Host Range of *Uromyces viciae-fabae*

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ABSTRACT

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Rust fungus (*Uromyces viciae-fabae*) isolates collected from species of *Vicia*, *Lathyrus*, and *Pisum* were used in cross-inoculation studies on a total of 18 *Vicia* spp., 10 *Lathyrus* spp., one *Lens* sp., and one *Pisum* sp. The isolates had much wider host ranges than previously reported. Isolates of *U. vicia-fabae* share so many hosts in common that it was impossible to classify them into formae speciales. All of the isolates from native species of *Vicia* and *Lathyrus* infected one or more of the crop species, *Vicia faba*, *Pisum sativum*, and *Lens culinaris*. This suggests that these native plant species might have an important role in the epidemiology of rust on these crops.

Additional key words: Lathyrus ochroleucus, L. venosus, Vicia americana, V. Cracca.

Uromyces viciae-fabae (Pers.) Schroet. attacks several important crop species including faba beans (*Vicia faba* L.), peas (*Pisum sativum* L.) and lentils (*Lens culinaris* Medic.). Several species of *Vicia* and *Lathyrus* grown as ornamentals or as forage crops, as well as many wild species, are also infected by this rust. *U. viciae-fabae* has been reported to infect a total of 52 species of *Vicia* and 22 species of *Lathyrus* (8). In Canada and the United States the pathogen has been identified on six species of *Vicia* (*V. americana* Muhl., *V. angustifolia* Reichard, *V. caroliniana* Walt., *V. cracca* L., *V. faba*, and *V. sativa* L.) and on six species of *Lathyrus* (*L. japonicus* Willd., *L. nuttallii* Wats., *L. ochroleucus* Hook., *L. ornatus* Nutt., *L. palustris* L., and *L. venosus* Muhl.) (1,5).

Conners (4) reported that isolates of *U. viciae-fabae* obtained from *P. sativum* at different locations in Canada could be separated into three groups based on ability to infect *V. cracca*, *V. faba*, and *P. sativum*. He found an isolate from Manitoba that infected *V. faba* but not *V. cracca*, a second isolate from Nova Scotia that infected only *P. sativum*, and a third isolate from Quebec that could infect *V. cracca*. More extensive studies on the host specialization of isolates of *U. viciae-fabae* have been conducted in Europe and Japan (6,9). Gäumann (6) summarized most of the early host range work and proposed that the fungus be classified into nine different formae speciales, each with a host range limited to two or three species. Kispatic (12) later found the host range of f. sp. *viciae-fabae* de By. to be much larger when additional species of *Vicia* and *Lathyrus* were tested. More recently, Kapooria and Sinha (10,11) found that isolates of *U. viciae-fabae* from India were able to infect species included in the host ranges of several formae speciales.

The study reported here was undertaken to compare the host ranges of rust fungus isolates from native and cultivated hosts in Manitoba in order to better understand the epidemiology of this disease. The results were also compared with previous research on the host specificity of this fungus in a reevaluation of the formae speciales concept.

MATERIALS AND METHODS

Isolates of *U. viciae-fabae* were collected from *P. sativum* and several species of *Vicia* and *Lathyrus* at 13 locations in southern Manitoba, many of which were remote from areas of cultivation (Fig. 1). Two isolates from infected peas in Normandin, Quebec, were also included in this study. Fifteen single-pustule isolates from *V. faba* and five single-pustule isolates from *P. sativum* were used. All other isolates used in this study were mass transfers of urediospores from many uredia. Isolates were increased on their original host under a plastic cap connected to a source of filtered air

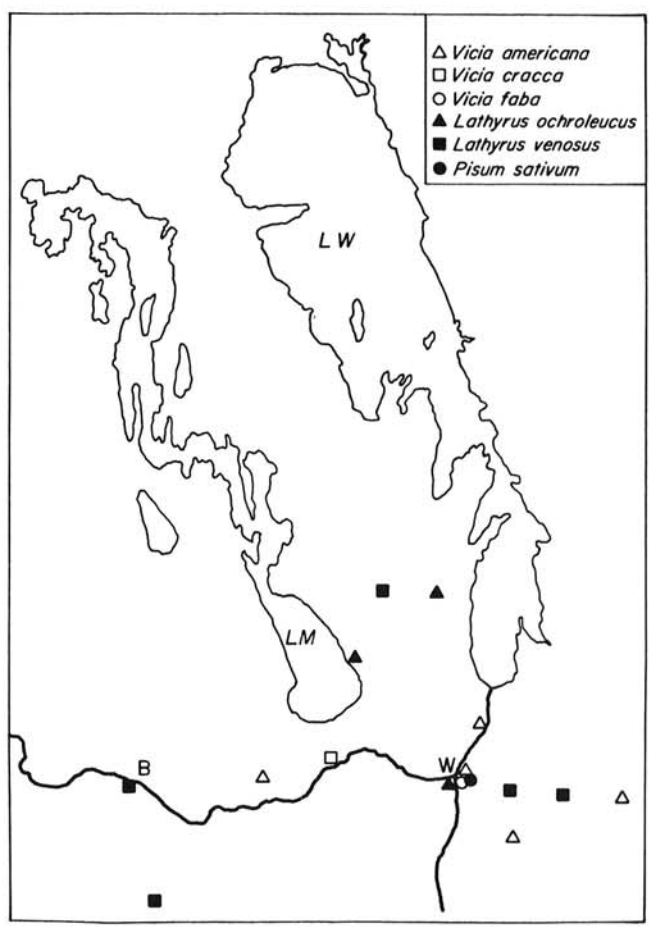

Fig. 1. Collection sites of *Uromyces viciae-fabae* isolates in southern Manitoba. W = Winnepeg, B = Brandon, LW = Lake Winnepeg, and LM = Lake Manitoba.

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in order to prevent cross-contamination of the isolates (7). Uninoculated plants of PI 222128 and of either pea cultivars Little Marvel or Melody were included in all tests to detect any possible contamination. Inoculum was collected with a cyclone spore collector (2) and stored at 5 C for no longer than 1 mo before use.

The host range tests included 18 *Vicia* spp., 10 *Lathyrus* spp., one *Pisum* sp. and one *Lens* sp. Each species was either native to Manitoba or has been used in previous studies. Two different selections for each species were used if seed was available.

Seed from these selections was scarified and placed in moist perlite. One week later, seedlings were transferred into 7.5-cm-diameter paper Jiffypots (Jiffy Products (N.B.) Ltd., Shippegan, N.B. Canada) containing a mixture of clay loam, sand, and peat (2:1:1, v/v). The Jiffypots were arranged in flats of 20 pots, each pot containing a different selection. Two weeks later, plants were sprayed with uredospores of a specific isolate suspended in a light oil (Soltrol 170, Philips Petroleum Co., Special Products Div., Borger, TX 79007) by means of a spore-oil suspension atomizer (2). After drying, the plants were maintained for 24 hr in a chamber at 100% relative humidity and then transferred to a growth room with a 16-hr photoperiod and a 20–16 C diurnal temperature cycle. Two weeks after inoculation plants were examined for the presence or absence of sporulation. A species was considered to be a host of a specific isolate if uredia developed on plants of at least one of the selections or lines. All isolates were tested at least twice.

RESULTS

Rust fungus isolates with identical host ranges are combined in Table 1. Species resistant to all of the isolates included *V. angustifolia* Reichard, *V. bithynica* (L.) L., *V. hirsuta* (L.) S. F. Gray, *V. lutea* L., *V. narbonensis* L., *V. sativa* L., *V. sepium* L., *V. tetrasperma* (L.) Shreber, *V. unijuga* A. Br., *Lathyrus hirsutus* L., *L. montanus* Bernh., and *L. pratensis* L.

Isolates from *V. faba* can be classified in two major groups based on ability to infect either *V. americana* or *L. latifolius* L. Group 1 includes single-pustule isolates 3, 11, 15, 17, 34, 36, 48, and 80, which were all able to infect *V. americana, V. calcarata* Desf., *V. disperma* DC., *V. faba*, *L. japonicus*, and *L. culinaris* (Table 1). The isolates in group 1 could be further separated on the basis of minor differences in host range. Isolates from *V. americana* had a host range very similar to that of *V. faba* isolates in group 1.

Group 2 of the isolates from *V. faba* includes single-pustule isolates 50, 51, 54, 56, 61, 81, and 82, which infect *L. latifolius* but not *V. americana*. These isolates all infect *V. calcarata*, *V. faba*, *V. monantha*, *L. culinaris*, *P. sativum*, *L. japonicus*, *L. latifolius*, and *L. sativus* L. Isolates in group 2 differed in ability to infect *V. disperma*, *V. ervilia*, *V. villosa* Roth., *L. ochroleucus*, and *L. odoratus*.

The two isolates collected from *P. sativum* in Quebec infected fewer hosts than isolates collected from *P. sativum* in Manitoba. The latter infected the cultivated species *V. faba* and *L. culinaris* as well as all of the hosts infected by the Quebec isolates. However, the pustules produced by Manitoban isolates on *V. faba* were smaller than normal susceptible pustules. *Lathyrus* species native to Manitoba and *L. sativus* were susceptible to the Manitoban rust isolates from *P. sativum*, but not to the Quebec isolates.

The single isolate from *V. cracca* had a host range similar to that of the isolates from *P. sativum* from Quebec, except that the isolate from *V. cracca* infected *V. villosa*, and *L. japonicus*.

The isolates from *L. ochroleucus* were similar to certain isolates from *V. faba* in group 2, most notably SP82. However, the isolates from *L. ochroleucus* differed from isolate SP82 in being unable to produce normal susceptible-type pustules on *V. faba*. The host range of isolates from *L. venosus* includes all the hosts infected by the isolates from *L. ochroleucus* and additional hosts such as *V. pisiformis*, *L. odoratus*, *L. tuberosus*, and *L. venosus*.

Consistent differences in response to certain rust isolates were found between lines within the species *V. calcarata*, *L. sativum*, and *L. culinaris*. In addition, the reactions of individual plants within selections of other host species to specific isolates were often inconsistent.

DISCUSSION

We found that the host ranges of our isolates of *U. viciae-fabae* were more extensive than previous research had indicated. Many isolates infected hosts included in the host ranges of several formae speciales, as described by Gäumann (6). This can be seen for both groups 1 and 2 of the *V. faba* isolates, which infected hosts included in the host ranges of f. sp. *viciae-fabae*, f. sp. *viciae-sepium*, and f. sp. *lathyri-maritimi*. These isolates behaved similarly to isolates of the f. sp. *viciae-fabae* described by Kispatic (11) except that some infected *V. monantha* and none infected *V. bithynica* or *V. narbonensis*.

We also found that isolates from *P. sativum* from different regions in Canada differ considerably in their host ranges. The isolates from Quebec correspond to Gäumann's f. sp. *craccae*, since they infected *P. sativum* and *V. cracca* but were unable to infect *V. faba*. However, these isolates also infect *V. ervilia* and *V. monantha*, which f. sp. *craccae* could not infect. The Manitoban isolates from *P. sativum* infected hosts of f. sp. *viciae-fabae*, f. sp.

TABLE 1. Host range of isolates of *Uromyces viciae-fabae* collected on native and cultivated hosts in Manitoba and Quebec, Canada

	Isolates from *V. faba*							Rust isolates from:					
	Rust group 1			Rust group 2									
Host	3,11,36,80	17	15,34,48	50,51	54,61	56,81	82	*V. americana*	Quebec *P. sativum*	Manitoba *P. sativum*	*V. cracca*	*L. ochroleucus*	*L. venosus*
Vicia americana[a]	+[b]	+	+	−	−	−	−	±	−	−	−	−	−
V. calcarata	±	±	±	±	±	±	±	+	±	±	±	−	−
V. cracca[a]	−	−	−	−	−	−	−	−	+	±	+	−	−
V. disperma	±	+	±	±	+	±	−	±	+	±	+	−	−
V. ervilia	±	−	−	−	−	±	−	−	+	+	±	−	−
V. faba	+	+	+	+	+	+	+	+	−	*	−	*	*
V. monantha	±	−	−	±	+	±	±	−	±	+	±	±	±
V. pisiformis	+	···	−	−	−	−	···	+	−	−	···	−	+
V. villosa	−	−	−	±	−	−	−	−	−	−	±	−	−
Lens culinaris	±	±	±	±	+	±	±	±	−	±	−	±	±
Pisum sativum	±	+	−	+	+	+	+	±	+	+	+	+	+
Lathyrus japonicus[a]	±	±	±	±	±	+	+	±	−	−	±	±	±
L. latifolius	−	−	−	±	±	±	+	−	−	−	−	+	±
L. ochroleucus[a]	−	±		−	±	−	+	−	−	+	−	+	±
L. odoratus	−	±	−	+	+	−	−	−	−	−	−	−	±
L. sativus	±	±	−	±	+	+	+	±	−	±	−	±	±
L. tuberosus	−	±	−	−	−	−	−	−	−	−	−	−	±
L. venosus[a]	···	−	−	−	−	−	···	−	−	+	−	−	+

[a] Native to Manitoba.

[b] Symbols: ± = not all plants in a species became infected; * = smaller than a susceptible-type pustule; and ··· = missing data.

craccae and f. sp. *lathyri-maritimi*.

The isolate collected on *V. cracca* infected hosts found in the host ranges of f. sp. *viciae-fabae*, f. sp. *pisi-sativi*, f. sp. *craccae*, f. sp. *viciae-sepium*, and f. sp. *lathyri-maritimi*.

Most rust isolates that could infect *P. sativum* corresponded to either the Manitoban or Quebec *P. sativum* "rust strains" described by Conners (4). Only the rust isolates collected in Manitoba from *P. sativum* could infect *V. cracca* and produce small pustules on *V. faba*. No other isolate that infected *P. sativum* could infect both *V. faba* and *V. cracca*.

Recent studies with pea cultivars and faba bean inbred lines have shown that distinct races of *U. viciae-fabae* exist (3). Consistent differences in susceptibility to specific rust isolates observed between lines of *V. calcarata*, *L. culinaris*, and *L. sativus* also indicate the presence of race specificity. Therefore, host range tests that include only one or two cultivars or accessions per species may yield negative results for some species that contain plants susceptible to some races of the pathogen, but not others.

The formae speciales concept seems inapplicable where so many hosts are shared in common by isolates with distinct host ranges. Hybridization between different rust isolates could occur on common hosts, and the resulting gene flow might account for the broad spectrum of host specificity found in this study.

Our isolates of *U. viciae-fabae* show little relationship to the formae speciales described by Gäumann (6). It is possible that the Manitoban isolates differ greatly from the European isolates. However, the studies summarized by Gäumann were not systematic or complete, as rust isolates were often not tested on key hosts of the formae speciales. Therefore, it appears that differences between the reported host ranges of Manitoban isolates and European isolates might be due more to incomplete testing of the latter, rather than inherent differences between the isolates from the two regions.

The results of this study also establish the importance of wild species of *Vicia* and *Lathyrus* in the epidemiology of this disease. The close similarities between the host ranges of isolates from *V. americana* and group 1 isolates from *V. faba* suggests that all these isolates may have originated on *V. americana*.

The origin of the group 2 isolates from *V. faba* remains unknown. The inability of isolates from this group to consistently infect native species of *Vicia* or *Lathyrus* suggests that they did not originate on these hosts. The numerous differences in host range between the isolates from *P. sativum* and group 2 isolates from *V. faba* seem to rule out peas (which have been grown in Western Canada for many decades) as the source of these isolates. Perhaps rust isolates in group 2 were introduced into this area, as McKenzie and Morrall (13) have suggested is the case for *U. viciae-fabae* in other areas of Canada.

LITERATURE CITED

1. Anonymous. 1960. Index of plant disease in the United States. Agric. Handb. 165. Washington, DC. 531 pp.
2. Browder, L. E. 1971. Pathogenic specialization in cereal rust fungi, especially *Puccinia recondita* f. sp. *tritici*: Concepts, methods of study and application. U.S. Dep. Agric. Bull. 1432. 51 pp.
3. Conner, R. L. 1981. Evaluation of resistance to rust (*Uromyces viciae-fabae*) in faba bean (*Vicia faba*) and pathogenic variability in *Uromyces viciae-fabae*. Ph.D. thesis, University of Manitoba. 118 pp.
4. Conners, I. L. 1937. Annual Report. Can. Plant Dis. Surv. 17:30.
5. Conners, I. L. 1967. An annotated index of plant diseases in Canada. Publ. 1251, Can. Dep. Agric., Res. Branch, Ottawa. 381 pp.
6. Gäumann, E. 1934. Zur Kenntnis des *Uromyces fabae* (Pers.) de By. Ann. Mycol. 32:464-470.
7. Green, G. J. 1981. Identification of physiologic races of *Puccinia graminis* f. sp. *tritici* in Canada. Can. J. Plant Pathol. 3:33-39.
8. Guyot, A. L. 1957. Les Urédinées (ou rouilles des végétaux). III. *Uromyces*. Encycl. Mycol. 29:505-554.
9. Hiratsuka, N. 1933. Studies on *Uromyces fabae* and its related species. Jpn. J. Bot. 6:329-379.
10. Kapooria, R. G., and Sinha, S. 1966. Studies on the host-range of *Uromyces fabae* (Pers.) de Bary. Indian Phytopathol. 19:229-230.
11. Kapooria, R. G., and Sinha, S. 1971. Further studies on the host spectrum of *Uromyces fabae* in India. Indian Phytopathol. 24:170-171.
12. Kispatic, J. 1949. Prilog poznovanju biologije i suzbijanaja bobove rdje *Uromyces fabae* (Pers.) de By. f. sp. *viciae-fabae* de By. Ann. Trav. Agric. Sci. 1(1):61.
13. McKenzie, D. L., and Morrall, R. A. A. 1975. Faba bean diseases in Saskatchewan in 1973. Can. Plant Dis. Surv. 55:1-7.