said about the species of *Alternaria* and *Cladosporium,* and *Coniella pulchella,* isolated from leaves, at least until identifications and pathogenicity tests are complete. *Alternaria* spp. have been reported to cause leaf, pod, and stem blights of broad bean in other provinces (6,9,13), and *A. tenuis* has been reported as a secondary pathogen of broad bean in the United States (17).

In conclusion, this survey revealed a number of potentially serious pathological problems in fababean production in Saskatchewan. While this is a regrettable situation when the crop has been grown in the Province for only 2 years, control measures for many of the diseases are known and attempts to develop and expand fababean production should continue. However, the need for further pathological studies, both surveys and experimental studies on epidemiology, disease resistance, and control, is clearly evident.

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