Ascochyta blight of lentils in western Canada: 1978 to 1980

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Ascochyta blight of lentils was reported in Canada for the first time in 1978. Surveys of seed samples clearly demonstrated that the disease was already widespread in Saskatchewan and Manitoba. The main symptoms of ascochyta blight consist of purplish-brown shrunken seed and white to tan-colored leaf, stem and pod lesions, which usually become speckled with black pycnidia. The causal organism is similar morphologically to *Ascochyta fabae* Speg. sensu Boerema & Dorenbosch but the authors prefer to retain the name *A. lentis* Bondartzeva-Monteverde & Vassilievsky because of the apparent host specialization of the pathogen. A field survey in Saskatchewan in the summer of 1979 showed very low levels of ascochyta blight in southern and west-central areas. More disease was present in the moister region north of Saskatoon. Reduction in seed quality due to the disease is probably more important than yield losses.

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La brûlure ascochytique de la lentille a été identifiee pour la premiere fois au Canada en 1978, alors que des echantillonnages de semences montraient que la maladie était déjà répandue en Saskatchewan et au Manitoba. Les principaux symptômes de cette maladie sont une coloration blanche à brun clair des feuilles, l'apparition sur la tige et les gousses de lesions habituellement parsemees, a maturite, de pycnides noirs et une decoloration brun pourpre et un rabougrissement des graines. La pathogene est morphologiquement semblable à *Ascochyta fabae* Speg. sensu Boerema & Dorenbosch, mais nous preferons lui conserver le nom de *A. lentis* Bondartzeva-Monteverde & Vassilievsky, à cause de sa specificite apparente en ce qui concerne l'hôte. Une enquête de terrain effectuee en Saskatchewan durant l'ete 1979 a indique un tres faible taux d'infection dans le sud et le centre-ouest de cette province mais les regions plus humides au nord de Saskatoon ont été plus touchees. La baisse de la qualite des semences causee par la brûlure sera probablement plus importante que la reduction du rendement.

Introduction

Lentils have been grown commercially in western Canada since 1970. Despite fluctuations in the area planted in the first seven years, lentils now represent a well-established cash crop in several regions. The estimated Canadian hectarage for 1980 is 30,000 compared with 19,000 in 1979 and 10,000 in 1978 (Sask. Pulse Crop Growers Assn. Newsletter No. 43, Feb. 1980). The majority of these areas are in Saskatchewan. Surveys of commercial lentil fields in the early and mid-seventies (8, 9, 14, R.A.A. Morrall, unpublished) showed that the crop was relatively disease free, particularly with respect to foliar diseases. Before 1978 the only significant epidemics in western Canada were severe sclerotinia stem rot in isolated fields in Manitoba (A.E. Slinkard, personal communication).

In September 1978 a sample of severely discolored lentil seeds was received from Laird, Saskatchewan, about 70 km north of Saskatoon. Isolations were made from surface disinfected seeds on 20% V8 juice agar (V8). Ninety eight percent of the discolored seeds and 48% of the normal seeds in the sample yielded an *Ascochyta* sp. which caused lesions on roots and shoots developing from seeds in the isolation plates. The same fungus was isolated from leaf and stem lesions on volunteer lentil seedlings and lentil re-growth in the Laird district in early October 1978. Koch's postulates were fulfilled for these *Ascochyta* isolates by inoculating commercial lentil seedlings in pots in the greenhouse. Crude spore suspensions prepared from V8 plate cultures of the fungus were sprayed on 2-week old seedlings and the pots were covered for 24 hours with plastic bags. After 10 - 14 days lesions appeared on the leaves and stems and the same *Ascochyta* was again isolated from them.

Further investigation demonstrated that this was the first record in North America of ascochyta blight of lentils, an important disease known in other parts of the world (*2*, 4, 6, 7, 11, K. Davatzi-Helena, personal communication). The origin of the disease in Saskatchewan is unclear. Earlier surveys (8, 9, 14) failed to reveal its presence, but subsequent seed tests demonstrated clearly that it had been widespread in 1978. The grower who submitted the original discolored seed sample claimed to have observed a similar problem in 1977. Prior to that, he had grown lentils since 1972, consistently using his own seed.

The purpose of the present paper is (a) to describe the symptoms of the disease, (b) to discuss briefly the morphology and taxonomic position of the pathogen, (c) to report on surveys of seed samples and of commercial fields conducted in 1979 and 1980, and (d) to discuss control of the disease. A preliminary report on parts of the work has already been presented (15).

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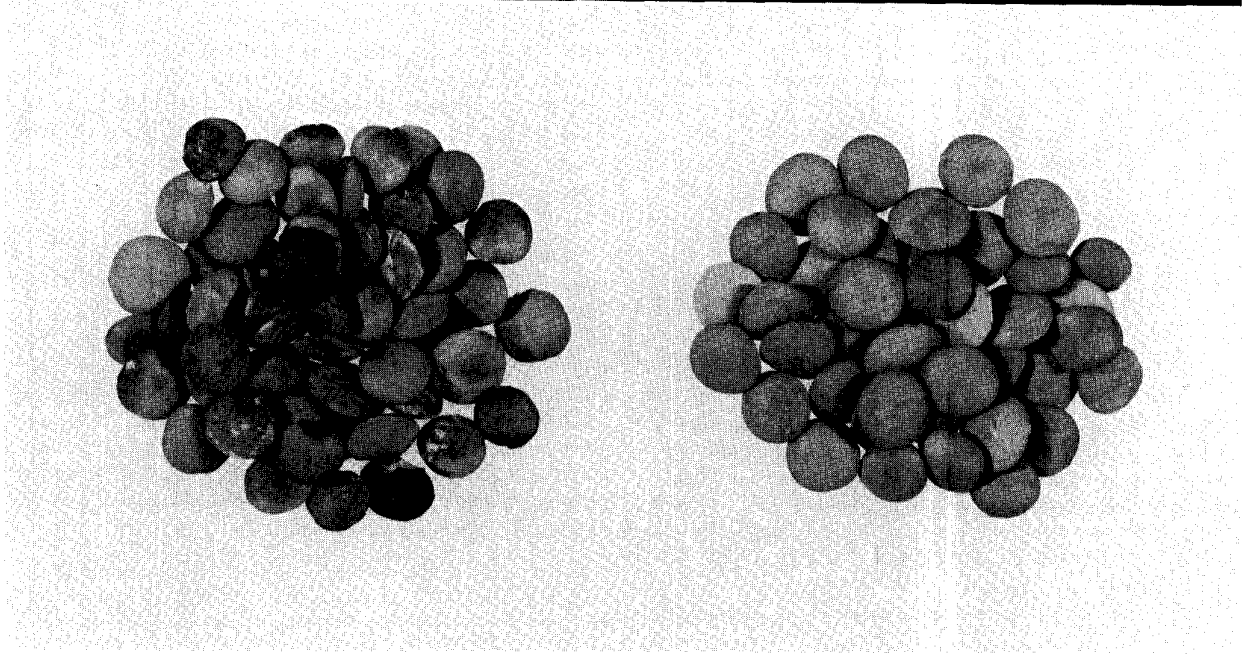

Figure 1. Lesions on lentil leaflets caused by ***Ascochyta*** infection. Note prominent pycnidia in lesions. (X3)

Figure 2. Healthy lentil seed and seed severely infected by ***Ascochyta.*** Note discoloration, and shrivelling of infected seed and presence of white mycelial flecks. (X2)

Symptoms of the disease

Lesions on the stems and leaves are initially whitish to greyish becoming light tan colored. Mature lesions usually have darker margins and the centres are speckled with pycnidia (Fig. 1). The pycnidia may be scattered or in concentric circles. Coalescing lesions cause blighting and leaflet abscission. Lesions on pods are generally darker than those on leaves; after the pods have ripened the infected areas tend to have a purplish hue. Severely infected seeds are shrivelled and show a purplish brown discoloration, sometimes in patches and sometimes covering the entire seed (Fig. 2). Occasionally pycnidia and small flecks of mycelium are present on the seed surface. Seeds fail to germinate if they are badly shrivelled and discolored.

Review of the morphology and taxonomic position of the pathogen and names of the disease

The first report of *Ascochyta* on lentils was from Russia in 1938 (4) when the pathogen was described as a new species, *Ascochyta lentis* Bondartzeva-Monteverde & Vassilievsky. The symptoms described are similar to those observed in Saskatchewan, and the description of the pathogen suggests that the differences from Saskatchewan isolates, if any, are only minor. *Ascochyta lentis* from Russia was described as producing 2-celled conidia 11.5-19.5 X 3.5-5.8 μ on lentils, or 13.5-17 X 4-5.7 μ in oat agar culture (4). Saskatchewan isolates generally produce conidia 10-20 X 4-8 μ (Mean: 15.8 X 5.7 μ) on lentil plants and there are a few multiseptate conidia among a majority of 2-celled forms. Unfortunately, we do not know the exact formula of the oat agar used by the Russian workers, but we have tested Saskatchewan isolates on three oat-based agar media (1, 17). On oat agar (1, p. 242) and oatmeal agar (17, p. 51) mycelial growth is dense and sporulation is protuse; however, on oatmeal agar (Shirling and Gottlieb No. 3) (17, p. 51) mycelial growth and sporulation are sparse. There are no significant differences between the three media in conidial dimensions, which are 10-23 X 4-8 μ (Mean 15.6 X 5.9 μ). Multicellular conidia occur occasionally. On V8, Saskatchewan isolates grow well and sporulate profusely; the conidia average 14.7 X 4.1 μ and multicellular forms are slightly more common than on lentil plants or oat-based media. A disease with the same symptoms as those described in Russia and Saskatchewan has been referred to in Argentina either as lentil stain (2) or lentil spot (11) and has been attributed to *A. lentis.* One report from India described a disease with similar symptoms which was called lentil blight; the pathogen was referred to as *A. pisi,* but the figures and description in the text (7) leaves some doubt about the identity. The fungus has larger and more frequently multi-septate conidia than *A. pisi* Lib. fide Jones (5) and is probably identical to the fungus from Saskatchewan. On the other hand, a recent general publication on lentil pathology from India (6) refers to the disease as ascochyta leaf blight caused by *A. lentis.*

Cultures of the lentil ascochyta from Saskatchewan have been examined by Drs. J. Bissett (Biosystematics Research Institute, Ottawa) and H.A. van der Aa (Centraalbureau voor Schimmelcultures, Baarn) and compared with related ascochytas from legumes. They both express the opinion that the fungus should be referred to *A. fabae* Speg. sensu Boerema & Dorenbosch (3), which has conidial dimensions of about 15 X 4-5 μ. Dr. Bissett believes that *A. lentis* is possibly a synonym of *A. fabae.* On the other hand, a recent Russian monograph on *Ascochyta* (10) places *A. lentis* in synonymy with *A. boltshauseri* Sacc. fide Sprague (16). In view of these different taxonomic opinions and the fact species delimitation in *Ascochyta* has frequently been based on host specialization, the present authors are reluctant to reject the name *A. lentis* in favor of *A. fabae* or *A. boltshauseri.* Bondartzeva-Monteverde and Vassilievsky (4) mentioned originally that *A. fabae* and *A. lentis* were specific to broad bean and lentil respectively and the lentil *Ascochyta* from Saskatchewan appears to be quite host specific. To date we have been unable to find the same fungus on other native or cultivated legumes in Saskatchewan. In preliminary cross-inoculation tests in the greenhouse using isolates of *A. pinodes* Jones and *A. pisi* from peas, *A. fabae* from fababeans in western Canada and the lentil *Ascochyta* from Saskatchewan, we have induced symptoms only on the original hosts. The results with *Vicia faba* cv. Petite Tic Bean were particularly dramatic. This cultivar is highly susceptible to *A. fabae* and is used at Saskatoon as a "spreader" in disease nurseries. Whereas Petite Tic Bean showed severe leaf and stem spotting and leaf abscission when inoculated with a mixture of isolates of *A. fabae,* it showed no symptoms at all when inoculated with *Ascochyta* from lentils.

The lentil *Ascochyta* and *A. fabae* are somewhat different culturally when grown on V8, but there are microscopic similarities between the two. Thus, despite the apparent host specialization the possibility of *forma speciales* or even physiologic races of one species cannot be ruled out. However, until more isolates of *Ascochyta* from fababeans, lentils and other legumes have been studied and their host ranges tested we are willing to propose erecting *forma speciales* when there is little taxonomic precedent in the genus *Ascochyta.* We intend to retain the name *A. lentis* for the isolates from lentils in western Canada. Further work is in progress in the senior author's laboratory which will lead to a detailed description of the cultural, morphological and pathogenic characteristics of *A. lentis* from western Canada.

Surveys of seed samples

Saskatoon

Once the potential of the disease for serious seed discoloration was realized, it was decided to determine if the Laird outbreak in 1978 was an isolated occurrence. Therefore, from February to early May 1979 a survey of seed samples from the 1978 crop in western Canada was undertaken at Saskatoon.

Commercial seed samples were obtained from various parts of Saskatchewan through Pioneer Grain Ltd., one of the major lentil contracting companies in 1978. Random subsamples of 200 seeds were taken from each sample, surface disinfected for 10 min. in 0.6% NaOCl, plated on V8 and incubated on the laboratory bench for at least one

week. Colonies of *Ascochyta* on the plates were counted to derive percentage infection figures. Where *Ascochyta* was not obtained from a subsample, but discolored seeds had been observed in the original sample, isolations were made selectively from the discolored seeds. If these yielded *Ascochyta* the infection was recorded as a trace. The results (Table 1) showed that the disease had been widespread in Saskatchewan in 1978. At least traces of infection occurred in seed from six geographic regions; several samples from central Saskatchewan showed high levels of infection and severe discoloration.

The second part of the survey conducted at Saskatoon involved lentils destined for seed use in 1979 in western Canada. Samples were solicited from contracting companies and seed suppliers, and, where possible information on the geographic origin of the seed was obtained. Nineteen samples were submitted and subsamples of seeds were plated on V8, as before. Some samples were so severely discolored that it was clearly unnecessary to plate 200 seeds to obtain a reliable estimate of percentage infection with *Ascochyta*. Thus, the estimates (Table 2) were based on subsamples of from 100 to 400 seeds. Again it was evident that the pathogen had been widely distributed in 1978 and it was disturbing to see the extremely poor quality of seed that some contractors were handling. In all, 74% of the samples carried the pathogen; the most heavily infected were from central Saskatchewan.

Table 1. Incidence of Ascochyta in 1978-grown commercial lentil samples from Saskatchewan growers*.

Saskatchewan Crop District	Geographic location in arable part of Saskatchewan	No. samples tested	No. samples with Ascochyta infection	No. of samples in different % infection categories					
				0%	Trace***	0.5%	0.75–2.5%	2.75–5.75%	〉6%
2	S. Central	2	2				1	1	
3	S.W.	2	2				1	1	
5	E. Central	2	2					1	1
6	Central	9	5	4		1		2	2
7	W. Central	1	0	1					
8	N.E.	1	1		1				
9	N.W.	3	1	2	1				
Total		20	13	7	2	1	2	5	3

'Samples obtained through Pioneer Grain Ltd.
** Usually 200 seeds per sample plated on 20% V8 agar after surface disinfection for 10 mins. in 10% Javex (0.6% NaOCl).
*** Trace - see text for explanation.

Table 2. Incidence of Ascochyta in lentil seed samples tested at Saskatoon in late winter 1979*.

No. of Supplier of seed	Geographic origin of seed	No. of samples	No. with ascochyta infection	No. of samples in different % infection categories				
				0%	0.5%	0.75–2.5%	2.75–5.75%	〉6%
1	? Sask.	1	1				1	
2	? Sask.	1	1					1
3	?	1	1			1		
4	? Manitoba	2	1	1		1		
5	W. Central Sask.	2	0	2				
6	S. Central Sask.	4	3	1		1	1	1
7	Central Sask.	5	5				1	4
8	? W. Central Sask.	1	0	1				
9	Central Sask.	1	1					1
10	? Manitoba	1	1		1			
Total		19	14	5	1	3	3	7

*loo-400 seeds per sample plated on 20% V8 agar after surface disinfection for 10 mins. in 10% Javex (0.6% NaOCl).

Table 3. Incidence of Ascochyta in seed samples from the 1978 lentil crop tested in Ottawa.

Origin	No. samples tested	No. samples with *Ascochyta spp.*	No. of samples in different % infection categories				
			0%	0.5%	0.75–2.5%	2.75–5.75%	> 6%
Manitoba	43	18	25	7	4	4	3
Sask.	20	15	5	1	4	2	8
Alberta	1	1			1		
B.C.	6	4	2		1		3
Unknown	2	1	1				1
Total	72	39	33	8	10	6	15

Ottawa

Surveys of seed samples from the 1978 and 1979 crops were also conducted at Ottawa. The samples were obtained from Customs offices, from seed companies and from growers in the four western provinces. However, it is probable that samples from British Columbia were grown elsewhere. More samples from the 1979 crop were obtained than from the 1978 crop, probably because news of the disease had spread among pulse crop growers through newsletters and other media. Producers were invited to submit seed to Ottawa for agar plate testing. Thus, the 1979 crop samples may have been more representative than the 1978 crop samples of all lentil growing areas in western Canada.

Four hundred seeds were drawn from each sample received in Ottawa and surface-disinfected by soaking for 10 min. in NaOCl adjusted to 2% available chlorine. After disinfection the seeds were plated on V8, 10 seeds to a plate, and incubated for 7 days at 22°C with a 12 hr. photo-period and near ultra violet light. After counting colonies of ***Ascochyta*** on the plates, percentage infection figures were derived.

It is probable that some of the 1978 crop samples overlapped those tested at Saskatoon, but in any case the results (Table 3) confirmed the widespread distribution of the pathogen. Nearly 55% of the samples were infected and 21% showed an infection level above 6%. Most of the heavily infected samples came from Saskatchewan. Samples from the 1979 crop were generally not as heavily infected as those from the 1978 crop (Table 4). About 38% of the 1979 samples were infected and 11% carried more than 6% ascochyta. However, the most severely infected samples came proportionately equally from Manitoba and Saskatchewan.

Field survey, 1979

To obtain further information on the geographic range of the pathogen as a sequal to the initial seed testing, a survey of lentil fields was done in 1979 in Saskatchewan. Emphasis was placed on the major lentil growing districts. Most fields were visited twice, once in mid to late June to check for seedling infection of possible seed-borne origin, and once in early August to check the intensity of disease shortly before harvest. Each field was usually inspected in only one or two places, and mainly qualitative observations of the intensity of ascochyta blight were made. When the symptoms were questionable, plant samples were collected and isolations made to confirm the presence of the pathogen. Where possible, information was obtained from the grower on source of seed, agronomic practices and crop history of the field.

There was an extremely low level of ascochyta blight in most areas of Saskatchewan (Table 5). The disease was found in only 23% of 61 fields visited during the summer, and only 11% of the fields showed more than trace of disease by early August. Generally fields in the central and northeastern crop districts were more heavily infested. The low levels of disease made detailed comparisons with seed source, etc., valueless, but it is noteworthy that ascochyta blight occurred in all three of the fields which had been planted on lentil stubble.

Table 4. Incidence of Ascochyta in seed samples from the 1979 lentil crop tested in Ottawa.

Origin	No. samples tested	No. samples with *Ascochyta spp.*	No. of samples in different % infection categories				
			0%	0.5%	0.75–2.5%	2.75–5.75%	> 6%
Manitoba	33	11	22	4	2	1	4
Sask.	53	23	30	6	7	3	7
B.C.	11	4	7	4			
Total	97	38	59	14	9	4	11

Table 5. Incidence of ascochyta blight in commercial lentil fields in 1979 in Saskatchewan.

Saskatchewan Crop District No.	Geographic location in arable part of Saskatchewan	Total No. of fields inspected	First inspection*		Second inspection		No. fields with more than trace' of ascochyta
			Total No. of fields	No. fields with ascochyta	Total No. of fields	No. fields with ascochyta	
2	S. Central	29	29	3	27	5	0
3	S.W.	7	7	0	7	0	0
5	E. Central	3	3	0	2	0	0
6	Central	10	2	0	8	5	5
7	W. Central	9	9	1	9	0	0
8	N.E.	3	3	3	1	1	1
Total	- -	61	53	7	54	11	6

*mid-late June
**early August
+Trace-for explanation see text.

Discussion

Ascochyta blight is now established as the major disease of lentils in western Canada. Probably it affects seed quality and marketability more than yield. A report from Argentina (2) refers to the lowered commercial value of infected lentil seeds and many Saskatchewan growers experienced similar losses in 1978. Under Saskatchewan management practices much of the seed discoloration associated with ascochyta infection may be due more to saprophytic growth of the fungus on ripening pods after the crop has been swathed (cut and placed in windrows) than to parasitic infection of immature pods and seeds. Lentil plants are short and are usually cut close to the ground. The swath lies almost flat on the ground rather than on top of a stubble which would assist ventilation. Hence, rain or heavy dew after cutting may cause prolonged wetness of lentil swaths and provide excellent conditions for the saprophytic development of *Ascochyta.* Even when the disease is scarce in a standing crop, the opportunity for severe seed discoloration to develop at harvest time may still exist. Studies of the relative importance of yield and quality losses due to ascochyta blight and of the role of harvest date and weather conditions on seed discoloration are in progress in the senior author's laboratory.

Various ascochyta diseases of legumes are favored by moist weather and ascochyta blight of lentil appears to be no exception (2, 15). The lower incidence of seed infection in 1979 crop samples probably reflects the generally drier harvest conditions in 1979. In August and September 1978 rains in most parts of Saskatchewan resulted in many lentil crops lying in the swath for about four weeks. Similarly, in the field survey in 1979 the low levels of disease in the south and west-central parts of Saskatchewan undoubtedly partly reflected the dry conditions prevailing there for most of the growing season. More disease was present north of Saskatoon where more rainfall occurred. Observations in a smaller number of fields in 1980 (R.A.A. Morrall and B.D. Gossen, unpublished) were similar. However, in the more northern regions the role of infected stubble from previous diseased crops must be considered.

Disease control

Recommendations for disease control to western Canadian lentil growers are at present based only on general pathological principles. Crop rotation, early seeding to escape moister weather at harvest, the use of disease-free seed and obtaining agar plate tests of prospective seed lentils are advised. To date there are no data on ascochyta blight to suggest that pulse crop growers should not include other legumes in a rotation with lentils; *A. lentis* appears to be host-specific and will probably not be transmitted by native legumes, weeds, forage crops or other pulses.

Since ascochyta blight is seed-borne it is possible that seed treatments will help to control the disease. In Argentina the use of several fungicides, including captan and thiram, is recommended (2). Tests in Saskatchewan in 1979 and 1980 (12, 13) with 10 compounds have given equivocal results. However, seedling emergence figures were complicated by factors such as seed of very low germinability (13) and the presence of soil-borne seedling blight organisms (12). Disease control by seed treatment may be feasible only in established lentil growing areas because of the potential interference of fungicides with *Rhizobium* inoculant applied to the lentil seed (13). Moreover, because of the ability of lentil plants to compensate for reduced plant stands by branching, significant increases in seedling emergence from seed treatment will not always be translated into significant yield increases.

In Argentina 509 lentil lines were assessed for disease reaction to ascochyta blight and 115 were assigned to the lowest category, in which only a few spots developed on the leaves (11). However, in India Khatri and Singh (7) tested 947 lines and found that only five had a high level of resistance. Results from Saskatchewan in 1979 and 1980 (R.A.A. Morrall, unpublished) showed that there are significant differences in disease reaction between breeding lines of lentils and that cv. Laird is more resistant than cv. Eston or commercial lentils. Thus, developing greater cultivar resistance should be another objective for disease control in the future.

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Literature cited

1. Ainsworth, G.C. 1961. Ainsworth and Bisby's dictionary of the fungi. 5th ed. Commonwealth Mycological Institute. 547 pp.
2. Anon. 1979. Lentils Diseases. Proc. 1st Internat. Lentil Res. Semin. Aleppo, Syria, May 1979. 13-16.
3. Boerema, G.H. and M.M.J. Dorenbosch. 1973. The Phoma and Ascochyta species described by Wollenweber and Hochapfel in their study on fruit rotting. Stud. Mycol. 3: 18-19 and 38-39.
4. Bondartzeva-Monteverde, V.N. and N.I. Vassilievsky. 1940. A contribution to the biology and morphology of some species of Ascochyta on Leguminosae. Acta. Instit. Bot. Acad. Sci. U.R.S.S. 1938, Ser. II (Pl. Crypt.) 345-376. (In. Rev. Appl. Mycol. 20: 232-234, 1941).
5. Jones, L.K. 1927. Studies of the nature and control of blight, leaf and pod spot, and footrot caused by species of Ascochyta. N. Y. Agric. Exp. Stat. Bull. 547: 46 pp.
6. Khare, M.N., S.C. Agrawal and A.C. Jain. 1979. Diseases of lentil and their control. Tech. Bull. Jawaharlal Nehru Univ. 29 pp.
7. Khatri, H. L. and K. Singh. 1975. Lentil blight - a new record for India. Labdev. J. Sci. Tech. 13-B: 73-74.
8. McKenzie, D.L. and R.A.A. Morrall. 1973. Diseases of three specialty legume crops in Saskatchewan in 1972: field pea, lentil, and fababean. Can. Plant Dis. Survey, 53: 187-190.
9. McKenzie, D.L. and R.A.A. Morrall. 1975. Diseases of specialty crops in Saskatchewan. II. Notes on field pea in 1973-74 and on lentil in 1973. Can. Plant. Dis. Survey 55:97-100.
10. Mel'nik, V.A. 1977. Opredelitel' gribov roda Ascochyta Lib. Leningrad, U.S.S.R. Izdatel'stvo Nauka. 246 pp.
11. Mitidieri, I.Z.M. DE. 1975. La mancha de la lenteja (Lens *culinaris*) Medik causada pro Ascochyta *lentis* Bond. y. Vassil., en la Argentina. Revta Invest. agric., B. Aires. 11:43-55.
12. Morrall, R.A.A. 1980. Evaluation of seed treatments to improve emergence of Ascochyta - infected lentil seed. Pesticide Res. Rept., Agric. Canada, Ottawa. 224.
13. Morrall, R.A.A. and B.D. Gossen. 1979. Evaluation of seed treatments for the control of seed-borne ascochyta blight of lentils. Pesticide Res. Rept., Agric. Canada, Ottawa. 406-407.
14. Morrall, R.A.A., D.L. McKenzie, L.J. Duczek and P.R. Verma. 1972. A qualitative survey of diseases of some specialty crops in Saskatchewan in 1970 and 1971; sunflower, safflower, buckwheat, lentil, mustards and field pea. Can. Plant. Dis. Survey. 52: 143-148.
15. Morrall, R.A.A., J.W. Sheppard, and J. Bissett. 1979. Distribution of seed-borne ascochyta on lentils in western Canada in 1978-79. Proc. Can. Phytopath. Soc. 46: 65-66 (Abstr.).
16. Sprague, R. 1935. Ascochyta *boltshauseri* on beans in Oregon. Phytopathology 25: 416-419.
17. Tuite, J. 1969. Plant pathological methods. Fungi and bacteria. Burgess Publ. Co. 239 pp.