Evaluation of Resistance in *Vicia faba* to Two Isolates of the Rust Fungus *Uromyces viciae-fabae* from Manitoba

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ABSTRACT

Rashid, K. Y., and Bernier, C. C. 1984. Evaluation of resistance in *Vicia faba* to two isolates of the rust fungus *Uromyces viciae-fabae* from Manitoba. Plant Disease 68: 16-18.

Reactions of faba bean (*Vicia faba*) accessions from various regions of the world to single-pustule isolates SP3 and SP51 of the rust fungus *Uromyces viciae-fabae* were evaluated in the greenhouse. Accessions with at least one resistant plant of eight tested were common and a few accessions with several resistant plants were also observed. After three cycles of testing and selfing, 117 uniform lines were grouped into nine classes based on their reactions to the two rust isolates. Eleven lines showed a high level of resistance to both rust isolates and eight lines showed a high level of resistance to SP51 and were moderately resistant to SP3. Additional useful combinations of resistance included lines with moderate resistance to SP51 and high to moderate resistance to SP3 and lines with a high level of resistance to SP3 and moderate resistance to SP51. Resistant accessions identified in this study originated from six regions of the world.

Rust fungus *Uromyces viciae-fabae* (Pers.) Schroet. is a major disease of faba beans (*Vicia faba* L.) in the Middle East and North Africa, where epidemics cause yield losses as high as 20% (1). Rust has also been reported in both Manitoba and Saskatchewan on this crop since its introduction into Western Canada in 1970 (2,4,6,13).

In faba beans, the amount of cross-pollination can reach levels as high as 70% (10). Crop heterogeneity is reflected in the lack of uniformity in the reaction of cultivars to both rust (4,6,11,12) and chocolate spot, caused by *Botrytis fabae* Sard. (7). Failure to find rust resistance in previous attempts has been attributed to lack of cultivar uniformity (11,12) or to absence of resistance (9). Recently, Conner and Bernier (4–6) tested reactions of 17 cultivars and accessions of faba bean to two single-pustule isolates (SP3 and SP51) of rust with distinct virulence patterns. After three generations of selfing, three lines were uniformly resistant to isolate SP3 and one line to both isolates SP3 and SP51.

The purpose of this study was to evaluate reactions of faba bean accessions from various regions of the world to rust isolates from Manitoba in an effort to find additional sources of resistance and determine the distribution of resistance in germ plasm collections.

MATERIALS AND METHODS

Seventy-six faba bean accessions from various regions of the world were evaluated in addition to the susceptible line 2N40 (PI 222128) and four cultivars (Ackerperle, Diana, Erfordia, and Herz Freya) grown in western Canada. Eight seeds of each accession or cultivar were planted in two 15-cm clay pots in a 2:1:1 (v/v) mixture of soil, sand, and peat. The two youngest fully developed leaves of the 2-wk-old seedlings were inoculated with a suspension of uredospores in light oil (Soltrol 170, Philips Petroleum Co. Special Products Div., Borger, TX 79007) with a fine nylon brush. After drying, seedlings were incubated at 100% relative humidity for 24 hr, then moved into a growth room with a 16-hr photoperiod and a night and day temperature of 15–20 C. After 11–12 days, seedlings were scored for infection type (5) on a scale of 0–4, where 0–; =

Contribution 634, University of Manitoba, Winnipeg, Canada.

Accepted for publication 7 July 1983.

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highly resistant, 1–2 = moderately resistant, and 3–4 = susceptible. Selected plants were saved for selfing and seed increase.

In the first two cycles of testing, a mixture of rust isolates was used as inoculum, whereas in the third cycle, two single-pustule isolates (SP3 and SP51) with distinct virulence patterns were used (5,6). Plants were inoculated first with the less virulent isolate (SP3) and scored for infection type after 11 days, then infected leaves were removed and plants were inoculated with isolate SP51 and treated as outlined for isolate SP3.

Uredospores were increased on 2-wk-old plants of the rust-susceptible line 2N40 with standard procedures to prevent contamination (8). Inoculated plants were covered with polyvinyl caps and incubated as outlined before, then moved to the greenhouse, where the caps were connected to a source of filtered air to provide aeration and prevent cross-contamination of isolates. Uredospores were collected two or three times with a cyclone spore collector and stored at 5 C for no longer than 3 mo before use.

RESULTS AND DISCUSSION

All accessions and cultivars tested expressed considerable variability in their reaction to rust when inoculated with a mixture of isolates. However, accessions with at least one resistant plant (infection types 0–2) were common and a few accessions had several plants with resistant to highly resistant reactions. This variability can be attributed to heterogeneity of the accessions as well as to use of a mixture of rust isolates. Progenies from 239 selfed single-plant selections with resistance were subjected to a second cycle of testing and reselection. The level of heterogeneity within the selections was reduced considerably in the second cycle of selfing and 199 single resistant plants (0–2) were selected from 60 accessions for a third cycle of testing to single-pustule isolates SP3 and SP51. One hundred seventeen selections selfed three times (S_3) from 38 accessions reacted uniformly to either one or both rust isolates and were grouped into nine classes based on their reactions to the rust isolates (Table 1).

Resistance to isolate SP51 was less common than to isolate SP3; 63 S_3 lines showed resistance to SP51 compared with 100 lines with resistance to SP3. These results support the findings of Conner and Bernier (4) that isolate SP51 is more virulent than isolate SP3.

Eleven S_3 lines possessed a high level of resistance (0–;) to both isolates (class 1) and eight lines possessed a high level of resistance (0–;) to isolates SP51 and a moderate level of resistance (1–2) to isolate SP3 (class 4). In addition, five S_3 lines showed high to moderate resistance to SP51 but were susceptible to SP3 (classes 7 and 8).

Table 1. Classification of S_3 faba bean inbred lines based on their reaction to isolates SP3 and SP51 of *Uromyces viciae-fabae*

Class	Reaction to rust isolates[a]		Accession number[b] and source[c]
	SP3	SP51	
1	HR	HR	2N311 (NA), 2N319 (EU), Ackerperle (EU), Erfordia (EU), ILB96 (CA), ILB403 (NA), ILB431 (NA), ILB479 (EA), ILB866 (EU), ILB919 (NA), ILB938 (SA)
2	HR	MR	2N311 (NA), 2N319 (EU), 2N382 (ME), 2N435 (NA), Diana (EU), Erfordia (EU), Herz Freya (EU), ILB96 (CA), ILB226 (ME), ILB318 (EU), ILB335 (EU), ILB403 (NA), ILB431 (NA), ILB490 (CA), ILB919 (NA)
3	HR	S	2N168 (CA), 2N175 (CA), 2N255 (ME), 2N285 (EU), 2N319 (EU), 2N431 (EA), 2N432 (EA), 2N435 (NA), ILB75 (EU), ILB335 (EU), ILB431 (NA), ILB490 (CA), ILB534 (EA), ILB864 (EU)
4	MR	HR	2N192 (ME), 2N319 (EU), 2N255 (ME), 2N441 (NA), ILB315 (EU), ILB411 (EU), ILB479 (EA), ILB920 (NA)
5	MR	MR	2N431 (EA), ILB335 (EU)
6	MR	S	2N26 (EU), 2N34 (EA), 2N122 (EU), 2N285 (EU), 2N319 (EU)
7	S	HR	2N168 (CA), 2N319 (EU), ILB920 (NA)
8	S	MR	2N281 (CA), ILB Giza 3 (EA)
9	S	S	2N34 (EA), 2N122 (EU), 2N285 (EU), 2N319 (EU), Herz Freya (EU), ILB534 (EA)

[a] Reaction to rust: HR = highly resistant (infection types 0–;), MR = moderately resistant (infection types 1–2), and S = susceptible (infection types 3–4).
[b] Letters preceding accession numbers refer to faba bean collections: 2N = University of Manitoba collection and ILB = International Legume faba bean collection at ICARDA.
[c] Letters in parentheses refer to region of origin: EA = East Africa, NA = North Africa, CA = Central Asia, ME = Middle East, EU = Europe, and SA = South America.

Twenty-nine S_3 lines characterized as highly resistant (0–;) to isolate SP3 were either susceptible (3–4) or moderately resistant (1–2) to isolate SP51 (classes 3 and 2, respectively). Seven additional S_3 lines characterized as moderately resistant (1–2) to isolate SP3 were also either susceptible (3–4) or moderately resistant (1–2) to isolate SP51 (classes 6 and 5, respectively). Susceptibility to both isolates SP3 and SP51 was expressed in only six S_3 lines (class 9).

Resistance specific to rust isolates from Manitoba was present in accessions and cultivars originating from various regions of the world (Table 1), indicating that the accessions had been exposed previously to rust isolates carrying the same genes for virulence as SP3 and SP51.

Chlorotic and necrotic zones surrounding rust pustules were observed occasionally but appeared to be influenced more by environmental conditions than by host genotypes. Such characters were not useful in further characterization of the infection type.

Accessions such as 2N319 and ILB431 gave rise to several single-plant selections homozygous for a range of resistant infection types to each rust isolate, indicating that the accessions are heterogeneous populations of several resistant genotypes. The range of resistant reactions (infection types 0–2) observed in this study was greater than that reported by Conner and Bernier (5) who found only infection types 0, ;, or 1. The high and moderate sources of resistance identified in this study could be useful in developing faba bean cultivars with durable rust resistance based either on gene pyramiding (8,14) or multilines (3).

ACKNOWLEDGMENTS

We gratefully acknowledge the financial support received from the International Development Research Centre of Canada during this study and the generous supply of seed from the faba bean accessions by the International Center for Agricultural Research in the Dry Areas.

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