

## Evaluation of Soybean Germplasm for Resistance to *Phakopsora pachyrhizi*

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### Abstract

*Phakopsora pachyrhizi*, the causal fungus of soybean rust, was discovered in the continental U.S. in November 2004. The presence of this disease in the U.S. may have an impact on soybean (*Glycine max*) production, as the current commercial varieties are considered to be susceptible, and the use of one or more applications of fungicides will add additional costs to production. One objective of the USDA-ARS research on soybean rust is to identify soybean germplasm with resistance to the disease. There are over 16,000 soybean accessions in the USDA Germplasm Collection located at the University of Illinois. These accessions were evaluated in a two-tiered inoculation program using a mixture of four *P. pachyrhizi* isolates in Biosafety Level 3 containment greenhouses the FDWSRU. In the first round of evaluations, 16,595 accessions were rated for rust severity. Of these, 3,215 accessions, based on low visual rust severity or the presence of a red-brown reaction, were selected for a second round of evaluation. After the second round of replicated evaluations of the 3,215 accessions, 805 were selected for further evaluation, again based on low mean visual severity or the presence of a red-brown reaction. Some of these selected accessions have the potential to provide soybean rust resistance genes that may be useful for incorporation into commercial soybean cultivars.

### Introduction

Soybean rust, *Phakopsora pachyrhizi*, may drastically reduce yields and/or increase production costs for U.S. producers. Yield losses have been significant in some countries in Africa, Asia, and South America (6,12,15). The risk to U.S. soybean producers was reviewed in 2003 (9), and now has become more imminent since the first report of soybean rust in the continental U.S. occurred in November, 2004 (11).

Specific resistance to *P. pachyrhizi* is known. Four single dominant genes identified as *Rpp<sub>1</sub>*, *Rpp<sub>2</sub>*, *Rpp<sub>3</sub>*, and *Rpp<sub>4</sub>* have been reported, and a recent symposium review cites the original sources of the references for these named genes (4). These four genes condition resistance to a limited set of *P. pachyrhizi* isolates. There are three reactions associated with soybean rust (1). The two resistant reactions include an "immune" (no visible signs or symptoms) and a red-brown reaction (RB). The susceptible reaction is tan (TAN) (Fig. 1). The immune reaction, where no visible symptoms are observed, has only been reported with *Rpp<sub>1</sub>* when inoculated with certain isolates, including India 73-1 (1). These single gene sources have not been durable when used in commercial cultivars and are not effective when challenged with additional isolates of *P. pachyrhizi* (3).

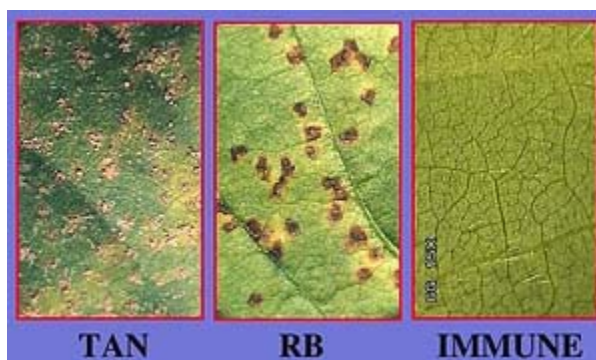


Fig. 1. Soybean rust reaction types: TAN = fully susceptible reaction, RB = resistant reddish brown lesions with defined margins, and immune = no visible symptoms (1).

Partial resistance to *P. pachyrhizi*, also referred to as rate reducing resistance, is also known in soybean (14). Lines with partial resistance in field evaluations were rated as moderately resistant, since fewer lesions developed on plants throughout the season (2,14). In greenhouse inoculation studies, host-pathogen combinations that resulted in RB reactions tended to have longer latent periods, lower rates of increase in pustule number over time, and smaller lesions compared with susceptible interactions that resulted in a TAN reaction (1,7). Identification and utilization of partial resistance in breeding programs has been limited and more research is needed to fully utilize partial resistance traits.

Since the report of soybean rust in Hawaii in 1994 (5), the USDA-ARS has renewed its support for soybean rust research. The USDA-ARS FDWSRU at Ft. Detrick, Frederick, MD, has been the focal point of identifying resistant soybean germplasm. There are over 16,000 soybean accessions in the USDA Germplasm Collection located at the University of Illinois. The objective of this work was to evaluate these soybean accessions for resistance to *P. pachyrhizi* under controlled conditions in the FDWSRU Biosafety Level 3 containment greenhouses (8). The overall goal of these evaluations was to identify accessions that may provide new sources of resistance. Part of these data were previously reported (10).

### Plant Propagation and Growth Conditions

Seeds for all soybean accessions were obtained from R. L. Nelson, USDA Germplasm Collection located at the University of Illinois. Two seeds of each accession were glued to pre-labeled 10-cm wooden pot labels with washable white school glue (Elmers Products, Columbus, OH). Seeds were planted in a single cell by placing the "seed on a stick" into one cell of a flat (27 × 52 cm) containing 6 × 12 cells filled with Sunshine LC1 mix (Sun Grow Horticulture Products, Bellevue, WA). Plants were thinned to one plant per cell after germination. Inoculation sets contained 10 to 18 flats each and were inoculated and incubated together in dew chambers. Cells on the outside edge of the flats were planted with a susceptible public cultivar ('Ina,' 'Maverick,' or 'Pana') as a border.

### Rust Isolates and Inoculation Methods

Four *P. pachyrhizi* isolates, Thailand (TH01-1), Brazil (BZ01-1), Paraguay (PG01-2), and Zimbabwe (ZM01-1), all collected in 2001, were used as a mixture in all studies. The isolates were sent to R. Frederick at the FDWSRU under the appropriate APHIS permit by the following individuals: TH01-1, Srisuk Poonpolgul, Thailand Department of Agriculture, Bangkok, Thailand; BZ01-1, José Tadashi Yorinori, EMBRAPA SOJA, Londrina, Brazil; PG01-2, Wilfrido Morel Paiva, Centro Regional de Investigación Agrícola, Capitán Miranda, Paraguay; and ZM01-1, Clive Levy, Commercial Farmers Union of Zimbabwe, Harare, Zimbabwe. After arrival at FDWSRU, urediniospores of each isolate were inoculated on the soybean cv. 'Williams.' Individual isolates were separately increased on Williams, and all urediniospores collected from each

isolate were stored in liquid nitrogen. Prior to inoculation, urediniospores were removed from liquid nitrogen tank, heat shocked at 40°C for 5 min, and hydrated by incubating over water in an enclosed petri plate overnight. Inoculum was prepared by combining equal weights of the four isolates in distilled water with 0.1% Tween 20, vigorously mixing, and then filtering the mixture through a 53 µ nylon screen. Urediniospores were quantified using a hemocytometer and diluted in distilled water with 0.1% Tween 20 to a final concentration 60,000 per ml for inoculation.

Seedlings were inoculated when plants were 14 to 18 days old and evaluated 14 days later. Plants were atomized with 40 ml spore concentrate per flat at 20 psi until runoff several successive times, and placed in dew chambers at 20 to 25°C overnight. Plants were removed from dew chambers and placed in the greenhouse at 20 to 25°C under a 16-h photoperiod and watered from below. Supplemental light was provided by 1000 watt Metalarc lights (Sylvania, Danvers, MA) spaced 0.6 m apart 1.2 m above the bench. Susceptible cultivars (Dwight or Ina) were randomly placed within each set, with at least one susceptible cultivar per every sixth flat. The cultivars were used to evaluate the success of the inoculation and to provide a visual reference for disease severity assessments.

### Germplasm Evaluations

Disease severity was evaluated on the first trifoliolate leaf for most accessions; however, the unifoliolate leaf was evaluated for a few accessions that were slower in growth. A disease severity scale of 1 to 5, based on lesion density, was used where 1 = no visible lesions, 2 = few scattered lesions present, 3 = moderate number of lesions on at least part of the leaf, 4 = abundant number of lesions on at least part of the leaf, and 5 = prolific lesion development over most of the leaf (Fig. 2). The presence of TAN, RB, or mixed lesions was also recorded. The TAN lesion was considered a susceptible reaction, while the RB or lack of lesions was considered resistant (1). The mixed reaction was recorded when both RB and TAN lesions were observed on the same leaf, and were considered an RB reaction for part of the data summary.

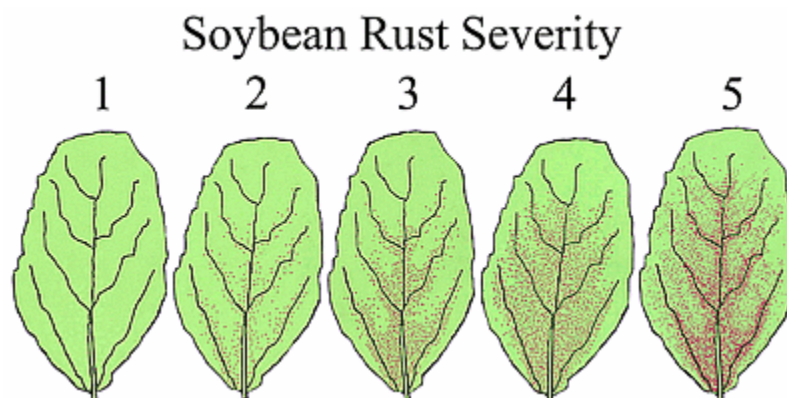


Fig. 2. Scale used for the visual assessment of soybean rust in the preliminary evaluations of the germplasm in the USDA Soybean germplasm collection. 1 = no visible lesions, 2 = few scattered lesions present, 3 = moderate number of lesions on at least part of the leaf, 4 = abundant number of lesions on at least part of the leaf, and 5 = prolific lesion development over most of the leaf.

**Preliminary evaluation one (P1).** A total of 16,595 soybean accessions were evaluated as single seedlings in inoculation sets of approximately 1,000 accessions each. Soybean rust severity ranged from one to five with the majority of accessions having a disease severity rating of three or four (Fig. 3). The RB lesion type was recorded in 1,237 accessions with 9 accessions (1%) rated as a one, 170 accessions (14%) rated as a two, 558 accessions (45%) rated as a three, 410 accessions (33%) rated as a four, and 90 accessions (7%) rated as a five. A total of 3,215 accessions (19%) were selected for a second evaluation. Those that

were advanced to the next level had severity scores of two or less or had RB lesions at any disease severity. All other accessions were not re-evaluated except for a few accessions that had a disease severity of three and appeared to have low spore-producing TAN lesion types.

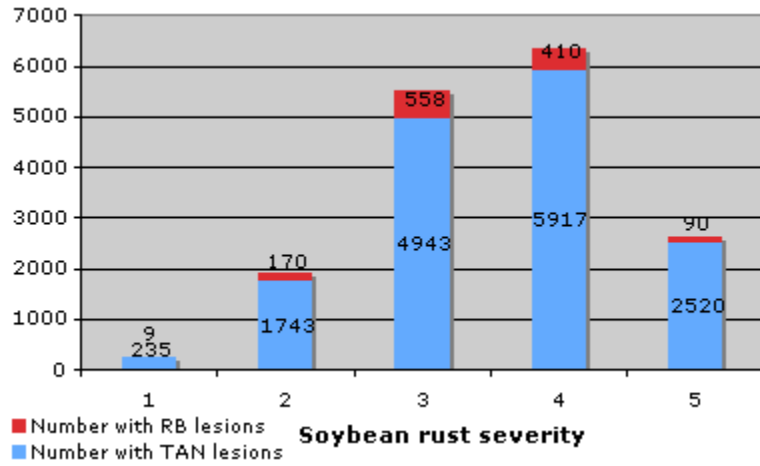


Fig. 3. Frequency distribution of 16,595 soybean accessions that had rust severities of 1, 2, 3, 4 and 5 with either a TAN or RB lesion type in the first preliminary evaluation.

**Preliminary evaluation two (P2).** The P2 evaluation was done in inoculation sets of 300 to 340 accessions each that were replicated three times. Entries were randomized within each replication using a randomized complete block design. If germination was low or if greenhouse conditions did not permit normal disease development, inoculation sets or subsets within an inoculation set were repeated. In the P2 evaluation, severity ranged from 1 to 5 with 58% of the accessions rated between 3.0 and 3.9 (Fig. 4). RB lesions were recorded on a total of 535 accessions (17%) distributed across all severities. The greatest number of accessions with a RB lesion occurred within a severity range of 3.0 to 3.9, but the ratios of RB to TAN were greater at lower severity ratings.

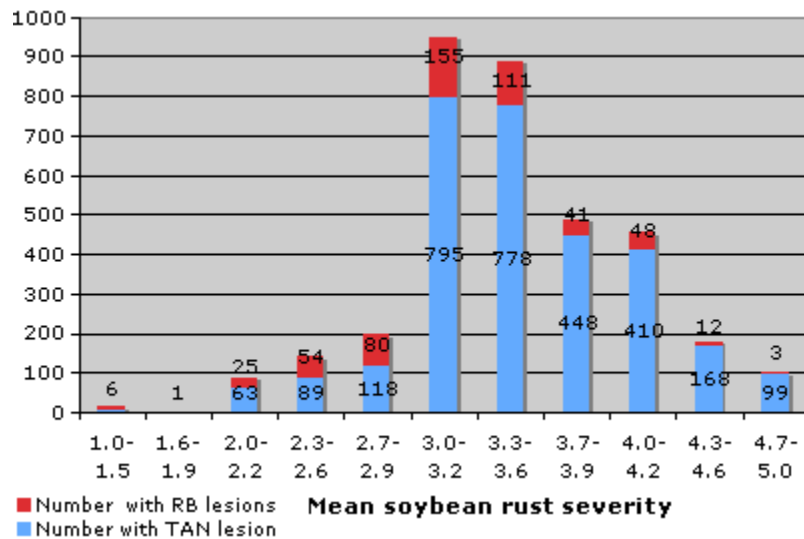


Fig. 4. Frequency distribution of 3,215 soybean accessions with either TAN or RB lesion type in the first preliminary evaluation (additional data is presented of 697 severity ratings due to duplication of some accessions in more than one set).

There were 805 accessions selected as potential sources of resistance from the P2 evaluation. These accessions had a mean severity of 2.7 or less, or had an RB lesion recorded from two of three plants evaluated (see Appendix, Table 1). Since the accessions were evaluated in several P2 sets that were inoculated and evaluated in different time periods, no comparison among them was made, although in tabular format the accessions are ranked by severity. The distribution of the selected lines ranged from 1 to 4.3 in severity (Fig. 5). Among these accessions, 486 (60%) had RB or mixed lesion types and 319 (40%) accessions had the TAN lesion type. Of the accessions where the RB lesion type was reported, 321 (66%) had a severity greater than 3.0, while most of the selected accessions with the TAN lesion type had severity ratings from 2.0 to 2.9.

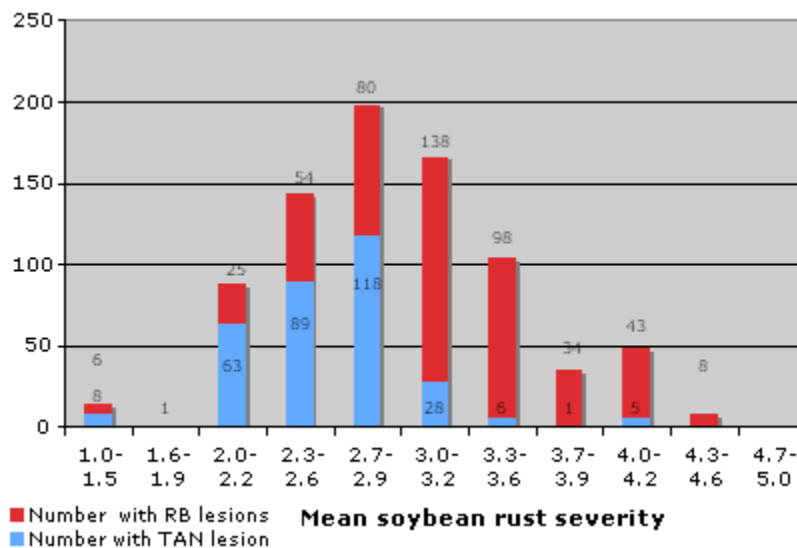


Fig. 5. Frequency distribution of 805 soybean accessions with either TAN or RB lesion type in the second preliminary evaluation.

Among the selected accessions, the number of plants evaluated differed, with some accessions having only one or two seedlings evaluated. Although attempts were made to re-evaluate accessions in sets with poor germination or poor disease development, not all accessions produced three plants. Rather than discard potential sources of resistance, those accessions with mean severities of 2.5 or less, and those accessions with RB reactions were selected for further evaluation.

### Conclusions

In our study, a two-tiered preliminary screen of 16,595 soybean accessions of the USDA Germplasm Collection has identified accessions that have resistance to soybean rust in seedling evaluations. Some of these accessions had RB lesions, which have been associated with single gene resistance (3), while others had TAN lesions but had low visual rust severity. The accessions with low rust severities may be sources of partial resistance, that may limit infection and/or lesion development, or may be the result of an incompatible reaction similar to that reported in *Rpp1*, when challenged with a limited number of isolates.

In the P2 evaluation, three seedlings per accession were evaluated within each inoculation set. However, many accessions have data from more than three seedlings, while other accessions have data from only one or two seedlings. If germination within a set was poor, or if greenhouse conditions did not permit normal development of disease, sub-sets within each inoculation set were replanted and re-evaluated. Accessions with data from fewer than three seedlings from the P2 screen were included for further evaluation if severities were low (less than 2.5) or if they had the RB lesion type. Even though the rust severity was low, further evaluation is needed before these lines can be identified as superior to others on the list.

The accessions selected in these preliminary evaluations were inoculated with a mixture of four *P. pachyrhizi* isolates. These isolates were among the most recent in the soybean rust collection at the FDWSRU, and they were selected to represent a diverse geographic distribution covering three continents in an attempt to challenge the accessions with a broad array of virulence. Since a mixture of isolates was used, none of the accessions selected in this study have been evaluated for race-specific resistance. Race-specific resistance to *P. pachyrhizi* in soybeans is well documented (3), but it has not been considered durable when these lines were deployed in the field. Single *P. pachyrhizi* isolate evaluations will need to be done on these accessions in order to evaluate race specificity.

The P1 and P2 preliminary evaluations were done using seedling screens. Under field conditions, soybean rust severity increases after flowering; therefore all the accessions selected in these seedling screens should be evaluated in the field to identify differences in adult plant resistance before they can be considered useful in a breeding program. There is no information correlating severity in a seedling screen with adult plant resistance to soybean rust. Previous resistance sources were identified in field screens in Taiwan and India (1) and confirmed using a single isolate in greenhouse evaluations (1,4). A set of 776 accessions has been identified from the P2 screen. These accessions were planted, by maturity group, in field trials at several locations across the U.S. in 2005. If soybean rust develops at these sites and the appropriate data is collected, this will be the first evaluation of adult plant resistance in these materials.

The commercial soybean cultivars currently in use throughout the U.S. soybean production areas may be moderately to very susceptible to soybean rust based on a limited number of cultivars that have been tested in containment (13). In the absence of high levels of genetic resistance to the pathogen, producers may need to rely on fungicides to protect the crop. In order to reduce this expense, incorporation of rust resistance into commercial soybean cultivars from sources identified in this and other research is imperative. The sources of resistance identified in this research may provide the resistance genes needed for future development of soybean cultivars with soybean rust resistance.

### Disclaimer and Acknowledgments

Names are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the product, and the use of the name by the USDA implies no approval of the product to the exclusion of others that may also be suitable.

We are grateful to Randy Nelson and his staff for providing soybean seed; Theresa Herman and Tara Lynch for organizing the sets of seed sent to containment; and to Craig Austin, JoAnn Garrett, Sheila Diepold, and Christine Stone for their technical assistance with the seedling evaluations at the FDWSRU. This research was in part supported by the United Soybean Board as USB Projects 2229, 3217, and 4217.

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## Appendix

Table 1. Soybean rust severity and lesion type for accessions selected as potential resistance sources from the preliminary one (P1) and preliminary two (P2) evaluations based on plants inoculated as seedlings with a mixture of *Phakopsora pachyrhizi* isolates at the USDA-ARS Foreign Disease-Weed Science Research Unit Biosafety Level 3 containment greenhouses.

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI240667A	2	RB	1	1.0	NA <sup>5</sup>	RB
PI438482	3	TAN	1	1.0	NA	RB
PI518759	3	Mixed	1	1.0	NA	TAN
PI594767B	3	TAN	1	1.0	NA	TAN
PI424299A	1	TAN	3	1.3	0.33	TAN
PI567565	2	TAN	3	1.3	0.33	TAN
PI196528	2	RB	2	1.5	0.50	RB
PI407730	2	TAN	2	1.5	0.50	RB
PI417317	3	TAN	2	1.5	0.50	TAN
PI437437A	3	RB	2	1.5	0.50	RB
PI437527	3	RB	2	1.5	0.50	TAN
PI437663	1	RB	2	1.5	0.50	RB
PI594250	2	TAN	2	1.5	0.50	TAN

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI628870	2	TAN	2	1.5	0.50	TAN
PI635033	2	TAN	3	1.7	0.33	TAN
FC031927	2	RB	3	2.0	0.00	TAN
PI068494	3	TAN	2	2.0	1.00	RB
PI068806	3	TAN	2	2.0	0.00	Mixed
PI084632	1	TAN	1	2.0	NA	TAN
PI086078	2	TAN	2	2.0	0.00	TAN
PI091159S	2	TAN	2	2.0	0.00	TAN
PI091730	3	TAN	1	2.0	NA	TAN
PI094159	2	TAN	1	2.0	NA	Mixed
PI124871	2	TAN	2	2.0	0.00	TAN
PI165524	3	RB	1	2.0	NA	RB
PI166028	2	TAN	1	2.0	NA	Mixed
PI181561	3	TAN	2	2.0	1.00	Mixed
PI189968	3	TAN	1	2.0	NA	Mixed
PI194636	2	TAN	2	2.0	0.00	TAN
PI194648	3	Mixed	1	2.0	NA	TAN
PI200446	2	TAN	1	2.0	NA	TAN
PI232989	3	Mixed	3	2.0	0.58	TAN
PI243524	3	RB	2	2.0	1.00	RB
PI258383	3	RB	3	2.0	0.58	TAN
PI291309C	3	Mixed	3	2.0	0.58	RB
PI355069S	2	TAN	1	2.0	NA	TAN
PI384470	3	TAN	1	2.0	NA	TAN
PI398335	2	TAN	1	2.0	NA	Mixed
PI398359	2	TAN	3	2.0	0.58	TAN
PI398734	2	TAN	1	2.0	NA	TAN
PI407799	2	TAN	1	2.0	NA	TAN
PI407819	2	TAN	2	2.0	0.00	TAN
PI407833C	2	TAN	3	2.0	0.00	Mixed
PI407859-1	2	TAN	1	2.0	NA	Mixed
PI407987	2	TAN	1	2.0	NA	TAN
PI408034	2	TAN	1	2.0	NA	TAN
PI408068C	2	TAN	1	2.0	NA	TAN
PI408085	2	TAN	1	2.0	NA	TAN
PI408134B	2	TAN	1	2.0	NA	TAN
PI408203A	1	TAN	2	2.0	1.00	TAN
PI408209C	2	TAN	3	2.0	0.58	TAN



Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI408234B	2	TAN	1	2.0	NA	RB
PI408272B	2	TAN	1	2.0	NA	TAN
PI416898	3	Mixed	3	2.0	0.00	TAN
PI417235	2	TAN	1	2.0	NA	TAN
PI417357	2	TAN	1	2.0	NA	TAN
PI417452	3	TAN	1	2.0	NA	RB
PI423717	3	RB	1	2.0	NA	TAN
PI423728A	3	TAN	1	2.0	NA	TAN
PI423823	2	TAN	1	2.0	NA	Mixed
PI423967	3	TAN	1	2.0	NA	TAN
PI424386B	2	RB	3	2.0	0.00	TAN
PI424539	3	TAN	3	2.0	0.00	TAN
PI424578	2	TAN	1	2.0	NA	TAN
PI437534	2	TAN	3	2.0	0.00	TAN
PI437921	4	Mixed	1	2.0	NA	TAN
PI438444	3	TAN	1	2.0	NA	Mixed
PI468972	2	TAN	2	2.0	1.00	TAN
PI506589	1	TAN	1	2.0	NA	TAN
PI506717	2	TAN	1	2.0	NA	TAN
PI506737	2	TAN	1	2.0	NA	Mixed
PI506863	3	Mixed	1	2.0	NA	TAN
PI507009	4	Mixed	1	2.0	NA	TAN
PI507113	2	TAN	1	2.0	NA	RB
PI507414	2	TAN	1	2.0	NA	TAN
PI507518	2	TAN	2	2.0	1.00	TAN
PI508269	3	TAN	2	2.0	0.00	TAN
PI518758	3	Mixed	2	2.0	0.00	Mixed
PI547878	3	Mixed	1	2.0	NA	Mixed
PI548325	2	RB	3	2.0	0.58	Mixed
PI561287A	3	TAN	1	2.0	NA	TAN
PI561289	3	TAN	1	2.0	NA	TAN
PI561330A	2	TAN	2	2.0	0.00	TAN
PI561337	1	TAN	3	2.0	0.58	TAN
PI567093B	3	Mixed	1	2.0	NA	TAN
PI567175C	2	TAN	1	2.0	NA	Mixed
PI567300A	2	TAN	1	2.0	NA	TAN
PI567457	2	TAN	1	2.0	NA	TAN
PI567470	2	TAN	3	2.0	0.58	TAN

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI567489A	2	TAN	1	2.0	NA	TAN
PI567507B	2	TAN	1	2.0	NA	TAN
PI567554A	2	TAN	1	2.0	NA	TAN
PI567679C	2	TAN	2	2.0	0.00	TAN
PI567692	2	TAN	2	2.0	0.00	TAN
PI567718	2	TAN	2	2.0	0.00	Mixed
PI574480A	1	TAN	3	2.0	0.00	TAN
PI587914B	3	TAN	1	2.0	NA	TAN
PI587922A	3	Mixed	2	2.0	0.00	Mixed
PI592907A	2	TAN	3	2.0	0.00	TAN
PI594538A	2	TAN	2	2.0	0.00	Mixed
PI603358A	2	TAN	1	2.0	NA	TAN
PI603419A	2	TAN	3	2.0	0.58	TAN
PI612613	2	TAN	1	2.0	NA	TAN
FC 31745	3	TAN	3	2.3	0.88	TAN
PI088452	3	RB	3	2.3	0.33	Mixed
PI132217	3	TAN	3	2.3	0.88	Mixed
PI200455	3	RB	3	2.3	0.33	Mixed
PI200456	3	TAN	3	2.3	0.88	TAN
PI229346	2	TAN	3	2.3	0.33	TAN
PI232990	3	Mixed	3	2.3	0.33	Mixed
PI235340	2	TAN	3	2.3	0.33	TAN
PI238109	3	RB	3	2.3	0.67	RB
PI372413	2	TAN	3	2.3	0.88	TAN
PI374189	3	Mixed	3	2.3	0.33	Mixed
PI378663	2	TAN	3	2.3	0.33	TAN
PI398482	2	TAN	3	2.3	0.33	TAN
PI407858	2	TAN	3	2.3	0.88	TAN
PI407881	2	TAN	3	2.3	0.33	Mixed
PI408059	2	TAN	3	2.3	0.33	TAN
PI408088	2	TAN	3	2.3	0.33	TAN
PI416915	2	TAN	3	2.3	0.33	TAN
PI417042	2	TAN	3	2.3	0.88	TAN
PI417071	2	TAN	3	2.3	0.33	Mixed
PI417251	2	TAN	3	2.3	0.33	TAN
PI417335	2	TAN	3	2.3	0.33	TAN
PI423722	2	TAN	3	2.3	0.33	Mixed
PI423730B	3	Mixed	3	2.3	0.33	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI423852	2	TAN	3	2.3	0.33	Mixed
PI424294B	2	TAN	3	2.3	0.88	TAN
PI437110A	2	TAN	3	2.3	0.33	TAN
PI437740B	2	TAN	3	2.3	0.33	TAN
PI437982	2	TAN	3	2.3	0.33	TAN
PI438073	3	Mixed	3	2.3	0.33	Mixed
PI479735	3	TAN	3	2.3	0.33	TAN
PI506760	3	TAN	3	2.3	0.33	Mixed
PI507021	4	Mixed	3	2.3	0.33	TAN
PI561356	3	TAN	3	2.3	0.33	Mixed
PI561377	2	TAN	3	2.3	0.33	Mixed
PI567010B	2	TAN	3	2.3	0.33	TAN
PI567129	3	Mixed	3	2.3	0.33	Mixed
PI567174C	2	TAN	3	2.3	0.33	Mixed
PI567396A	2	TAN	3	2.3	0.33	TAN
PI567409A	2	TAN	3	2.3	0.33	TAN
PI567472	1	TAN	3	2.3	0.33	TAN
PI567474	2	TAN	3	2.3	0.67	TAN
PI567502	2	TAN	3	2.3	0.33	TAN
PI567675	2	TAN	3	2.3	0.33	TAN
PI567780A	2	TAN	3	2.3	0.33	TAN
PI587935A	3	Mixed	3	2.3	0.33	Mixed
PI592962B	2	TAN	3	2.3	0.33	TAN
PI597480A	2	Mixed	3	2.3	0.33	Mixed
PI603293B	2	TAN	3	2.3	0.33	TAN
PI603465B	2	TAN	3	2.3	0.33	TAN
PI603564A	2	TAN	3	2.3	0.33	TAN
PI603612	2	TAN	3	2.3	0.33	TAN
PI091144	3	TAN	5	2.4	0.51	RB
PI507305	2	Mixed	5	2.4	0.40	TAN
PI628932	3	Mixed	5	2.4	0.40	Mixed
PI081765	1	RB	7	2.4	0.43	Mixed
PI417089A	3	RB	9	2.4	0.29	RB
PI072328	3	RB	2	2.5	0.50	TAN
PI072337	1	TAN	2	2.5	0.50	TAN
PI084674	3	TAN	2	2.5	0.50	RB
PI085089	3	TAN	2	2.5	0.50	TAN
PI164885	3	RB	2	2.5	0.50	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI170889	3	RB	2	2.5	0.50	RB
PI200488	2	Mixed	2	2.5	0.50	Mixed
PI200516	2	TAN	2	2.5	0.50	TAN
PI205901B	3	TAN	2	2.5	0.50	TAN
PI222549	2	TAN	2	2.5	0.50	Mixed
PI227331	3	RB	2	2.5	0.50	Mixed
PI229333	2	TAN	2	2.5	0.50	TAN
PI341252	4	Mixed	2	2.5	0.50	TAN
PI378682B	2	TAN	2	2.5	0.50	TAN
PI398292	2	TAN	2	2.5	0.50	TAN
PI398399	2	TAN	2	2.5	0.50	TAN
PI399070	2	TAN	2	2.5	0.50	TAN
PI407822	2	TAN	2	2.5	0.50	TAN
PI407831	2	TAN	2	2.5	0.50	TAN
PI407836	2	TAN	2	2.5	0.50	TAN
PI407845A	2	TAN	2	2.5	0.50	Mixed
PI407846	2	TAN	2	2.5	0.50	TAN
PI408308B	2	TAN	2	2.5	0.50	TAN
PI416782	2	TAN	2	2.5	0.50	TAN
PI417105	2	TAN	2	2.5	0.50	Mixed
PI417122	1	TAN	2	2.5	0.50	Mixed
PI417126	3	RB	2	2.5	0.50	RB
PI424190	2	TAN	2	2.5	1.50	TAN
PI424433	4	Mixed	2	2.5	0.50	TAN
PI434973A	2	RB	4	2.5	0.96	Mixed
PI437520B	4	Mixed	2	2.5	0.50	TAN
PI437684	2	TAN	2	2.5	0.50	TAN
PI438371	2	TAN	2	2.5	0.50	TAN
PI438480	1	TAN	2	2.5	0.50	RB
PI458529	4	Mixed	2	2.5	0.50	TAN
PI486335	2	TAN	2	2.5	0.50	TAN
PI497965	3	Mixed	6	2.5	0.22	Mixed
PI503334	3	RB	2	2.5	0.50	RB
PI506578	2	TAN	2	2.5	0.50	Mixed
PI507142	2	TAN	2	2.5	0.50	Mixed
PI508296H	2	TAN	2	2.5	0.50	TAN
PI509089	2	TAN	2	2.5	0.50	TAN
PI549017	2	TAN	2	2.5	0.50	TAN

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI549058	2	TAN	2	2.5	0.50	TAN
PI549060	2	TAN	2	2.5	0.50	TAN
PI561282A	2	TAN	2	2.5	0.50	TAN
PI561329	1	TAN	2	2.5	0.50	TAN
PI561330B	2	TAN	2	2.5	0.50	TAN
PI566978	2	TAN	2	2.5	0.50	TAN
PI566985A	2	TAN	2	2.5	0.50	TAN
PI567085B	2	TAN	2	2.5	0.50	Mixed
PI567104B	2	TAN	2	2.5	0.50	TAN
PI567108B	2	TAN	2	2.5	0.50	Mixed
PI567140B	3	Mixed	2	2.5	0.50	RB
PI567374	3	TAN	2	2.5	0.50	TAN
PI567397	2	TAN	2	2.5	0.50	TAN
PI567404A	2	TAN	2	2.5	0.50	TAN
PI567473C	2	TAN	2	2.5	0.50	Mixed
PI567481	2	TAN	2	2.5	0.50	TAN
PI567560	3	TAN	2	2.5	0.50	TAN
PI567561	3	TAN	2	2.5	0.50	TAN
PI574479A	2	TAN	2	2.5	0.50	TAN
PI578305B	3	Mixed	2	2.5	0.50	Mixed
PI578313A	2	TAN	2	2.5	0.50	Mixed
PI578323A	2	RB	4	2.5	0.29	Mixed
PI587598A	3	Mixed	2	2.5	0.50	Mixed
PI587814C	2	TAN	2	2.5	0.50	Mixed
PI588000	3	Mixed	4	2.5	0.29	RB
PI588034	2	Mixed	6	2.5	0.34	TAN
PI594525	2	Mixed	2	2.5	0.50	TAN
PI594552A	3	RB	2	2.5	0.50	Mixed
PI594754	2	RB	8	2.5	0.27	Mixed
PI603165A	2	TAN	2	2.5	0.50	TAN
PI603296	2	TAN	2	2.5	0.50	TAN
PI603347	2	TAN	2	2.5	0.50	TAN
PI603392	2	TAN	2	2.5	0.50	TAN
PI603429D	2	TAN	2	2.5	0.50	TAN
PI603584	3	Mixed	2	2.5	0.50	TAN
PI603704A	2	TAN	2	2.5	0.50	TAN
PI605885C	3	TAN	2	2.5	0.50	TAN
PI605891B	4	Mixed	2	2.5	0.50	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI612750	1	TAN	2	2.5	0.50	TAN
PI612753B	2	TAN	2	2.5	0.50	TAN
PI506553	3	Mixed	5	2.6	0.51	TAN
PI549077	3	TAN	5	2.6	0.24	RB
PI567059	4	Mixed	5	2.6	0.40	Mixed
PI068475	3	Mixed	3	2.7	0.67	Mixed
PI081773	1	RB	6	2.7	0.21	Mixed
PI084668	3	RB	6	2.7	0.21	Mixed
PI192867	2	TAN	3	2.7	0.33	Mixed
PI259538	2	TAN	3	2.7	0.33	TAN
PI274205	2	TAN	3	2.7	0.33	TAN
PI307866	4	Mixed	3	2.7	0.33	Mixed
PI319525	3	RB	9	2.7	0.37	Mixed
PI325779	2	TAN	3	2.7	0.33	Mixed
PI347540C	2	TAN	3	2.7	0.33	TAN
PI347550B	2	TAN	3	2.7	0.33	Mixed
PI360954	2	TAN	3	2.7	0.67	TAN
PI370058	2	TAN	3	2.7	0.67	TAN
PI372403A	2	TAN	3	2.7	0.67	TAN
PI374200B	2	TAN	3	2.7	0.33	Mixed
PI379618	2	RB	3	2.7	0.33	RB
PI379620	2	TAN	3	2.7	0.33	Mixed
PI398326	2	TAN	3	2.7	0.33	TAN
PI398377	2	TAN	3	2.7	0.33	TAN
PI398495	2	TAN	3	2.7	0.67	TAN
PI398558	2	TAN	3	2.7	0.67	TAN
PI398639	3	Mixed	3	2.7	0.33	TAN
PI398726	2	RB	3	2.7	0.33	TAN
PI398937	2	TAN	3	2.7	0.33	TAN
PI407715	2	TAN	3	2.7	0.33	Mixed
PI407808-1	2	TAN	3	2.7	0.67	TAN
PI407882	2	TAN	3	2.7	0.67	Mixed
PI407989	2	TAN	3	2.7	0.33	TAN
PI408090	2	TAN	3	2.7	0.67	TAN
PI408106	2	TAN	3	2.7	0.33	Mixed
PI408133	1	TAN	3	2.7	0.33	TAN
PI408268	2	Mixed	3	2.7	0.33	TAN
PI408283	2	TAN	3	2.7	0.33	TAN

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI416841	2	RB	3	2.7	0.67	TAN
PI416900	3	TAN	3	2.7	0.33	Mixed
PI417120	3	RB	3	2.7	0.67	Mixed
PI417190	2	TAN	3	2.7	0.33	TAN
PI417363	2	TAN	3	2.7	0.33	Mixed
PI417389A	2	TAN	3	2.7	0.33	Mixed
PI417445	2	TAN	3	2.7	0.33	TAN
PI417528	2	TAN	3	2.7	0.67	Mixed
PI423821	2	TAN	3	2.7	0.33	TAN
PI423880	3	TAN	3	2.7	0.33	TAN
PI424159C	3	Mixed	3	2.7	0.33	Mixed
PI424373	3	Mixed	3	2.7	0.67	TAN
PI424420	3	Mixed	3	2.7	0.67	TAN
PI424450	3	Mixed	3	2.7	0.67	TAN
PI424596	3	Mixed	3	2.7	0.33	Mixed
PI430598A	3	TAN	3	2.7	0.33	TAN
PI437211B	2	TAN	3	2.7	0.67	TAN
PI437285	3	Mixed	3	2.7	0.33	TAN
PI437420B	2	TAN	3	2.7	0.33	TAN
PI437462C	3	Mixed	3	2.7	0.67	TAN
PI437471	2	TAN	3	2.7	0.33	TAN
PI437500B	2	RB	3	2.7	0.67	TAN
PI437661B	3	RB	3	2.7	0.33	RB
PI437667	4	TAN	3	2.7	0.33	TAN
PI437867B	3	Mixed	3	2.7	0.33	TAN
PI437874	2	TAN	3	2.7	0.33	TAN
PI437878B	2	TAN	3	2.7	0.67	TAN
PI438398	2	TAN	3	2.7	0.33	TAN
PI438426	2	TAN	3	2.7	0.33	Mixed
PI438473	2	TAN	3	2.7	0.33	RB
PI438495	4	Mixed	3	2.7	0.33	RB
PI442023	2	TAN	3	2.7	0.33	TAN
PI458266	2	TAN	3	2.7	0.33	TAN
PI458273	4	TAN	3	2.7	0.33	Mixed
PI467323A	3	Mixed	6	2.7	0.56	Mixed
PI476888	3	TAN	3	2.7	0.33	TAN
PI476911	3	TAN	3	2.7	0.67	TAN
PI476930	2	TAN	3	2.7	0.88	TAN

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI476933	3	RB	3	2.7	0.33	TAN
PI476942	2	TAN	3	2.7	0.33	TAN
PI483459	2	TAN	3	2.7	0.33	TAN
PI497963	3	TAN	3	2.7	0.33	TAN
PI497969	2	TAN	3	2.7	0.33	TAN
PI506679	3	TAN	3	2.7	0.33	Mixed
PI506828	2	TAN	3	2.7	0.33	Mixed
PI506939	4	Mixed	6	2.7	0.21	TAN
PI507282	2	TAN	3	2.7	0.33	TAN
PI507298	3	Mixed	3	2.7	0.33	TAN
PI507354	3	TAN	3	2.7	0.33	Mixed
PI507473	2	TAN	3	2.7	0.33	TAN
PI507535	2	TAN	3	2.7	0.33	TAN
PI507546	3	TAN	3	2.7	0.33	TAN
PI507564	3	TAN	3	2.7	0.33	TAN
PI507688	3	TAN	3	2.7	0.33	TAN
PI522190	2	TAN	3	2.7	0.67	Mixed
PI532464	3	TAN	3	2.7	0.33	TAN
PI538377	2	TAN	3	2.7	0.33	TAN
PI538401A	3	TAN	3	2.7	0.33	TAN
PI549019	3	TAN	3	2.7	0.33	TAN
PI561389B	2	TAN	3	2.7	0.67	TAN
PI566964A	2	TAN	3	2.7	0.33	RB
PI566989A	3	TAN	3	2.7	0.33	Mixed
PI567005A	2	TAN	3	2.7	0.33	TAN
PI567053	2	Mixed	3	2.7	0.33	Mixed
PI567099A	2	TAN	3	2.7	0.33	RB
PI567108C	2	TAN	3	2.7	0.33	Mixed
PI567123A	2	TAN	3	2.7	0.33	Mixed
PI567141	2	TAN	3	2.7	0.33	TAN
PI567146A	3	RB	3	2.7	0.33	RB
PI567150B	3	RB	3	2.7	0.33	Mixed
PI567206	3	TAN	3	2.7	0.33	TAN
PI567230	4	RB	6	2.7	0.21	TAN
PI567335B	2	TAN	3	2.7	0.33	TAN
PI567341	2	TAN	3	2.7	0.33	TAN
PI567365	3	TAN	3	2.7	0.33	TAN
PI567367	3	TAN	3	2.7	0.33	TAN



Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI567376A	3	TAN	3	2.7	0.33	TAN
PI567387	2	TAN	3	2.7	0.33	TAN
PI567388	1	TAN	3	2.7	0.33	TAN
PI567390	2	TAN	3	2.7	0.33	TAN
PI567411	2	TAN	3	2.7	0.33	TAN
PI567418C	2	TAN	3	2.7	0.33	TAN
PI567461	1	TAN	3	2.7	0.33	TAN
PI567476	2	TAN	3	2.7	0.33	TAN
PI567489B	2	TAN	3	2.7	0.33	TAN
PI567491B	1	TAN	3	2.7	0.33	TAN
PI567534	2	TAN	3	2.7	0.33	TAN
PI567545	2	TAN	3	2.7	0.33	TAN
PI567556	3	TAN	3	2.7	0.33	TAN
PI567648A	2	TAN	3	2.7	0.33	TAN
PI567660A	3	TAN	3	2.7	0.33	TAN
PI567683A	2	TAN	3	2.7	0.33	TAN
PI567758	3	TAN	3	2.7	0.33	Mixed
PI578306B	3	Mixed	3	2.7	0.33	Mixed
PI578316C	2	Mixed	3	2.7	0.33	Mixed
PI578447	3	RB	3	2.7	0.33	TAN
PI578449	3	Mixed	3	2.7	0.33	Mixed
PI578457A	3	Mixed	3	2.7	0.33	Mixed
PI587616	3	RB	3	2.7	0.33	TAN
PI587629	4	Mixed	3	2.7	0.67	TAN
PI587767B	2	TAN	3	2.7	0.33	TAN
PI587794	3	Mixed	3	2.7	0.33	TAN
PI587809B	2	RB	3	2.7	0.33	TAN
PI587831	2	TAN	3	2.7	0.33	TAN
PI587880A	3	RB	3	2.7	0.33	RB
PI587885	2	RB	3	2.7	0.33	RB
PI587905	2	RB	3	2.7	0.33	RB
PI587911A	2	TAN	3	2.7	0.33	Mixed
PI587975	3	TAN	3	2.7	0.33	TAN
PI588022B	3	TAN	3	2.7	0.33	TAN
PI593942	4	Mixed	3	2.7	0.33	Mixed
PI593951	2	TAN	3	2.7	0.33	Mixed
PI593953	2	TAN	3	2.7	0.33	TAN
PI594172A	3	RB	3	2.7	0.67	RB

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI594510C	3	TAN	3	2.7	0.33	TAN
PI594734	2	TAN	3	2.7	0.33	TAN
PI594739A	3	TAN	3	2.7	0.33	TAN
PI594761	4	RB	3	2.7	0.33	Mixed
PI602497B	2	TAN	3	2.7	0.67	Mixed
PI603174A	2	TAN	3	2.7	0.33	TAN
PI603299	2	TAN	3	2.7	0.33	TAN
PI603328	2	TAN	3	2.7	0.33	TAN
PI603348B	2	TAN	3	2.7	0.88	TAN
PI603441	3	TAN	3	2.7	0.33	TAN
PI603488	2	TAN	3	2.7	0.67	TAN
PI603571B	2	TAN	3	2.7	0.67	Mixed
PI603687B	2	TAN	3	2.7	0.33	TAN
PI603758C	3	TAN	3	2.7	0.33	Mixed
PI603913D	2	TAN	3	2.7	0.33	TAN
PI605786C	3	TAN	3	2.7	0.33	TAN
PI605854B	4	Mixed	3	2.7	0.33	Mixed
PI612742	1	TAN	3	2.7	0.33	Mixed
PI612757	2	TAN	3	2.7	0.67	TAN
PI612758A	2	RB	3	2.7	0.33	Mixed
PI612759C	1	TAN	3	2.7	0.33	TAN
PI615437	2	TAN	3	2.7	0.33	TAN
PI615445	3	Mixed	3	2.7	0.33	Mixed
PI603727	3	TAN	3	2.7	0.67	TAN
PI248405	2	RB	7	2.7	0.42	RB
PI417088	3	TAN	4	2.8	0.48	RB
PI567003A	4	Mixed	4	2.8	0.25	TAN
PI567027A	3	RB	4	2.8	0.48	Mixed
PI594882A	3	TAN	4	2.8	0.25	Mixed
PI603419B	2	TAN	4	2.8	0.25	TAN
PI628898	3	TAN	4	2.8	0.25	Mixed
PI208437	3	RB	5	2.8	0.49	Mixed
PI561291	2	RB	5	2.8	0.20	Mixed
PI561381	3	TAN	5	2.8	0.49	TAN
PI567107A	4	Mixed	5	2.8	0.20	Mixed
PI567150A	3	TAN	5	2.8	0.20	Mixed
PI567382B	4	Mixed	5	2.8	0.20	TAN
PI578461	2	Mixed	5	2.8	0.20	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI592923	3	RB	5	2.8	0.58	RB
PI605885B	3	Mixed	5	2.8	0.20	Mixed
PI079648	2	RB	6	2.8	0.48	Mixed
PI165914	3	RB	6	2.8	0.31	TAN
PI340898A	3	Mixed	6	2.8	0.31	TAN
PI437151	5	TAN	6	2.8	0.31	Mixed
PI438230A	2	TAN	6	2.8	0.31	RB
PI497960	2	RB	6	2.8	0.17	Mixed
PI497961	2	TAN	6	2.8	0.17	Mixed
PI549018	4	Mixed	6	2.8	0.17	RB
PI567553	3	Mixed	6	2.8	0.31	Mixed
PI605830A	3	Mixed	8	2.9	0.30	Mixed
PI230970	3	Mixed	9	2.9	0.31	Mixed
PI054857	3	TAN	2	3.0	0.00	tan
PI068503	3	Mixed	3	3.0	0.58	Mixed
PI069533	3	RB	2	3.0	0.00	RB
PI088490	2	Mixed	1	3.0	NA	Mixed
PI174862	3	RB	3	3.0	0.58	Mixed
PI181546	3	Mixed	3	3.0	0.58	Mixed
PI194654	3	TAN	2	3.0	0.00	Mixed
PI200492	3	Mixed	4	3.0	0.41	Mixed
PI203399	3	RB	3	3.0	0.58	Mixed
PI219732	3	TAN	1	3.0	NA	RB
PI232988	2	RB	3	3.0	0.58	Mixed
PI240663	3	TAN	1	3.0	NA	TAN
PI291278	3	Mixed	3	3.0	1.00	Mixed
PI307896	2	TAN	3	3.0	0.58	Mixed
PI307899A	2	TAN	2	3.0	0.00	Mixed
PI317334A	2	TAN	2	3.0	1.00	TAN
PI323275	3	Mixed	2	3.0	0.00	Mixed
PI340050	3	RB	2	3.0	0.00	Mixed
PI398624	3	TAN	1	3.0	NA	RB
PI398935	2	TAN	3	3.0	1.00	Mixed
PI398998	3	TAN	6	3.0	0.37	RB
PI404156	2	TAN	2	3.0	1.00	TAN
PI407766	2	TAN	1	3.0	NA	Mixed
PI407861C	3	RB	3	3.0	0.00	Mixed
PI408096	2	TAN	2	3.0	0.50	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI408122	2	TAN	2	3.0	0.00	Mixed
PI408307B	2	TAN	3	3.0	0.00	Mixed
PI416778	2	TAN	2	3.0	0.00	RB
PI416826A	4	Mixed	1	3.0	NA	Mixed
PI416834	3	RB	1	3.0	NA	RB
PI416851	3	TAN	3	3.0	0.67	TAN
PI416886	5	Mixed	3	3.0	0.00	Mixed
PI417012	3	RB	6	3.0	0.45	Mixed
PI417128	3	Mixed	2	3.0	0.00	Mixed
PI417208	3	Mixed	3	3.0	0.58	Mixed
PI417503	4	Mixed	3	3.0	0.00	Mixed
PI417560	3	TAN	1	3.0	NA	TAN
PI423706	2	RB	1	3.0	NA	RB
PI423766	3	Mixed	3	3.0	0.58	Mixed
PI423984	2	TAN	2	3.0	0.00	Mixed
PI424456	3	RB	4	3.0	0.41	TAN
PI432359	4	Mixed	3	3.0	0.00	Mixed
PI437166A	3	Mixed	3	3.0	0.58	TAN
PI437182	2	TAN	3	3.0	1.00	TAN
PI437658	4	Mixed	3	3.0	0.58	Mixed
PI445826	2	TAN	3	3.0	0.00	TAN
PI464920B	4	Mixed	3	3.0	0.00	Mixed
PI467321	3	Mixed	3	3.0	0.00	Mixed
PI471900	2	TAN	2	3.0	0.00	RB
PI471943A	2	RB	2	3.0	0.00	RB
PI475813A	3	TAN	3	3.0	0.00	RB
PI476889	3	TAN	4	3.0	0.41	TAN
PI476905A	2	RB	6	3.0	0.26	Mixed
PI479724A	2	TAN	3	3.0	0.00	Mixed
PI494851	3	TAN	2	3.0	0.00	Mixed
PI497957	3	Mixed	3	3.0	0.00	TAN
PI497962	2	TAN	2	3.0	0.00	Mixed
PI504503	2	TAN	3	3.0	0.00	Mixed
PI504510	2	TAN	6	3.0	0.45	TAN
PI506488	2	TAN	2	3.0	0.00	Mixed
PI506491	3	Mixed	2	3.0	0.00	Mixed
PI506493	2	TAN	1	3.0	NA	RB
PI506604	2	TAN	4	3.0	0.41	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI506677	2	TAN	2	3.0	0.00	Mixed
PI506947	4	Mixed	3	3.0	0.00	Mixed
PI506988	4	Mixed	1	3.0	NA	RB
PI507002	2	TAN	1	3.0	NA	Mixed
PI507279	2	TAN	3	3.0	0.00	Mixed
PI507479	2	TAN	3	3.0	0.58	Mixed
PI507566	2	TAN	2	3.0	1.00	TAN
PI507704B	4	Mixed	3	3.0	0.00	Mixed
PI507709	3	TAN	3	3.0	0.00	Mixed
PI532458	2	RB	5	3.0	0.00	Mixed
PI548178	3	TAN	2	3.0	0.00	TAN
PI548484	3	TAN	6	3.0	0.45	TAN
PI561287B	3	Mixed	4	3.0	0.41	Mixed
PI566955	2	TAN	1	3.0	NA	Mixed
PI566992A	2	Mixed	1	3.0	NA	Mixed
PI567005B	2	TAN	3	3.0	0.00	Mixed
PI567023A	2	TAN	1	3.0	NA	TAN
PI567025A	4	Mixed	2	3.0	0.00	Mixed
PI567026	2	TAN	2	3.0	1.00	Mixed
PI567031B	2	Mixed	3	3.0	0.00	Mixed
PI567034	3	Mixed	4	3.0	0.00	Mixed
PI567037	2	Mixed	2	3.0	1.00	Mixed
PI567046A	2	TAN	3	3.0	0.00	RB
PI567046C	2	Mixed	3	3.0	0.00	RB
PI567048B	2	TAN	2	3.0	0.00	Mixed
PI567056A	2	TAN	2	3.0	0.00	RB
PI567058D	2	TAN	3	3.0	0.00	Mixed
PI567083A	5	TAN	6	3.0	0.26	Mixed
PI567102B	3	Mixed	3	3.0	0.00	RB
PI567131B	3	Mixed	3	3.0	0.00	RB
PI567139A	2	TAN	2	3.0	0.00	Mixed
PI567139B	2	TAN	2	3.0	0.00	Mixed
PI567145C	3	RB	1	3.0	NA	Mixed
PI567154	2	TAN	2	3.0	0.00	Mixed
PI567189A	4	Mixed	8	3.0	0.19	Mixed
PI567200A	3	TAN	3	3.0	0.00	Mixed
PI567238	3	TAN	5	3.0	0.00	Mixed
PI567261A	3	TAN	5	3.0	0.32	TAN

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI567275	3	TAN	1	3.0	NA	TAN
PI567417A	1	TAN	3	3.0	0.00	Mixed
PI567503	2	TAN	3	3.0	0.00	Mixed
PI567522A	1	TAN	2	3.0	0.00	Mixed
PI567659	2	TAN	3	3.0	1.00	Mixed
PI567661B	3	TAN	3	3.0	0.00	Mixed
PI567767A	4	Mixed	2	3.0	0.00	Mixed
PI578323B	3	Mixed	2	3.0	0.00	Mixed
PI587604D	4	Mixed	3	3.0	0.00	Mixed
PI587687A	3	Mixed	3	3.0	0.58	Mixed
PI587759	3	Mixed	2	3.0	0.00	Mixed
PI587815A	2	TAN	2	3.0	0.00	Mixed
PI587830A	3	Mixed	2	3.0	0.00	Mixed
PI587834	2	TAN	2	3.0	0.00	Mixed
PI587910	3	Mixed	2	3.0	1.00	TAN
PI587965	3	Mixed	4	3.0	0.41	TAN
PI594013	2	TAN	2	3.0	0.00	Mixed
PI594149	4	RB	1	3.0	NA	Mixed
PI594397A	3	Mixed	2	3.0	0.00	Mixed
PI594430B	2	TAN	3	3.0	0.58	Mixed
PI594430E	3	Mixed	2	3.0	0.00	Mixed
PI594470D	3	TAN	2	3.0	0.00	RB
PI594485	4	RB	2	3.0	1.00	TAN
PI594494A	3	TAN	3	3.0	0.00	RB
PI594510B	3	RB	3	3.0	0.00	RB
PI594514	2	Mixed	1	3.0	NA	Mixed
PI594539	3	TAN	5	3.0	0.63	TAN
PI594557B	4	RB	2	3.0	1.00	Mixed
PI594561	4	Mixed	2	3.0	0.00	Mixed
PI594679	3	Mixed	3	3.0	0.00	Mixed
PI594716B	3	TAN	3	3.0	0.58	Mixed
PI594740A	2	TAN	3	3.0	0.00	Mixed
PI594758A	2	Mixed	2	3.0	0.00	Mixed
PI594762	3	RB	3	3.0	0.00	RB
PI594796	4	RB	3	3.0	0.58	Mixed
PI594877	3	TAN	3	3.0	3.00	TAN
PI597440B	2	TAN	2	3.0	1.00	Mixed
PI603151A	3	TAN	3	3.0	0.00	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI603333	2	TAN	3	3.0	1.00	Mixed
PI603427B	2	TAN	3	3.0	0.58	Mixed
PI603516	3	TAN	3	3.0	0.00	Mixed
PI603569A	2	TAN	3	3.0	0.58	Mixed
PI603597	2	TAN	7	3.0	0.22	Mixed
PI603669	2	TAN	3	3.0	0.00	Mixed
PI603692	3	TAN	3	3.0	0.00	Mixed
PI605773	4	Mixed	3	3.0	0.58	Mixed
PI605787C	3	RB	2	3.0	1.00	RB
PI605825C	2	TAN	4	3.0	0.41	TAN
PI605833	2	RB	8	3.0	0.19	RB
PI605857A	3	RB	5	3.0	0.32	Mixed
PI605859A	3	TAN	5	3.0	0.00	Mixed
PI605863A	3	TAN	3	3.0	0.00	Mixed
PI612759D	2	RB	2	3.0	0.00	Mixed
PI628859	3	TAN	8	3.1	0.30	TAN
PI507337	3	TAN	6	3.2	0.31	TAN
PI548463	3	TAN	6	3.2	0.40	TAN
PI567048A	3	Mixed	6	3.2	0.31	Mixed
PI605781A	2	RB	6	3.2	0.17	RB
PI605781C	3	RB	6	3.2	0.17	RB
PI612755	3	RB	6	3.2	0.17	RB
PI196529	3	RB	5	3.2	0.37	RB
PI385942	3	TAN	5	3.2	0.37	RB
PI594767A	3	RB	5	3.2	0.37	RB
PI603354	3	Mixed	5	3.2	0.20	Mixed
PI476927	2	TAN	9	3.2	0.15	Mixed
PI423972	2	RB	8	3.3	0.25	RB
PI459025B	3	TAN	4	3.3	0.25	Mixed
PI605828A	2	Mixed	8	3.3	0.16	Mixed
PI068427	3	Mixed	3	3.3	0.33	Mixed
PI068443	3	Mixed	3	3.3	0.33	Mixed
PI068461	3	Mixed	3	3.3	0.33	Mixed
PI068488	3	Mixed	3	3.3	0.33	Mixed
PI092563	3	Mixed	3	3.3	0.33	Mixed
PI203398	3	Mixed	3	3.3	0.33	TAN
PI303651	1	TAN	3	3.3	0.67	RB
PI307884B	4	Mixed	3	3.3	0.33	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI365426	2	TAN	3	3.3	0.67	Mixed
PI374190	3	Mixed	3	3.3	0.33	Mixed
PI374191	4	Mixed	3	3.3	0.67	Mixed
PI407716	3	Mixed	3	3.3	0.67	Mixed
PI416819A	3	Mixed	3	3.3	0.33	Mixed
PI417013	3	Mixed	3	3.3	0.33	Mixed
PI417115	3	Mixed	3	3.3	0.67	Mixed
PI417117	4	Mixed	3	3.3	0.33	Mixed
PI417125	4	RB	3	3.3	0.33	RB
PI417134	3	Mixed	3	3.3	0.33	Mixed
PI417463	2	Mixed	3	3.3	0.33	Mixed
PI417486	2	TAN	3	3.3	0.33	Mixed
PI437895A	4	Mixed	3	3.3	0.33	Mixed
PI438002	4	Mixed	3	3.3	0.33	Mixed
PI445832	2	TAN	3	3.3	0.33	RB
PI504493	1	TAN	3	3.3	0.33	Mixed
PI506812	4	Mixed	3	3.3	0.67	Mixed
PI506847	2	TAN	3	3.3	0.33	Mixed
PI506969	2	TAN	3	3.3	0.33	Mixed
PI507193	3	Mixed	6	3.3	0.21	Mixed
PI567024	2	TAN	3	3.3	0.33	RB
PI567190	3	Mixed	6	3.3	0.21	Mixed
PI567313	3	Mixed	3	3.3	0.67	Mixed
PI578307A	3	Mixed	3	3.3	0.33	Mixed
PI578307B	3	Mixed	3	3.3	0.33	Mixed
PI578319A	3	Mixed	3	3.3	0.33	Mixed
PI578378	1	TAN	3	3.3	0.67	Mixed
PI587613	2	TAN	3	3.3	0.88	Mixed
PI587656	4	Mixed	3	3.3	0.33	Mixed
PI587743	3	Mixed	3	3.3	0.33	Mixed
PI587758	3	RB	3	3.3	0.33	Mixed
PI587880B	3	RB	3	3.3	0.33	RB
PI587886	2	RB	3	3.3	0.33	RB
PI587934	2	Mixed	3	3.3	0.33	Mixed
PI588032A	4	Mixed	3	3.3	0.67	Mixed
PI594172C	3	Mixed	3	3.3	0.33	Mixed
PI594448A	2	TAN	3	3.3	0.33	TAN
PI594660D	3	TAN	3	3.3	0.33	Mixed



Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI594723	3	RB	3	3.3	0.33	RB
PI594784A	3	Mixed	6	3.3	0.33	TAN
PI594826A	2	TAN	3	3.3	0.33	Mixed
PI594837B	3	RB	3	3.3	0.33	Mixed
PI594839A	3	TAN	3	3.3	0.33	RB
PI594839B	3	RB	3	3.3	0.33	RB
PI597395	4	Mixed	3	3.3	0.33	Mixed
PI597405D	3	Mixed	3	3.3	0.67	Mixed
PI597430A	3	Mixed	3	3.3	0.67	Mixed
PI603329	2	TAN	3	3.3	0.67	Mixed
PI603372	3	TAN	3	3.3	0.33	Mixed
PI603490	3	RB	3	3.3	0.33	Mixed
PI605781E	3	TAN	3	3.3	0.33	Mixed
PI605789A	4	RB	6	3.3	0.21	Mixed
PI605823	3	RB	3	3.3	0.33	Mixed
PI605829	4	Mixed	3	3.3	0.33	Mixed
PI605860	3	TAN	3	3.3	0.33	Mixed
PI605865B	4	Mixed	6	3.3	0.21	Mixed
PI605886A	3	Mixed	6	3.3	0.33	Mixed
PI606434	2	TAN	3	3.3	0.67	Mixed
PI606440A	3	Mixed	3	3.3	0.33	Mixed
PI612716	4	Mixed	3	3.3	0.33	Mixed
PI612753A	2	RB	3	3.3	0.33	Mixed
PI612760	3	Mixed	3	3.3	0.33	Mixed
PI605838	3	Mixed	8	3.4	0.18	Mixed
PI083881	3	TAN	5	3.4	0.51	TAN
PI506484	2	RB	5	3.4	0.40	Mixed
PI594813	3	TAN	5	3.4	0.24	RB
PI603570D	4	RB	5	3.4	0.51	Mixed
PI274508	2	TAN	2	3.5	0.50	Mixed
PI398288	2	TAN	2	3.5	0.50	Mixed
PI398985	2	TAN	2	3.5	0.50	TAN
PI416825B	2	TAN	2	3.5	0.50	RB
PI416825C	2	TAN	2	3.5	0.50	RB
PI417089B	2	TAN	2	3.5	0.50	RB
PI417116	3	Mixed	2	3.5	0.50	Mixed
PI437689	4	Mixed	2	3.5	0.50	Mixed
PI438303	4	Mixed	2	3.5	0.50	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI471929A	3	Mixed	6	3.5	0.22	Mixed
PI499955	1	TAN	6	3.5	0.22	Mixed
PI506695	3	Mixed	2	3.5	0.50	Mixed
PI547875	3	TAN	2	3.5	0.50	TAN
PI561302C	2	TAN	2	3.5	0.50	Mixed
PI567022A	3	Mixed	4	3.5	0.29	Mixed
PI567487	2	TAN	2	3.5	0.50	Mixed
PI567610B	3	TAN	2	3.5	0.50	Mixed
PI587873	3	RB	6	3.5	0.43	Mixed
PI592935	3	TAN	4	3.5	0.65	RB
PI594733	3	RB	6	3.5	0.43	Mixed
PI605779E	2	TAN	2	3.5	0.50	Mixed
PI606405	4	Mixed	6	3.5	0.22	Mixed
PI612749	2	TAN	2	3.5	0.50	Mixed
PI605891A	4	RB	9	3.6	0.18	Mixed
PI206258	3	TAN	5	3.6	0.51	RB
PI603910C	2	TAN	5	3.6	0.40	Mixed
PI068680-2	3	Mixed	3	3.7	0.67	Mixed
PI307869	2	Mixed	3	3.7	0.33	Mixed
PI341257	3	TAN	3	3.7	0.67	TAN
PI346306	2	TAN	3	3.7	0.33	Mixed
PI374206	2	TAN	3	3.7	0.33	Mixed
PI379621	2	Mixed	3	3.7	0.33	Mixed
PI407710	3	Mixed	3	3.7	0.33	Mixed
PI437609A	3	Mixed	3	3.7	0.33	Mixed
PI437695B	3	Mixed	3	3.7	0.33	Mixed
PI437845A	4	Mixed	3	3.7	0.33	Mixed
PI438001	4	Mixed	3	3.7	0.33	Mixed
PI458532B	2	TAN	3	3.7	0.67	Mixed
PI475814	3	TAN	3	3.7	0.33	RB
PI506965	2	TAN	3	3.7	0.33	Mixed
PI507672	2	TAN	3	3.7	0.33	Mixed
PI507689	4	Mixed	3	3.7	0.33	Mixed
PI561305	2	TAN	3	3.7	0.33	Mixed
PI561334	4	Mixed	3	3.7	0.33	Mixed
PI578326	3	Mixed	3	3.7	0.33	Mixed
PI587555B	4	Mixed	3	3.7	0.67	Mixed
PI587664B	3	Mixed	3	3.7	0.33	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI592947	3	RB	3	3.7	0.33	RB
PI594433C	4	Mixed	3	3.7	0.33	Mixed
PI594511B	3	RB	3	3.7	0.67	RB
PI594756	2	RB	3	3.7	0.33	RB
PI594760B	3	TAN	3	3.7	0.33	RB
PI597439	4	Mixed	3	3.7	0.33	Mixed
PI599509	3	RB	3	3.7	0.33	RB
PI603323	3	TAN	3	3.7	0.33	Mixed
PI603341	2	TAN	6	3.7	0.33	Mixed
PI603388	4	Mixed	3	3.7	0.33	Mixed
PI605772	2	TAN	3	3.7	0.33	Mixed
PI605791A	3	TAN	6	3.7	0.33	Mixed
PI606408	5	RB	3	3.7	0.33	RB
PI567351B	2	TAN	4	3.8	0.48	Mixed
PI068465	3	Mixed	3	4.0	0.00	Mixed
PI068585	3	Mixed	3	4.0	0.00	Mixed
PI068658	3	Mixed	3	4.0	0.58	Mixed
PI084686	3	Mixed	3	4.0	0.00	Mixed
PI291315	2	RB	3	4.0	0.00	Mixed
PI374187	4	Mixed	2	4.0	0.00	Mixed
PI374192A	4	Mixed	2	4.0	0.00	Mixed
PI407875A	3	RB	3	4.0	0.58	Mixed
PI416764	5	RB	3	4.0	0.58	RB
PI416790	2	TAN	2	4.0	1.00	Mixed
PI416873B	3	Mixed	2	4.0	0.00	Mixed
PI417132	5	Mixed	2	4.0	1.00	Mixed
PI417461	3	Mixed	3	4.0	0.58	Mixed
PI423923	5	RB	2	4.0	0.00	Mixed
PI437081B	4	Mixed	3	4.0	0.58	Mixed
PI437628	4	Mixed	3	4.0	0.58	Mixed
PI437649B	4	Mixed	3	4.0	0.58	Mixed
PI462312	3	TAN	4	4.0	0.58	TAN
PI468377	3	TAN	3	4.0	0.00	Mixed
PI470227B	3	Mixed	2	4.0	0.00	Mixed
PI471929B	2	RB	1	4.0	NA	Mixed
PI476350B	3	Mixed	3	4.0	0.00	Mixed
PI476350C	4	Mixed	3	4.0	0.00	Mixed
PI506628	4	Mixed	1	4.0	NA	Mixed

Table 1. (continued)

Soybean accession	P1 evaluation <sup>1</sup>		P2 evaluation <sup>2</sup>			
	Soybean rust severity <sup>3</sup>	Lesion type <sup>4</sup>	Number of plants evaluated	Mean soybean rust severity	Standard error of the mean	Lesion type <sup>4</sup>
PI506748	4	Mixed	1	4.0	NA	TAN
PI507032	2	TAN	1	4.0	NA	Mixed
PI507038	4	Mixed	3	4.0	0.58	Mixed
PI507092	3	TAN	3	4.0	0.00	Mixed
PI507259	4	Mixed	1	4.0	NA	RB
PI522189	2	TAN	3	4.0	0.00	Mixed
PI549069	2	TAN	3	4.0	0.58	Mixed
PI561282E	2	TAN	3	4.0	0.58	Mixed
PI561300B	2	TAN	3	4.0	0.58	Mixed
PI561338B	3	Mixed	1	4.0	NA	Mixed
PI567216B	2	TAN	2	4.0	0.00	Mixed
PI567679B	2	TAN	2	4.0	1.00	Mixed
PI567737	2	TAN	2	4.0	1.00	RB
PI578471A	3	RB	3	4.0	0.00	TAN
PI592938	3	TAN	5	4.0	0.45	Mixed
PI594510A	3	TAN	3	4.0	0.00	RB
PI594512C	3	RB	6	4.0	0.26	Mixed
PI594568A	4	Mixed	3	4.0	0.00	Mixed
PI603290	4	Mixed	3	4.0	0.00	Mixed
PI603348C	2	TAN	2	4.0	0.00	TAN
PI603404	2	TAN	2	4.0	0.00	TAN
PI606397B	3	Mixed	3	4.0	0.58	Mixed
PI612717	4	Mixed	3	4.0	0.00	Mixed
PI612724	4	Mixed	3	4.0	0.00	Mixed
PI391577	4	RB	3	4.3	0.67	RB
PI404176	4	RB	3	4.3	0.33	RB
PI417352	2	Mixed	3	4.3	0.33	Mixed
PI437167A	4	Mixed	3	4.3	0.33	Mixed
PI449457	2	TAN	3	4.3	0.33	Mixed
PI449458A	3	Mixed	3	4.3	0.33	Mixed
PI467322B	4	Mixed	3	4.3	0.33	Mixed
PI518291C	2	TAN	3	4.3	0.33	Mixed
Dwight	4	TAN	47	3.6	0.12	TAN
Ina	4	TAN	36	3.8	0.13	TAN

- <sup>1</sup> A total of 16,595 soybean accessions were evaluated as single seedlings in inoculation sets of approximately 1,000 accessions each.
- <sup>2</sup> Three seedlings per accession were evaluated within each inoculation set. However, many accessions had fewer than three seedlings evaluated if germination was low or had more than three seedlings if evaluated in multiple sets.
- <sup>3</sup> Disease severity scale of 1 to 5, based on symptom and lesion development, was used where 1 = no visible lesions, 2 = few scattered lesions present, 3 = moderate number of lesions on at least part of the leaf, 4 = abundant number of lesions on at least part of the leaf, and 5 = prolific lesion development over most of the leaf.
- <sup>4</sup> TAN, RB, or mixed lesion types.
- <sup>5</sup> Not applicable.