Soybean Diseases in Brazil

Soybean Production
Brazil is one of the largest producers of soybean in the world, producing 81.7 million metric tons (MMT) in 2013 (Table 5). The area of cultivated soybean production in this country doubled from the 1998–1999 growing season to the 2012–2013 growing season, increasing from 12.9 million ha to 27.9 million ha. One of the main factors in the successful expansion of soybean production in Brazil has been the development of cultivars adapted to low latitudes south and north of the equator. This development has enabled the expansion of production into the Cerrado region (central Brazil), which produces more than 50% of Brazil’s soybean crop (as of 2015).

Soybean is planted from October to December in many parts of Brazil. Under irrigation in central Brazil, soybean can be grown year-round.

Soybean Diseases
Disease problems vary according to region because of the large variation in weather conditions across Brazil. Even so, with the dramatic increase in production area has come a dramatic increase in diseases—in particular, soybean rust.

In addition to soybean rust, diseases such as frogeye leaf spot and southern stem canker have been important in the past but have become better controlled with resistance. For example, southern stem canker, which was identified during the 1988–1989 growing season in the state of Paraná (southern Brazil), caused yield losses of up to 100% in the mid-1990s. Other diseases that have more regional or local importance include brown stem rot, Phytophthora root and stem rot, Rhizoctonia aerial blight, and Sclerotinia stem rot, along with some diseases caused by nematodes and viruses. In addition, northern stem canker was identified during the 2005–2006 growing season in the state of Rio Grande do Sul (southern Brazil), but significant losses in commercial fields were neither observed nor reported.

Diseases Caused by Fungi and Oomycetes
A number of foliar diseases affect soybean in Brazil, but soybean rust has had the largest impact on production and management practices. Soybean rust caused by *Phakopsora pachyrhizi* was identified in May 2001 in the state of Paraná. Soybean rust caused by *P. meibomiae*, a less virulent species, was identified in Brazil in 1979, when it caused sporadic epidemics in regions with moderate temperatures, and it has remained a minor pathogen of soybean.

After the initial detection of *P. pachyrhizi*, soybean rust spread quickly into important soybean production regions in Brazil. Conditions in much of the country are conducive for year-round survival of the pathogen, affecting soybean grown during the winter in the central Cerrado region, as well as alternative hosts. From the first growing season in 2001–2002 after detection through 2012, annual losses were estimated at 15.5 MMT of soybean, valued at $3.8 billion. Sclerotinia stem rot, which can be found in central and southern Brazil, is problematic in regions above 700 m altitude, with moderate air temperatures and frequent rain events during the flowering stage. Rhizoctonia aerial blight is an important disease in the northern region, where warm, wet weather conditions prevail. In the southern region, diseases such as brown stem rot and Phytophthora root and stem rot are significant. Charcoal rot is a serious problem in the southwestern, southern, and northern regions of Brazil, where environmental stresses (e.g., low rainfall, high temperatures) frequently occur during the growing season.

Diseases Caused by Nematodes
A number of nematodes affect soybean production in Brazil. The most destructive is the soybean cyst nematode, the lesion nematode, the reniform nematode, the southern root-knot nematode, and the tropical root-knot nematode. The soybean cyst nematode was first detected in 1991–1992, and by 2015, it had infested approximately 3 million ha. Losses resulting from this parasite have decreased, however, because of crop rotation with nonhost species (mainly corn) and the use of genetically resistant soybean cultivars. The genetic variability of the nematode continues to be problematic. A number of types of soybean cyst nematode have been identified, and those that overcome the Hartwig source of resistance are of the greatest concern.

The lesion nematode has increased in importance in Brazil, especially in areas with sandy soils (less than 15% clay). The reniform nematode has increased in importance in the state of Mato Grosso do Sul (central-western Brazil), especially when soybean croppers have followed cotton in rotation.

Diseases Caused by Viruses
Plant virologists have been concerned about the expansion of the Brazilian soybean crop because of its proximity to other botanical species, some of which are hosts of viruses that infect soybean. In the early 2000s, *Cowpea mild mottle virus*, transmitted by whiteflies, caused severe losses among susceptible soybean cultivars. Other viruses found on soybean in Brazil include *Bean golden mosaic virus*, *Bean pod mottle virus*, *Soybean mosaic virus*, and *Tobacco streak virus*.

Disease Management
Resistance is a key element in the successful management of most important soybean diseases in Brazil, including frogeye leaf spot, Phytophthora root and stem rot, southern stem canker, and soybean rust, along with diseases caused by the root-knot nematode and the soybean cyst nematode. Soybean-breeding programs in this country have focused on incorporating disease resistance into elite genetic material whenever possible, and as a result, several diseases have been eliminated as economic threats. For example, frogeye leaf spot was first identified in Brazil in 1971 and was considered a major disease until the introduction of resistance gene *Rcx3* from cultivar Davis. Since the mid-1990s, the disease has practically been absent from the fields, although some races of the pathogen found in northern Brazil have overcome this resistance. Another example is southern stem canker, for which four resistance genes—*Rdc1*, *Rdc2*, *Rdc3*, and *Rdc4*—have been incorporated into commercial cultivars, resulting in nearly complete control of the disease. Resistance gene deployment using *Rpp2*, *Rpp4*, and *Rpp5* has also been effective, at least in part, in controlling soybean rust.

Rotating soybean with nonhost species is recommended for controlling the lesion, root-knot, and reniform nematodes, as well as diseases such as Sclerotinia stem rot. For instance, rotating soybean with species of *Crotalaria* or pearl millet (*Pennisetum glaucum*) was found to suppress the lesion nematode population. The use of tillage practices is also recommended for lesion nematode control; disking has been used to expose nematodes to sunlight and thus desiccation.

In some cases, changing planting times is recommended to help prevent disease. Growers are advised to plant early maturing cultivars in the beginning of the season and to reduce the length of the planting period to help the host avoid infection by the soybean rust pathogen. In 2013, 12 states in Brazil adopted a period of 60–90 days from July to September that is host free, during which farmers are restricted from planting soybean except under strictly controlled conditions. This practice was first adopted in 2007 to break the continuous cycle of the fungus (*P. pachyrhizi*) and to delay the onset of the epidemic in the regular season. Following this practice has been effective in delaying rust epidemics.

A major control strategy used by Brazilian growers is the use of fungicides. Recommendations for applying fungicides
(mainly sulfur and benzimidazoles) were first made during the 1996–1997 growing season to control powdery mildew and then some years later to control late-season diseases, such as brown spot and Cercospora leaf blight. With the introduction of *P. pachyrhizi* in 2001, fungicide use greatly increased at first and then stabilized after some years to an average of two or three applications per field per season. The use of triazoles alone was recommended in the first growing season after detection of the pathogen, but since 2007, following observations of reduced efficiency, only mixtures of triazoles and strobilurins have been recommended for rust control. The weakened efficiency of triazoles observed 6 years after the introduction of rust in Brazil has been associated with selection of less sensitive populations of *P. pachyrhizi*.

Increases have also been noted in some diseases that are not readily controlled by triazoles and strobilurins, including anthracnose and target spot. When these diseases occur, an additional application of benzimidazoles is required. However, isolates of the target spot pathogen have developed resistance to benzimidazoles in several regions of Brazil. Other diseases, such as Sclerotinia stem rot, can be controlled by benzimidazoles, which can also be used to treat seeds if they are suspected of harboring the pathogen.

New compounds from the carboxamide group have been shown useful in controlling some diseases and may be applied more frequently in the future. New compounds from the pyridinamine and dicarboximide groups, which may also have efficacy in controlling Sclerotinia stem rot and other diseases, are being tested along with other fungicides in a nationwide network of uniform field trials.

**Selected References**


