Evaluation of Australian Native Species of *Glycine* for Resistance to Soybean Rust

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ABSTRACT

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Extensive screening of six Australian native species of *Glycine* uncovered variation in reaction to *Phakopsora pachyrhizi*, the causal agent of leaf rust of soybeans. Some of these native species represent a potentially valuable source of resistance genes for soybean rust resistance breeding programs.

Soybeans are affected by a wide range of pests and diseases (1,4,11). The most important in the eastern hemisphere (2,12) is leaf rust caused by *Phakopsora pachyrhizi* Syd. In years favoring development and spread of this pathogen, the total soybean production of individual southeast Asian countries has been reduced by as much as 30%, and losses up to 90% have been reported in individual fields (2,6,10). This pathogen was recently discovered in Puerto Rico (13,14) and seriously threatens soybean production in the United States and South America.

The vulnerability of the American soybean crop to this pathogen is illustrated by a lack of resistance to the virulent and highly aggressive races found in Asia. Of 215 cultivars listed by Hymowitz et al (5) for which rust resistance has been assessed, 205 (95.4%) are highly susceptible, 8 (3.7%) are susceptible, and only 2 (0.9%) show intermediate resistance. Some resistance is apparent to pathogen isolates from Puerto Rico (3). This vulnerability is also true in Asia where extensive disease screening tests have demonstrated only one or two immune or highly resistant varieties (7,8).

A possible source of rust resistance that had not been considered is the perennial species of *Glycine*. One of the main centers of gene diversity within the genus *Glycine* is the east Asian-Australian region where at least six perennial species occur, in addition to *G. soja* Siebold & Zucc., the wild progenitor of soybean (9). We evaluated 189 accessions of the six perennial species (*G. canescens* F. J. Herm., *G. clandestina* Willd., *G. falcata* Benth., *G. latrobeana* (Meissn.) Benth., *G. tabacina* (Labill.) Benth., and *G. tomentella* Hayata) for resistance to one isolate of *P. pachyrhizi*.

MATERIALS AND METHODS

Seed of the 189 accessions was scarified to promote germination and planted in individual pots in a heated glasshouse. Eight weeks after emergence, plants were screened for resistance to *P. pachyrhizi*. Because this survey was designed to determine the extent of resistance in the six species, only one plant was tested per accession.

Levels of disease resistance were determined by using a detached leaf technique (16). Ten newly expanded leaves from each plant were placed, abaxial surface up, on a 0.4% water agar support medium containing 5 ppm gibberellic acid. Leaves were inoculated in a 1.2-m Perspex settling tower by compressed air injection of 6 mg of *P. pachyrhizi* spores through a modified surgical syringe into the top of the tower. For 5 min spores were allowed to settle, and then each agar gel was removed from the tower. Inoculated leaves were then sprayed with distilled water, covered with plastic film, and incubated at 24 C in a growth cabinet lit at 70 Wm^{-2} for 16 hr/day. Leaves of soybean cultivar Dare were included in all cases as a control.

For all accessions four epidemiologically related characters were assessed: incubation period (sensu [15]; the number of days from inoculation to visible symptoms such as flecking), latent period (number of days from inoculation until the first pustule [uredium] erupted), number of active pustules 5 days after the first pustule erupted, and intensity of pustule development 5 days after the first pustule erupted (scale of 0, no development, to 3, large, highly productive pustules).

Accessions were then categorized as highly resistant, intermediate, or highly susceptible. In highly resistant plants, disease failed to develop beyond visible flecking. Plants in the intermediate and highly susceptible categories showed a continuum in response to infection by *P. pachyrhizi* as measured by the three characters of the latent period, the number of pustules per square centimeter, and pustule intensity. Although many values differed significantly (Table 1), categorization of intermediate accessions

Table 1. Range of responses of six Australian native species of *Glycine*[a] to infection by *Phakopsora pachyrhizi*

Species Accession[b]	Incubation period (days)	Latent period (days)	Pustules (no./cm²)	Pustules Intensity
G. canescens				
1232	5.6 ± 0.5[c]	9.9 ± 0.3	52.1 ± 10.5	2.4 ± 0.4
1240	8.4 ± 0.3	14.8 ± 1.2	10.6 ± 3.7	1.6 ± 0.2
1237	9.2 ± 1.9	· · ·	0.0	· · ·
G. clandestina				
1059	5.3 ± 0.4	9.6 ± 0.7	112.4 ± 36.4	2.8 ± 0.4
1193	5.7 ± 0.7	17.0 ± 2.0	6.9 ± 3.1	1.2 ± 0.4
1243	7.7 ± 1.7	· · ·	0.0	· · ·
G. falcata				
1153	8.6 ± 0.5	15.1 ± 2.6	3.0 ± 1.5	1.2 ± 0.3
G. latrobeana				
1252	10.2 ± 2.5	18.9 ± 2.2	13.6 ± 4.2	1.1 ± 0.2
G. tabacina				
1210	4.7 ± 0.9	9.8 ± 0.3	29.7 ± 7.2	1.7 ± 0.2
1257	8.9 ± 1.3	23.4 ± 0.5	2.0 ± 1.2	1.1 ± 0.2
1297	7.1 ± 0.8	· · ·	0.0	· · ·
G. tomentella				
1183	6.6 ± 0.5	15.6 ± 2.0	15.3 ± 4.6	1.0 ± 0.0
1283	6.4 ± 1.5	18.0 ± 2.8	4.0 ± 1.6	1.3 ± 0.2
1389	7.6 ± 1.3	· · ·	0.0	· · ·
G. max				
cv. Dare	5.6 ± 0.7	14.3 ± 0.9	18.4 ± 4.1	1.7 ± 0.3

[a] Based on data from 10 replicate leaves for each accession.
[b] CSIRO Division of Plant Industry accession number.
[c] Standard deviation.

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Table 2. Accessions of the six Australian native species of *Glycine* tested and their categories of response to infection by *Phakopsora pachyrhizi*

Species	No. of accessions	Percent of accessions		
		Highly resistant	Intermediate	Highly susceptible
G. canescens	23	13.0	21.7	65.2
G. clandestina	40	15.0	12.5	72.5
G. falcata	3	0.0	100.0	0.0
G. latrobeana	2	0.0	100.0	0.0
G. tabacina	76	31.6	22.4	46.1
G. tomentella	45	33.3	26.7	40.0

was based on the distribution of their values around the means. Accessions with values less than the mean for the latent period and pustule intensity and values greater than the mean for the number of pustules per square centimeter were classified as highly susceptible.

Further checks on the evaluation methods were provided by inoculating a representative sample (10 plants per species) of whole rooted plants and repeated screening (at least twice) of all accessions that were highly resistant.

RESULTS AND DISCUSSION

Table 1 shows the reactions of the six *Glycine* spp. to *P. pachyrhizi*. Accessions with the least susceptible, intermediate-susceptible, and most susceptible reactions are presented for each species except *G. falcata* and *G. latrobeana*. *G. canescens, G. clandestina, G. tabacina,* and *G. tomentella* showed a considerable range in disease reaction. Some accessions of the first three species were considerably more susceptible (Table 1) than the control soybean cultivar. Equally, in all species, accessions occurred in which disease development (latent period) and expression (number of pustules and pustule intensity) were significantly slower and less pronounced ($P < 0.01$ for all characters) than in the soybean cultivar. Finally, in all but *G. falcata* and *G. latrobeana*, accessions exist in which disease fails to develop beyond a visible symptom stage.

The number of accessions of each species tested and their distribution among the three disease response categories are given in Table 2. For four species, the levels of resistance to *P. pachyrhizi* in these wild relatives of soybean are high (13–33% are highly resistant). The lack of extreme disease responses in *G. falcata* and *G. latrobeana* probably reflects the scarcity of accessions of these species in existing collections.

These results represent the first extensive screening of wild Australian species of *Glycine* for resistance to *P. pachyrhizi*. These species clearly represent an important potential source of rust resistance genes that could be used to reduce the vulnerability of soybean crops.

LITERATURE CITED

1. ANONYMOUS. 1974. Soybean diseases. Queensl. Agric. J. 100:194-201.
2. BROMFIELD, K. R. 1976. World soybean rust situation. In: L. D. Hill, ed. World Soybean Research, Proceedings of the World Soybean Research Conference, Interstate Printers & Publishers, Danville, IL.
3. BROMFIELD, K. R., J. S. MELCHING, and C. H. KINGSOLVER. 1980. Virulence and aggressiveness of *Phakopsora pachyrhizi* isolates causing soybean rust. Phytopathology 70:17-21.
4. DURICK, D. N. 1977. Major United States Crops in 1976. Ann. N.Y. Acad. Sci. 287:86-96.
5. HYMOWITZ, T., S. F. CARMER, and C. A. NEWELL. 1976. Soybean cultivars released in the United States and Canada. Int. Agric. Publ. INTSOY Ser. 9.
6. LIU, K. C. 1966. Studies on soybean rust and its control. Taiwan Agric. Q. 2:92-100.
7. McLEAN, R. J. 1979. Histological studies of resistance to soybean rust, *Phakopsora pachyrhizi* Syd. Aust. J. Agric. Res. 30:77-84.
8. McLEAN, R. J., and D. BYTH. 1976. Resistance of soybean to rust in Australia. Aust. Plant Pathol. Newsl. 5:34-36.
9. NEWELL, C. A., and T. HYMOWITZ. 1978. A reappraisal of the subgenus *Glycine*. Am. J. Bot. 65:168-179.
10. SANGAWONGSE, P. 1973. A preliminary report of study on soybean rust. Thai J. Agric. Sci. 6:166-169.
11. SINCLAIR, J. B. 1977. Infectious soybean diseases of world importance. PANS 23:49-57.
12. THURSTON, H. D. 1973. Threatening plant diseases. Annu. Rev. Phytopathol. 11:27-52.
13. VAKILI, N. G. 1979. Field survey of endemic leguminous hosts of *Phakopsora pachyrhizi* in Puerto Rico. Plant Dis. Rep. 63:931-935.
14. VAKILI, N. G., and K. R. BROMFIELD. 1976. *Phakopsora* rust on soybean and other legumes in Puerto Rico. Plant Dis. Rep. 60:995-999.
15. VANDERPLANK, J. E. 1963. Plant Diseases: Epidemics and Control. Academic Press, New York.
16. WILCOXSON, R. D., L. M. JOSHI, and E. E. SAARI. 1971. Some new methods and equipment for work with rust fungi in India. Indian Phytopathol. 24:667-671.