Epidemics of Soybean Rust (*Phakopsora pachyrhizi*) in Brazil and Paraguay from 2001 to 2003

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ABSTRACT

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In 5 March 2001, a severe rust outbreak was recorded at Pitapó, Paraguay, and the causal organism was determined to be *Phakopsora pachyrhizi* using polymerase chain reaction (PCR) and DNA sequence analysis. In May, rust surveys showed spread throughout most of Paraguay and into western and northern Parana, Brazil. In the 2001–02 season, rust was widespread in Paraguay, but losses were reduced due to severe drought; however, in Brazil it spread to more than 60% of the soybean acreage, causing field losses estimated at 0.1 million metric tons (MMT). In 2003, the disease was observed in more than 90% of the fields in Brazil, and the projected losses in Mato Grosso and Bahia alone are 2.2 MMT (US$487.3 million). Approximately 80% of the soybean acreage in Brazil was sprayed twice with fungicides at the cost of US$544 million. Differences in efficacy have been observed among the commercial strobilurin and triazol fungicides.

Soybeans (*Glycine max*) are infected by two species of *Phakopsora* that cause rust disease, *P. meibomiae* ("American" rust) (3,8) and the most feared, *P. pachyrhizi*, the cause of the "Asian" rust (1,6,7,9). In March 2001, a rust epidemic was recorded at Pitapó, Paraguay, causing severe yield losses (5). In May, the disease was also found on volunteer and second-crop soybeans in Paraguay and Brazil (Fig. 1). Comparative DNA tests between *P. meibomiae* and *P. pachyrhizi*, performed at USDA-ARS-NAA, Foreign Disease-Weed Science Research Unit (FDWSRU), Fort Detrick, MD, confirmed that the epidemic was caused by *P. pachyrhizi* (4). In this work, a report is given on the expansion of rust disease and the losses caused in Paraguay and Brazil from 2001 to 2003.

MATERIALS AND METHODS

Disease survey and yield loss assessments were carried out through field visits, fungicide trials, comparisons between sprayed and unsprayed farmers' fields, and visual assessment by associating disease severity and plant growth stages. In 2001, diseased leaf samples were collected from Paraguay and Brazil and sent to USDA-ARS-NAA, FDWSRU, for species identification by DNA analysis and comparisons between known *P. meibomiae* and *P. pachyrhizi* isolates.

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RESULTS

In Paraguay in 2001, rust control with fungicides resulted in 60% higher yield than the check (Fig. 2). A disease survey completed in May showed severe incidence of rust on volunteer and second-crop soybeans in all surveyed areas (4). In Brazil, rust was also found on volunteer and second-crop soybeans in the west and north of Parana state (5,10). The genetic analysis of the two *Phakopsora* species confirmed that the rust epidemic was caused by *P. pachyrhizi.* Besides soybeans, in Paraguay, kudzu bean (*Pueraria lobata*) growing wild on the roadside and in forested areas was heavily infected and showed to be an important source of inoculum for rust.

In the 2001–02 crop season, rust was found on all soybean fields in Paraguay, from Encarnación to Troncal 3 (Catueté) (Fig. 3), but severe drought and extensive use of fungicides reduced losses. In Brazil, the rust was found on an estimated 60% of soybean acreage, being especially serious in the south-central regions. In southern Goias (GO) and Mato Grosso (MT) and the northeast of South Mato Grosso (MS) (Fig. 3), yield losses ranged from 30 to 75%. In Rio Grande do Sul (RS), losses on individual farms were as high as 48%. Based on government (CONAB, JUN/03) soybean production estimates for the 2001–02 crop season (41.917 million t), total grain losses due to rust reached 569,220 t (US$125.5 million, at US$220.50/t) (2).

In 2002–03, the soybean rust spread to almost all of Brazil, with few places not reporting cases of rust (Fig. 4). Despite the abundant rainfall, the high temperatures in the South may have restricted rust development in those areas where it was severe the previous year. The disease was most severe where it was not recorded before: the northeast (Bahia-BA) and the north-central (MT, GO, and Minas Gerais) regions. In two of the hardest hit states (MT, with 4.2 million ha, and Bahia, with 830,000 ha), the losses were estimated at 3.1 million t or the equivalent to US$677 million. Additional losses, as high as 63%, occurred in the states of RS, GO, and MG. Total grain losses for 2003 were estimated at 3.4 million t or the equivalent to US$759 million. Because of the rust outbreak in the previous year, about 80% (14.8 million ha) of the

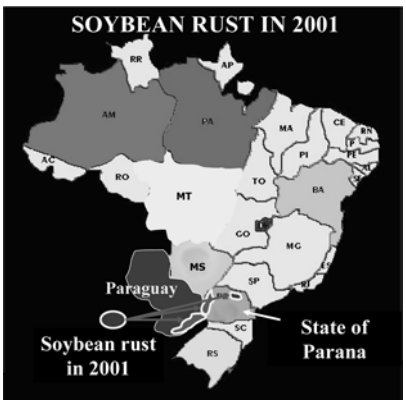

Fig. 1. First rust sites in Paraguay and Brazil.

Fig. 2. Efficacy of fungicide treatments. Photo by Wilfrido Morel.

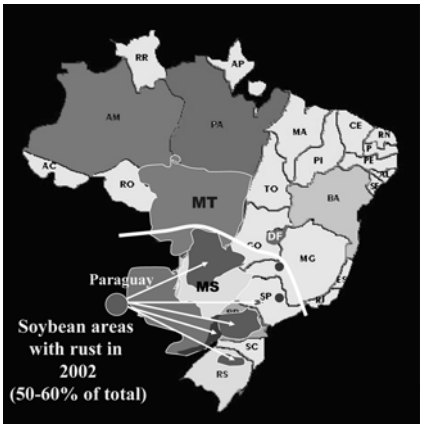

Fig. 3. Expansion of rust in 2002.

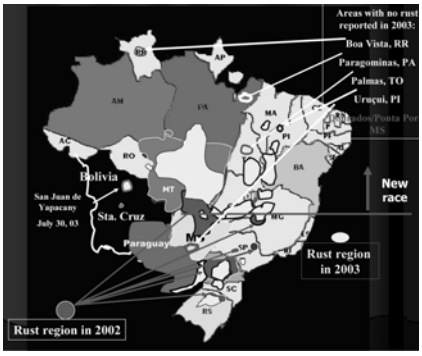

Fig. 4. Expansion of rust in 2003.

Fig. 5. Race–2003 sporulating on cotyledons.

soybean acreage in Brazil (18.534 million ha) had an average of two fungicide sprays. At the cost of US$40.00/ha, a total US$592 million was spent on control. Therefore, the cost of soybean rust to Brazilian farmers in 2003 reached the figure of US$2 billion.

The rust epidemics that occurred in the northeast and north-central regions of Brazil were due to a new and highly virulent race of *P. pachyrhizi*. This race broke the resistance of all available commercial varieties, and for the first time, a severe infection and sporulation on the cotyledons was seen under greenhouse conditions (Fig. 5).

The first outbreak of rust in Bolivia was detected at San Juan de Yapacany, in the last week of July 2003, affecting the second plantings grown in the winter for seed production. A little over 100,000 ha are normally sown during this season. Although there is no rainfall during the winter, the cool weather allows for adequate moisture for a prolonged dew period. Thus, there is a potential for heavy losses due to rust. Moreover, application of foliar fungicides is not a routine practice on second-crop soybeans.

The efficiency of rust control depends upon careful and continuous field monitoring and timely application of fungicide. Currently, strobilurins and triazol fungicides are being used. It is important to note that remarkable differences exist among these compounds in their mode of action (preventive and curative). Prior knowledge of this detail is of utmost importance in choosing the fungicide and the timing of application, once the disease is established on the plant.

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