

# Field Evaluation of Early Maturing Chinese Soybean Germplasm for Rust Resistance

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## Summary

Soybean rust has been reported as a major yield-reducing disease in many countries throughout the world. Fungicide application is currently the major method to control the disease. Very limited sources of soybean germplasm are known to be resistant to the disease. The objective of this research was to identify sources of field resistance to soybean rust in early maturing Chinese soybean germplasm. Over 1,800 accessions of early maturing (Maturity Group II and earlier) Chinese soybean germplasm were evaluated for rust resistance in 2004 and 2005 in two rust nurseries, one in Jiangsu Province and the other in Fujian Province of China. Each accession was planted in single one-meter row plots with two replications at each nursery. The rust nursery in Fujian was naturally infected and the rust nursery in Jiangsu was inoculated with mixtures of rust pathogen originally collected from Fujian. The nursery in Jiangsu was inoculated several times during V3, R1, and R2 stages with urediniospores of *Phakopsora pachyrhizi*. Ten plants from each plot were rated for rust severity 10-15 days before maturity using a rating system modified from the system developed by the International Working Group on Soybean Rust (IWGSR) in 1976. Nineteen accessions showed resistance in both nurseries in 2004 and four of these accessions remained resistant in both nurseries in 2005. Thirty one additional accessions showed resistance in both nurseries in 2005. These accessions will be further evaluated to confirm or negate their rust resistance.

## Introduction

Soybean rust has been reported as a major yield-reducing disease in many countries throughout the world. In southern Japan, yield losses due to soybean rust were estimated at 15-40% and up to 70-80% in individual fields (Bromfield, 1976). In a field trial in Korea, yield losses were 68.7% in a susceptible cultivar and 22.3% in a tolerant cultivar (Shin and Tschanz, 1986). In southeastern China, yield losses of 10-30% were common and losses of over 50% occurred in years with severe rust (Bromfield et al., 1980). Soybean rust was first found in continental states of the US in November 2004. In 2005, 87 counties in Alabama, Florida, Georgia, Mississippi, and South Carolina reported positive with soybean rust by October 25 (USDA Soybean Rust Information Site at <http://www.sbrusa.net>). The climate suitability of major US soybean-growing areas for soybean rust ranged from 0.38 (Texas and Oklahoma) to 0.83 (Florida, Alabama, Georgia, and South Carolina) with 1.00 as the perfect suitability (Livingston et al. 2004). Therefore, the pathogen will be able to survive and establish itself in the continental US.

Soybean rust is caused by two fungal pathogens, one is known as the Asian type (*Phakopsora pachyrhizi*) and the other is known as the New World type (*Phakopsora meibomia*). The Asian type is more aggressive than the New World type. Both types of pathogens have a wide range of host plant species. The Asian type infects 34 natural hosts and 61 experimental hosts (Hartman et al., 1999). The New World type infects 41 natural hosts and 25 experimental hosts (Hartman et al., 1999). Soybean rust is most severe during long periods of leaf wetness when the mean daily temperature is 15-28°C and relative humidity is 75-80%. A prolonged wet, cool period is required for infection and sporulation. The spores are spread by windblown rain. Severe rust causes premature defoliation and reduces the number of filled pods, number of seeds per pod, and seed weight (Melching et al., 1989).

Soybean rust is controlled by appropriate fungicide. Host resistance has not yet been employed as a major control method, probably due to the lack of known sources for stable and strong resistance. The objective of this research was to identify sources of field resistance to soybean rust in early maturing Chinese soybean germplasm.

## Materials and Methods

Over 1,800 accessions of early maturing (Maturity Group II and earlier) Chinese soybean germplasm were evaluated for rust resistance in 2004 and 2005 in two rust nurseries, one in Jiangsu Province and the other in Fujian Province of China (Fig. 1). Each accession was planted in single one-meter row plots with two replications at each nursery. The rust nursery in Fujian was naturally infected and the rust nursery in Nanjing was inoculated with mixtures of rust pathogen originally collected from Fujian. The nursery in Nanjing was inoculated several times during V3, R1, and R2 stages with urediniospores of *Phakopsora pachyrhizi* (the Asian type). The urediniospores were scraped from rust lesions on diseased leaves of soybean plants grown in a greenhouse. The spores were suspended in water at a concentration of 105 spores per ml. The spore suspension was sprayed onto soybean plants with a Micron Ulva + hand-held sprayer in humid evenings (Fig. 2).

Ten plants from each plot were rated for rust severity 10-15 days before maturity (Fig. 3) using a rating system modified from the system developed by the International Working Group on Soybean Rust (IWGSR) in 1976. The modified IWGSR rating system uses a three-digit rating score to record the rust severity. The first digit denotes the upper bond position of most diseased leaves in the leaf canopy of the plant. The second digit denotes the density of rust lesions on most of the diseased leaves. The third digit denotes the infection type on most of the diseased leaves. The rating scale of each digit is explained as follows:



Fig. 1. Locations of the two rust nurseries



Fig. 2. Inoculation of the rust nursery



Fig. 3. Rating the plants for rust severity in the Nanjing rust nursery



Fig. 4. The Sanming rust nursery showing rust symptoms

First digit: upper bond position of most diseased leaves

- 1 – bottom third of the leaf canopy of the plant
- 2 – middle third of the leaf canopy of the plant
- 3 – upper third of the leaf canopy of the plant

Second digit: density of rust lesions on most diseased leaves

- 0 – no lesion
- 1 – light lesion density (<10 lesions per cm<sup>2</sup>)
- 2 – medium lesion density (11 – 50 lesions per cm<sup>2</sup>)
- 3 – heavy lesion density (>50 lesions per cm<sup>2</sup>)

Third digit: infection type on most diseased leaves

- 1 – no pustules
- 2 – non-sporulating pustules
- 3 – sporulating pustules

The product of the three digits for each plant was calculated and the average product of the 10 plants in a plot was used as the disease severity value for the plot. The average of the two replications (plots) in a nursery was taken as the mean product of the accession in the nursery. The larger mean product of each accession in the two nurseries and the maximum products for individual plants of the accession were used to determine whether the germplasm was resistant to soybean rust according the following table.

Classification	The larger mean product of the two nurseries	The maximum products for individual plants
Immune	0	0
Resistant	0.1 – 5.0	≤6

## Results

In 2004, 850 accessions were tested in both nurseries and 19 were found resistant. None of these accessions were immune to the disease. The 19 accessions were tested again in 2005 in both nurseries. One of the 19 accession remained resistant based on the criteria shown in the above table and three other accessions had a larger mean product in the two nurseries less than 5.0 with a maximum product for individual plants of 8. These three accessions appeared to be resistant in the field.

In 2005, 1000 new accessions were tested in both nurseries and 31 accessions were found resistant. These accessions will be tested again in 2006 to confirm or negate their rust resistance.

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