ABSTRACT: 250

PATHOGENIC VARIATIONS OF SOYBEAN RUST IN ARGENTINA

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As a collaborative project with JIRCAS (Japan), preliminary studies on pathogenic variations of *Phakopsora pachyrhizi,* Asian soybean rust (ASR), are being carried out at INTA Pergamino, province of Buenos Aires, Argentina. Samples of soybean rust spores were collected from the provinces of Buenos Aires (central region); Chaco and Formosa (north-east region) during the season 2007-2008; from the provinces of Misiones (north-east region); Jujuy (north-west region) and Santa Fe (central region) during 2008-2009; and from the provinces of Misiones (north-east region); Tucumán, Salta and Santiago del Estero (north--west region); Buenos Aires, Entre Ríos and Santa Fe (central region) during 2009-2010.

The goal of this study was to characterize possible pathogenic variations among ASR isolates from different regions of Argentina. Similar research is being done in Paraguay (CIMC, formerly CRIA) and Brazil (EMBRAPA) to compare results within South America. A set of 16 differential varieties of soybean was inoculated with a freshly prepared spore suspension (50,000 spores/ml). Two weeks after the inoculation the reactions of the varieties were reported and classified as immune, resistant, intermediate and susceptible according to the number of uredinia per lesion (NoU), and the sporulation level (SL).

The results detected pathogenic variations among the *P. pachyrhizi* population in Argentina during the three crop seasons from 2007-2010.

Research of pathogenic variations of soybean rust in South America

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Soja

Pathogenic variations of soybean rust in Argentina

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Introduction

There are two forms of soybean rust, the Asian form (ASR), caused by *Phakopsora pachyrhizi*, and the American form caused by *Phakopsora meibomiae*. The Asian form is the one that produces the most severe losses to the crop.

Introduction

Losses due to soybean rust are related to the phenological stage at the time of infection and the severity of the symptoms.

The effect on the yield is caused by the early senescence of the plants and consequently the smaller size of the seed produced by the infected plants.

Introduction

Weather conditions in Argentina, generally do not allow the survival of ASR neither on soybean nor on alternative hosts, therefore rust spores arrival depends on the source of inoculum coming from southern Brazil and Paraguay. Incidence and severity of ASR in Argentina will depend on the presence of favorable weather conditions for the disease on both, Argentina, and Brazil and Paraguay.

Under favorable weather conditions soybean rust can cause premature senescence of plants and heavy defoliation reducing the seed size and yields. Under cool and humid weather the disease can reach from the initial infection to 90% in three weeks.

Introduction

The options for the management of the soybean rust are the use of tolerant/resistant cultivars, and the use of foliar fungicides.

There are five genes involved in the resistance: Rpp1, Rpp2, Rpp3, Rpp4 and Rpp5, identified in PI 200692, PI 230970, PI 462312 (Ankur), PI 459025 and PI 200526 (Shiranui) respectively.

Since available commercial varieties are susceptible the only effective tool to reduce yield losses is the application of fungicides.

Introduction

The Asian Vegetable Research and Development Center (AVRDC) identified nine races in Taiwan using a set of differentials composed of nine varieties of soybean (Yamaoka et al. 2002). Yamada et al. (2002) using the same set of differentials identified two races of soybean rust in Japan, later on Fujiwara et al identified six more races among eight isolates of the fungus collected on soybean and on a wild host plant.

Introduction

In order to test pathogenic variations of soybean rust in South America Jircas is sponsoring a joined study through an agreement between Jircas (Japan International Research Center for AgriculturalSciences, Tsukuba,Ibaraki, Japan); Empresa Brasileira de Pesquisa Agropecuária (Embrapa Brazil); Instituto Paraguayo de Tecnologia Agraria (IPTA), Paraguay and INTA (Instituto Nacional de Tecnologia Agropecuaria, Argentina).

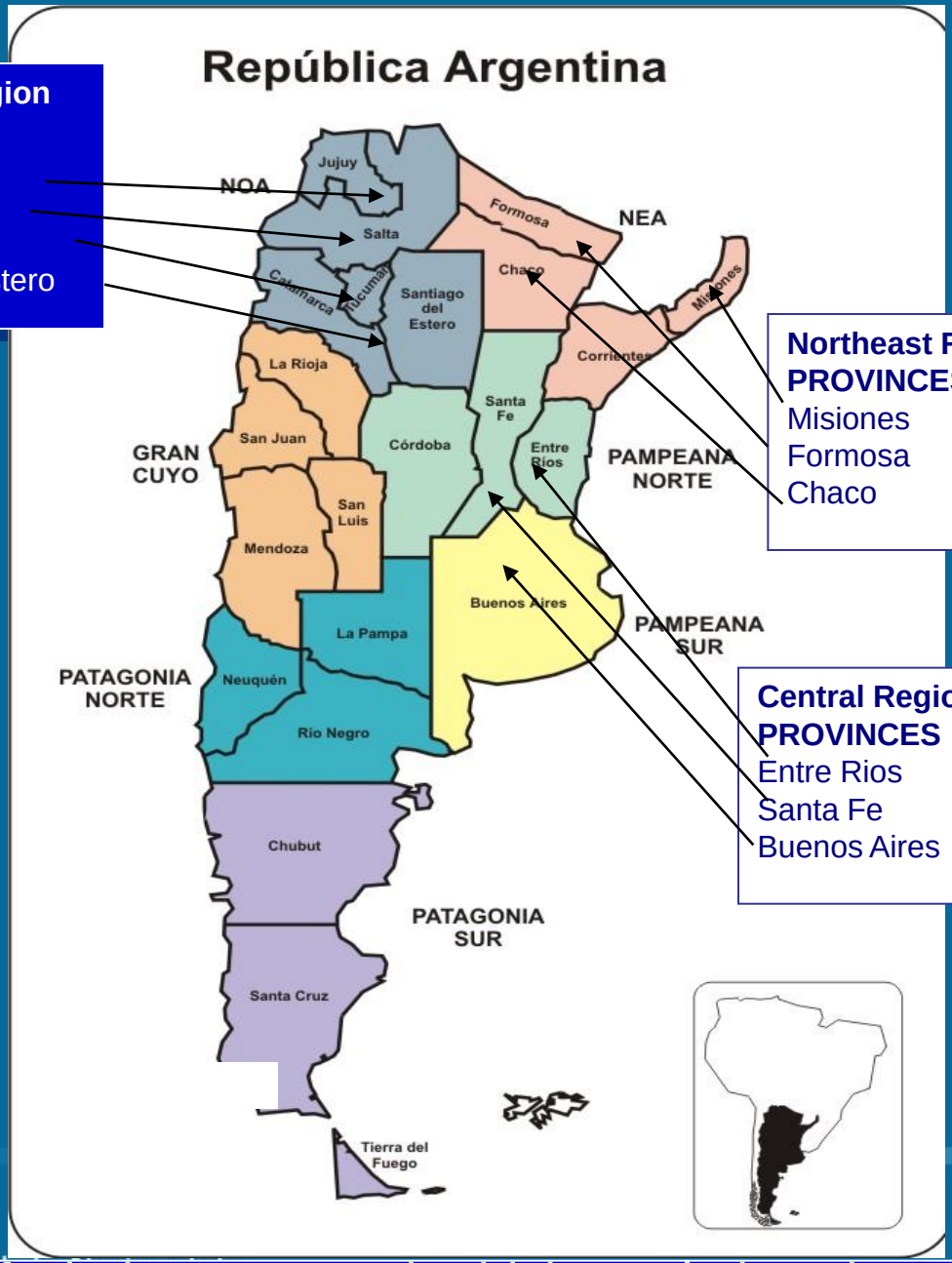
Introduction

The goal of this research is to get information on the pathogenic variability of *Phakopsora pachyrhizi* in Argentina by comparing the reaction of differential varieties to isolates collected from rust infected soybean at different locations in central and northern Argentina.

Materials and Methods

Soybean rust spores were collected from the fields during the season 2008-2009 from the provinces of Misiones (northeast region); Jujuy (northwestern region); and Santa Fe (central region); while during 2009-2010 from the provinces of Buenos Aires, Santa Fe, Misiones, Salta, Tucumán, Entre Ríos and Santiago del Estero; and during 2010-2011 from the provinces of Corrientes and Santa Fe.

Northwest Region
PROVINCES
Jujuy
Salta
Tucuman
Santiago del Estero



Northeast Region
PROVINCES
Misiones
Formosa
Chaco

Central Region
PROVINCES
Entre Rios
Santa Fe
Buenos Aires

Monitoring of *Phakopsora pachyrhizi* populations in South America – Sampling locations in Argentina

Materials and Methods

Infected soybean leaves collected no more than 24 or 48 hours before using were placed in Erlenmeyer with distilled water and manually shaked until getting 50000 spores/ml. A set of differential varieties obtained from Jircas, Japan, were inoculated, using three plants (at the first trifoliate leaf) per pot (table 1).

Materials and Methods

Inoculations were done by diluting the spores in destilled water with one drop of Tween 20 and spraying the plants. During the first 24 hours plants were kept under moist chamber, under darkness and 24ºC.

Finally plants were kept in growth chamber during 15 days and evaluated according to their reactions by using the scale from the protocol:

A-Lesion

B- Number of uredinia per lesion (average)

C- Sporulation (scale: 0-3)

Materials and Methods

Figure 1: Evaluation system for number of uredinia per lesion
(Average of at least 30 lesions under stereo microscope)

Materials and Methods

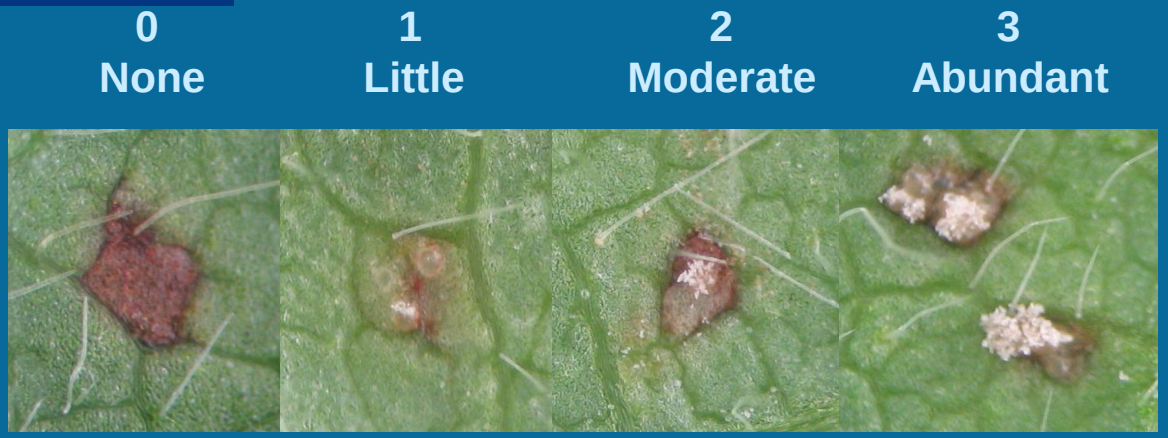


Figure 2: Evaluation system for sporulation level
(Scale by N. Yamanaka (0–3), by magnifying glass or stereo microscope)

Materials and Methods

Classification of reactions produced by soybean rust

Lesion	Mean Number of Uredinia	Sporulation level	Reaction
-	0	-	I Immune
+	0	-	R
+	Less than 1	Less than 1	R
+	1 ≤ x <1.5	Less than 1	R
+	Less than 1.5	More than 2	IM
+	More than 1.5	Less than 1	IM
+	1.5 ≤ x <3	More than 2	S
+	More than 3	More than 3	S

Table 1: Differential varieties used for the identification of soybean rust races (Jircas, Japan).

Variety	R. Gene
1- PI 200492	Rpp1
2- Tainung-4 (PI 368039)	Rpp1 + ?
3- PI 230970	Rpp2
4- PI 417125	Rpp2
5- PI 462312 (Ankur)	Rpp3
6- PI 459025	Rpp4
7- Shiranui (PI 200526)	Rpp5
8- PI 416764	Unknown
9- PI 587855	Unknown
10- PI 587880 A	Unknown
11- PI 587886	Unknown
12- PI 587905	Unknown
13- PI 594767 A	Unknown
14- BRS 154	Unknown (S)
15- TK5	Unknown (S)
16- Wayne	Unknown (S)

RESULTS

Table 2: Differential varieties used for the identification of soybean rust races (Jircas, Japan). Provinces of Misiones (northeast region); Jujuy (northwestern region and Santa Fe (central region) - 2008-2009

Variety	R. Gene	Reaction – Provinces		
		Misiones	Jujuy	Santa Fe
1- PI 200492	Rpp1	S	S	S
2- Tainung-4 (PI 368039)	Rpp1 + ?	S	S	S
3- PI 230970	Rpp2	R	S	S
4- PI 417125	Rpp2	IM	S	S
5- PI 462312 (Ankur)	Rpp3	S	S	S
6- PI 459025	Rpp4	S	R	R
7- Shiranui (PI 200526)	Rpp5	R	R	S
8- PI 416764	Unknown	IM	R	IM
9- PI 587855	Unknown	-	-	-
10- PI 587880 A	Unknown	R	R	R
11- PI 587886	Unknown	-	R	S
12- PI 587905	Unknown	R	R	R
13- PI 594767 A	Unknown	R	R	R
14- BRS 154	Unknown (S)	-	S	-
15- TK5	Unknown (S)	S	S	S
16- Wayne	Unknown (S)	S	S	-

(-) No data

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RESULTS

The weather conditions in Argentina during the summer 2009 were very adverse for the development of soybean and soybean rust (severe drought) so the number of isolates of rust collected was lower than expected during this period of time

RESULTS

Table 3: Differential varieties used for the identification of soybean rust races (Jircas, Japan). Provinces of Misiones (northeast region); Tucumán, Salta and Santiago del Estero (northwestern region); Buenos Aires, Entre Ríos and Santa Fe (central region) – 2009-2010.

Variety	R.Gene	Reaction – Provinces								
		Misiones	Tucumán	Salta	Sgo. del Estero	Buenos Aires	Entre Rios	Santa Fe		
								1	2	3
1- PI 200492	Rpp1	S	S	S	S	S	S	S	S	-
2- Tainung-4 (PI 368039)	Rpp1 + ?	S	S	S	R	S	S	S	S	S
3- PI 230970	Rpp2	-	S	S	-	S	S	S	S	R
4- PI 417125	Rpp2	-	S	S	S	S	S	S	S	S
5- PI 462312 (Ankur)	Rpp3	S	S	S	-	S	S	S	S	S
6- PI 459025	Rpp4	R	S	S	-	R	S	S	S	S
7- Shiranui (PI 200526)	Rpp5	S	-	R	-	IM	R	R	R	R
8- PI 416764	Unknown	S	S	R	-	S	R	S		S
9- PI 587855	Unknown	R	-	-	-	R	-	-	-	-
10- PI 587880 A	Unknown	R	R	R	S	R	R	R	R	R
11- PI 587886	Unknown	S	-	S	S	S	-	S	S	S
12- PI 587905	Unknown	R	R	R	R	S	R	I M	S	R
13- PI 594767 A	Unknown	R	R	R	R	IM	R	-	R	R
14- BRS 154	Unknown (S)	S	S	S	S	S	-	S	S	-
15- TK5	Unknown (S)	S	S	S	S	S	S	S	S	S
16- Wayne	Unknown (S)	S	S	S	-	S	S	S	S	S

(-) No data

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RESULTS

Table 4: Differential varieties used for the identification of soybean rust races (Jircas, Japan). Provinces of Misiones (northeast region), Tucuman, Salta and Santiago del Estero (northwestern region); Buenos Aires, Entre Ríos and Santa Fe (central region) – 2010-2011.

Variety	R. Gene	Reaction – Provinces				
		Formosa	Corrientes	Santa Fe		
				1	2	3
1- PI 200492	Rpp1	S	S	S	S	S
2- Tainung-4 (PI 368039)	Rpp1 + ?	S	S	S	S	S
3- PI 230970	Rpp2	S	S	S	R	IM
4- PI 417125	Rpp2	-	-	R	-	R
5- PI 462312 (Ankur)	Rpp3	R	R	R	R	R
6- PI 459025	Rpp4	-	-	-	S	-
7- Shiranui (PI 200526)	Rpp5	S	-	-	IM	S
8- PI 416764	Unknown	-	-	-	-	-
9- PI 587855	Unknown	R	R	R	R	R
10- PI 587880 A	Unknown	R	-	R	R	R
11- PI 587886	Unknown	S	-	R	S	S
12- PI 587905	Unknown	R	R	R	R	R
13- PI 594767 A	Unknown	R	R	R	-	R
14- BRS 154	Unknown (S)	S	S	S	-	S
15- TK5	Unknown (S)	S	S	-	S	S
16- Wayne	Unknown (S)	S	S	S	S	S

(-) No data

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CONCLUSIONS

Pathogenic variation was found among the *Phakopsora pachyrhizi* population, between and within different provinces of Argentina, during three crop seasons 2009-2011.

Information about the variation in pathogenicity among the soybean rust population in Argentina and in South America is an important feature to be considered for the soybean breeders in those regions.

Considering the reaction of the differential varieties to the total number of isolates (15) tested in different regions of Argentina during three consecutive seasons (2009-2011) PI 200492, PI 368039 (Rpp1), PI 417125, PI 230970 (Rpp2), and PI 462312 (Ankur) (Rpp3) were susceptible to most of the isolates tested, indicating that these resistance genes were broken in Argentina. BRS 154, TK 5 and Wayne were also susceptible (Tables 2, 3 and 4).

The differential varieties with unknown genes PI 587855, PI 587880A, PI 587886 and PI 587905 were resistant to most of the isolates tested; while PI 459025 (Rpp4), PI 200526 (Shiranui) (Rpp5) and PI 416764 (unknown gen) were resistant and susceptible in similar proportion (Tables 2, 3 and 4).

The results show pathogenic variation among the isolates of *Phakopsora pachyrhizi* tested from different regions of Argentina. Variability was also observed among the years within each region. Only PI 594767A was resistant to all the isolates tested in different regions and seasons.

Due to the adverse weather conditions ASR was not detected during all the three seasons in the provinces evaluated. Only isolates of the provinces of Buenos Aires, Santa Fe and Misiones were evaluated during two seasons.

In the province of Buenos Aires the reaction of all the varieties tested were the same in both seasons. In the province of Santa Fe three of the varieties behaved differently, while in the province of Misiones PI 459025 (Rpp4) was resistant in 2009-2010 and susceptible in 2008-2009 and PI 416764 (unknown gen) showed intermediate reaction in 2008-2009 and susceptible in 2009-2010.

Thank you very much

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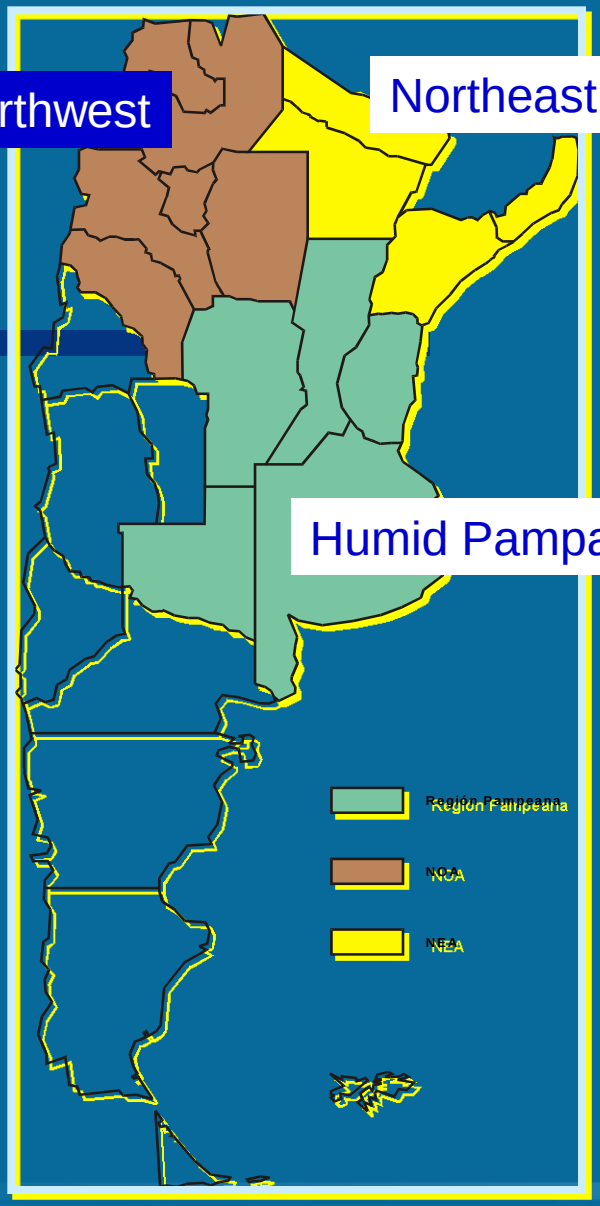

91% of the soybean production of Argentina is concentrated in the so called Pampa Húmeda (Humid Pampa)

5% Northwest

4 %Northeast

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Soybean Diseases in Argentina

Sclerotinia Stem Rot	***Sclerotinia sclerotiorum***
Sudden Death Syndrome	***Fusarium tucumaniae***
Stem Canker	***Phomopsis phaseoli*** **var. *meridionalis***

Soybean Diseases in Argentina

Brown Stem Rot	***Phialophora gregata***
Phytophthora Rot	***Phytophthora sojae***
Charcoal Rot	***Macrophomina phaseolina***
Sclerotium Blight	***Sclerotium rolfsii***
Anthracnose	***Colletotrichum truncatum***
Rhizoctonia Blight	***Rhizoctonia solani***

Late-Season Soybean Diseases

Brown Spot	***Septoria glycines***
Cercospora Blight and Leaf Spot	***Cercospora kikuchii***
Frogeye Leaf Spot	***Cercospora sojina***

During the last ten years

Late season soybean diseases

Soybean rust

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LATE SEASON SOYBEAN DISEASES

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- **Cercospora Blight**
- *Cercospora kikuchii*

Cercospora Leaf Blight
Cercospora kikuchii

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Cercospora leaf blight

Cercospora kikuchii

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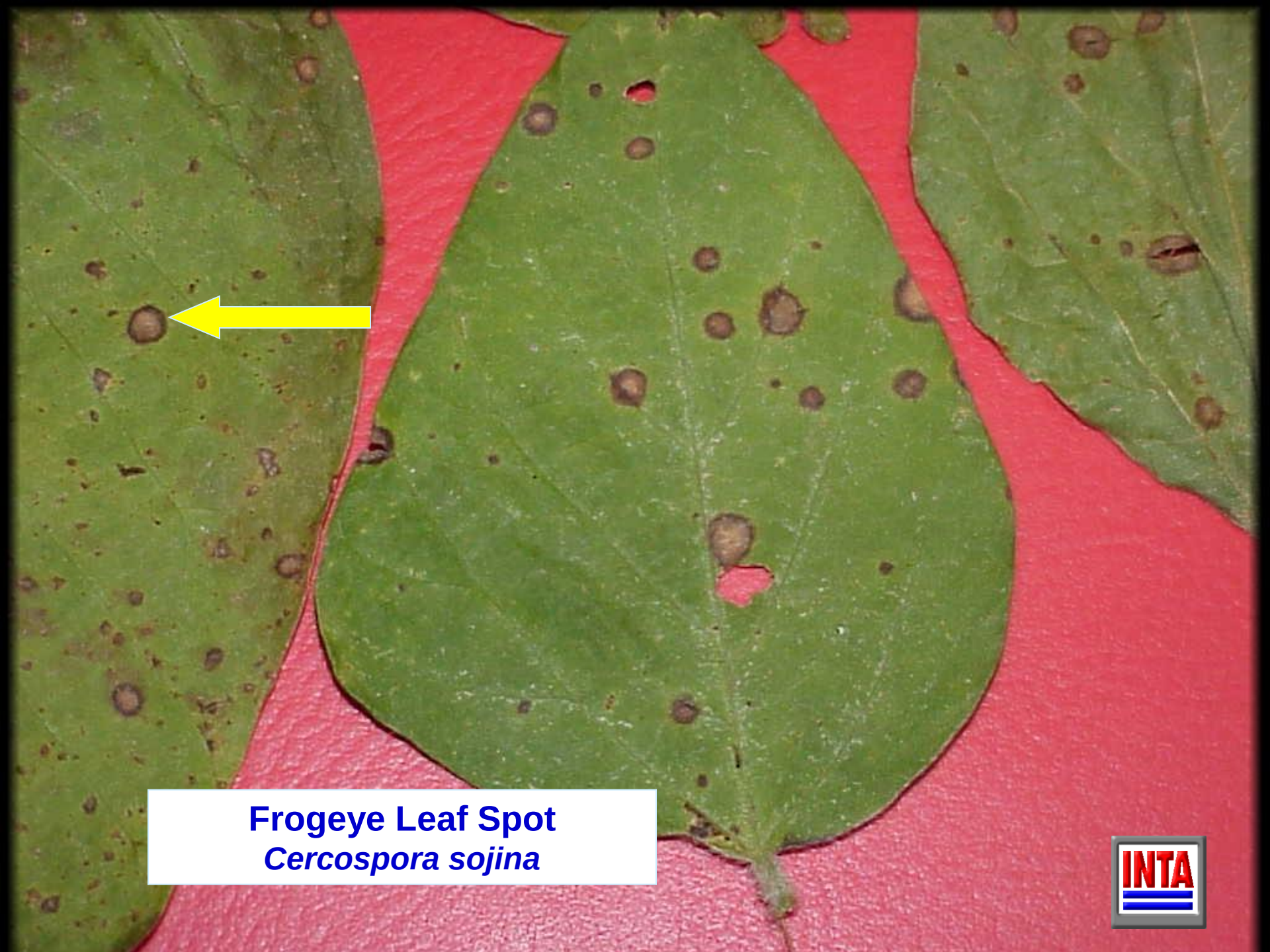
- **Frog Eye Leaf Spot**
- *Cercospora sojina*


Frogeye Leaf Spot
Cercospora sojina
INTA

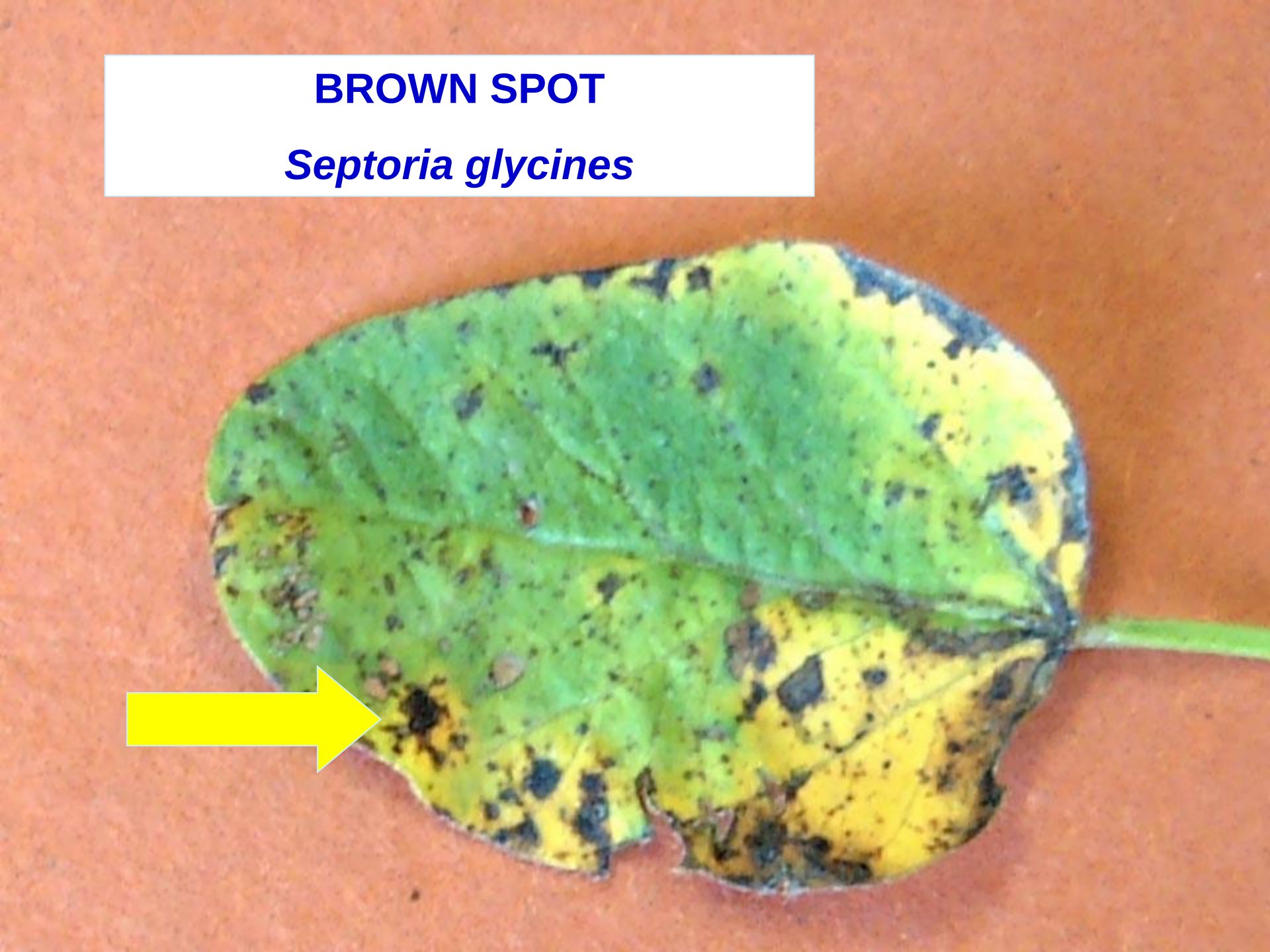
- In the main soybean region of Argentina Brown Spot is the predominant late season soybean disease, in both, incidence and severity.

BROWN SPOT

Septoria glycines

BROWN SPOT

Septoria glycines



BROWN SPOT

(*Septoria glycines*)

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