

Development of "Doncella INTA-JIRCAS," a new soybean variety with high Asian soybean rust resistance

Asian soybean rust (ASR) is a serious soybean disease that accelerates defoliation and reduces yield of soybean. Farmers have been using fungicides for ASR control, but the fungicide resistance of the pathogen is increasing. The use of resistant varieties would reduce production cost and environmental impact by limiting the excessive use of fungicides. Resistance genes (*Rpp*s) to ASR have been identified in soybean. In addition, JIRCAS has shown that soybean plants with multiple *Rpp* genes are not only resistant to many strains of the ASR pathogen with different virulence, but also show a high level of resistance to them. In this study, we developed a soybean variety with high ASR resistance adapted to Argentina, using the *Rpp*-pyramided lines bred by JIRCAS.

We crossed the ASR-resistant line "No6-12-1," which has three resistance genes (*Rpp2*, *Rpp4*, and *Rpp5*) developed by JIRCAS, as a non-recurrent parent and the variety "INTA ALIM5.09" from the National Agricultural Technology Institute (INTA), as a recurrent parent. The F₁ individuals were then backcrossed to the recurrent parent, and individuals carrying the three resistance genes were selected using DNA markers. This process was done continuously, and the line with the best production characteristics was selected and registered in the National Seed Institute (INASE) of the Ministry of Agriculture, Livestock and Fisheries of Argentina as "Doncella INTA-JIRCAS." The official date of registration of the new soybean variety was April 25, 2022 (Variety Registration Number: 4304). The new variety was similar to the recurrent parent, INTA ALIM5.09, for major soybean traits such as stem termination (Table 1). However, ASR severity on the leaves in the field experiment was less than 1% for the new variety, compared to more than 30% for the recurrent parent, INTA ALIM5.09 and the reference varieties, INTA Paraná 629 and INTA Paraná 5500, indicating that the new variety has high ASR-resistance derived from "No6-12-1" (Fig. 1).

Because both infection and spore production of ASR are suppressed in the new variety (Fig. 1), fungicide use can be significantly reduced. Actually, soybean varieties developed in Paraguay by introducing the same gene combinations have yielded 1.4- or 1.7-fold higher than pre-improved varieties under fungicide-free conditions. However, in order to maintain the resistance of new varieties for a long time, it is necessary to suppress the emergence of new ASR pathogens that can break the resistance, so fungicides should be used in appropriate quantities and frequencies.

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Name of variety	New variety	Reference variety 1 (Recurrent parent)	Reference variety 2	Reference variety 3
	Doncella INTA-JIRCAS	ALIM5.09	INTA Paraná 629	INTA Paraná 5500
Severity (%±SD)	Less than 1	37.3±1.1	46.2±4.0	50.8±1.1
Sporulation level	0	3	3	3
Infected leaves				

Fig. 1. Severity and resistance of a new soybean variety and reference varieties to Asian soybean rust

Severity (% area of lesions) and resistance (sporulation level 0–3 on lesions) of new variety: Doncella INTA-JIRCAS and the reference varieties for registration: INTA ALIM5.09 (recurrent parent), INTA Paraná 629, and INTA Paraná 5500. Results of trials in INTA-Cerro Azul Experimental Station, Argentina.

Table 1. Major characteristics of new soybean variety and reference varieties

	New variety	Reference variety 1 (Recurrent parent)	Reference variety 2	Reference variety 3
	Doncella INTA-JIRCAS	ALIM5.09	INTA Paraná 629	INTA Paraná 5500
Stem termination	Indeterminate	Indeterminate	Indeterminate	Indeterminate
Flower color (hypocotyl color)	Purple	Purple	Purple	Purple
Pubescence color (stem and pod)	Gray	Gray	Gray	Gray
Leaflet shape	Oval	Oval	Oval	Oblong
Seedcoat color	Yellow	Yellow	Yellow	Yellow
Hilum color	Yellow	Yellow	Light brown	Black
Growth period	104 days	107 days	119 days	121 days
Plant height	69.4 cm	69.1 cm	93.8 cm	87.5 cm
100-seed weight	18.5 g	21.1 g	15.2 g	11.9 g
Seed lipid content ¹⁾	23.1%	22.6%	23.5%	23.4%
Seed protein content ¹⁾	40.5%	40.9%	35.6%	34.0%
Stem canker resistance	Moderately resistant	Moderately resistant	Resistant	Resistant
Asian soybean rust resistance	Resistant	Susceptible	Susceptible	Susceptible
Herbicide resistance	Susceptible	Susceptible	Susceptible	Resistant
Yield (t/ha) in INTA experimental stations ²⁾				
2018–2019 Cerro Azul	1.7667	1.7778	1.8326	1.8289
2018–2019 Parana	3.9286	4.0715	4.5631	3.8447
2018–2019 Marcos Juarez	3.5929	3.8782	4.0828	3.0326
2017–2018 Cerro Azul	2.7370	2.9699	2.8815	2.6359
2017–2018 Parana	2.5236	1.6240	2.1481	2.0371

¹⁾ Seed protein and lipid content are averages from the Marcos Juarez and Parana experimental stations.

²⁾ The significance levels (5%) for a total of five yield data for two years at three locations are 0.2686, 0.5281, 0.5043, 0.7936, and 0.4001 (t/ha) from top to bottom.

References: Variety registration in INASE (number: 4304 and date: April 25, 2022).

Kato et al. (2022) *Tropical Plant Pathology* 47: 599–607.

Yamanaka and Hossain (2019) *Plant Breeding* 138: 686–695.

Data in Figure 1 and Table 1 taken from the application for variety registration.