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CROP PROTECTION

Host status of soybean genotypes to *Meloidogyne* species

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ABSTRACT: *This study aimed to evaluate the host status of soybean genotypes to Meloidogyne javanica (Est J3), Meloidogyne sp.0 (Est R0), and M. graminicola (Est VS1). In the first experiment, all tested genotypes (BMX Potência RR, BMX Valente RR, BMX Icone IPRO, PELBR10-6049 RR, and TECIRGA 6070 RR) were susceptible to M. javanica, with reproduction factor (RF) >1.0, and resistant to Meloidogyne sp.0 (0.01 > RF < 0.15), whereas in the second experiment, all genotypes (BRS 246 RR, PELBR11-6038 RR, PELBR11-6001 RR, PELBR10-6005 RR, BMX Apolo RR, PELBR11-6028 RR, PF11651, PF103251, PELBR11-6035 RR, PELBR10-6050 RR, PELBR11-6042 RR, PELBR10-6017 RR, PELBR11-6007 RR, PELBR10-6016 RR, and PELBR10-6049 RR) were resistant to M. graminicola (0.06 > RF < 0.43).*
Key words: *plant resistance, soybean, phytonematodes, Rio Grande do Sul.*

Reação de genótipos de soja a espécies de *Meloidogyne*

RESUMO: *No presente estudo objetivou-se avaliar a reação de genótipos de soja a Meloidogyne javanica (Est J3), Meloidogyne sp.0 (Est R0) e M. graminicola (Est VS1). No primeiro experimento, todos os genótipos (BMX Potência RR, BMX Valente RR, BMX Icone IPRO, PELBR10-6049 RR, and TECIRGA 6070 RR) testados mostraram-se suscetíveis a M. javanica, com fator de reprodução (FR) >1.0, e resistentes a Meloidogyne sp.0 (0.01 > FR < 0.15), enquanto no segundo experimento, todos os genótipos (BRS 246 RR, PELBR11-6038 RR, PELBR11-6001 RR, PELBR10-6005 RR, BMX Apolo RR, PELBR11-6028 RR, PF11651, PF103251, PELBR11-6035 RR, PELBR10-6050 RR, PELBR11-6042 RR, PELBR10-6017 RR, PELBR11-6007 RR, PELBR10-6016 RR, and PELBR10-6049 RR) testados comportaram-se como resistentes a M. graminicola (0.06 > FR < 0.43).*
Palavras-chave: *resistência de plantas, soja, fitonematoides, Rio Grande do Sul.*

Soybean (*Glycine max* L. Merril) is one of the most important legumes crops in the world, contributing to 25% of the edible oil production and providing approximately 67% of the protein concentrate for animal feed worldwide (AGARWAL et al., 2013).

However, intensive planting and expansion of croplands to new areas have intensified phytosanitary problems, particularly those related to plant parasitic nematodes. In this context, the species *Meloidogyne javanica* and *M. incognita* are widely distributed in the soybean growing areas of Brazil (DIAS et al., 2010). Other species have been reported in different regions of the world, such as *M. graminicola* in China (LONG et al., 2017). This must be taken into consideration when planting soybeans in areas previously destined for the rice sector. In addition, recently, there have been frequent reports of an atypical population, called *Meloidogyne* sp.0, in southern Brazil (MATTOS et al., 2017). Therefore, the objective of this study was to evaluate the response of soybean genotypes to *M. javanica*, *Meloidogyne* sp.0, and *M. graminicola*, under greenhouse conditions.

Two experiments were conducted in a greenhouse (25°C ± 5°C) at Embrapa Clima Temperado - Pelotas / RS (31°42′S 52°24′W), from November 2018 to February 2019 (70 days). In the first experiment, five genotypes were evaluated against

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M. javanica (Est J3) and *Meloidogyne* sp.0 (Est R0) (Tables 1 and 2), and in the second experiment, fifteen genotypes were evaluated against *M. graminicola* (Est VS1) (Table 3). The first experiment was performed in a completely randomized factorial design (5 genotypes × 2 species × with or without nematodes). The second experiment was also performed in a completely randomized design with 15 genotypes. Tomato (*Lycopersicon esculentum* Mill. 'Santa Cruz') seedlings for *M. javanica*, and irrigated rice (EPAGRI SCS112 and BR IRGA 403) for *Meloidogyne* sp.0 and *M. graminicola*, were included to verify the viability of the inoculum.

Specimens of *Meloidogyne* were obtained following the methodology of COOLEN and D'HERDE (1972). Ten days after emergence, each seedling, grown in a 3,500 mL pot containing previously sterilized soil, was inoculated with a suspension containing 5,000 specimens (eggs + J2) from each *Meloidogyne* population separately (initial population = Pi). Two evaluations were performed, 30 and 60 days after inoculation (dai), to determine the average chlorophyll content of the leaves, using a portable chlorophyll meter (SPAD-502 Plus®, KONICA MINOLTA OPTICS, INC., Marunouchi, Chiyoda, Tokyo, Japan, ©2009). The plants were removed from the soil after 60 days, and the fresh mass of the root system (FMRS), fresh mass of the aerial part (FMAP), and number of galls (NG) were determined. Subsequently, the nematodes were then extracted from the roots according to the aforementioned methodology, and the final population (Pf) and reproduction factor of each nematode species (RF = Pf / Pi) were estimated. Genotypes were classified as resistant (R; RF < 1.0) or susceptible (S; RF > 1.0) (OOSTENBRINK, 1966).

For data from the first experiment, the values of the different variables were subjected to analysis of variance (ANOVA) and compared with Tukey's test (1953) (α = 0.05), using SAS® software (SAS 9.3, SAS Institute, Cary, North Carolina, USA). Data from the second experiment were compared with the Scott-Knott grouping test (1974) (α = 0.05), using the SASM program.

There were significant interactions between the inoculation-genotype factors for the chlorophyll content assessed 30 dai in plants inoculated with *Meloidogyne* sp.0. For the effect of inoculation within each genotype, differences were observed only for BMX Potência RR. In plants inoculated with *M. javanica*, the effects were significant only for genotypes; however, after 60 dai, the effects were significant for both genotypes and inoculation. The chlorophyll content did not differ between the genotypes inoculated with *M. javanica* and *Meloidogyne* sp.0 (Table 1).

On analysis of the FMAP data, a significant interaction between factors was observed for *Meloidogyne* sp.0. In case of the effect of inoculation on FMAP within each genotype, a significative increase

Table 1 - Leaf chlorophyll content, and fresh mass of the aerial part (FMAP) and root system (FMRS) of soybean genotypes inoculated with *Meloidogyne javanica* and *Meloidogyne* sp.0, 30 and 60 days after inoculation.

Genotypes	---Nematodes---							
	---*Meloidogyne javanica*---							
	Chlorophyll 30		Chlorophyll 60		FMAP (g)		FMRS (g)	
	WN	IN	WN	IN	WN	IN	WN	IN
BMX Potência RR	40.2	37.5	24.6	28.6	105.5	113.8	94.7	127.3
PELBR10-6049 RR	37.9	37.7	25.5	27.9	101.3	109.8	74.3	119.5
BMX Valente RR	38.3	40.2	20.8	26.8	100.7	119.6	56.0	105.2
BMX Icone IPRO	37.9	37.4	26.8	25.4	93.4	98.7	91.3	121.6
TECIRGA 6070 RR	37.2	37.5	22.6	25.1	92.4	98.4	67.2	97.5
	---*Meloidogyne* sp.0---							
BMX Potência RR	40.2	37.1	24.6	27.7	105.5	116.1	94.7	78.6
PELBR10-6049 RR	37.9	38.7	25.5	27.3	101.3	121.5	74.3	84.0
BMX Valente RR	38.3	40.3	20.8	28.1	100.7	121.6	56.0	70.0
BMX Icone IPRO	37.9	36.8	26.8	28.6	93.4	105.5	91.3	115.8
TECIRGA 6070 RR	37.2	36.7	22.6	24.7	92.4	96.5	67.2	101.4

WN = without nematode; IN = inoculated with nematode; g = grams.

Table 2 - Response of soybean genotypes to *Meloidogyne javanica* and *Meloidogyne* sp.0.

Genotypes	---Nematode---		
	---*Meloidogyne javanica*---		
	Number of Galls**	RF	Response
TOMATO (Santa Cruz) [1]	613c*	22.23c	
PELBR10-6049 RR	3214.33a	12.47c	S
BMX Valente RR	1193.67b	43.56ab	S
BMX Potência RR	894.33b	49.52a	S
TECIRGA 6070 RR	511.33c	22.23c	S
BMX Icone IPRO	499.67c	28.25bc	S
CV (%)	15.97	34.52	
	---*Meloidogyne* sp.0---		
RICE (Epagri scs112) [1]	846.17a	187.11a	
BMX Potência RR	26.50b	0.15b	R
PELBR10-6049 RR	13.33b	0.018b	R
BMX Icone IPRO	4.83b	0.066b	R
TECIRGA 6070 RR	0.33b	0.022b	R
BMX Valente RR	0.17b	0.013b	R
CV (%)	46.33	45.59	

*Means followed by the same letter in the same column are not significantly different, based on the Tukey test at 5%; ** original values transformed into [√ (x + 0.5)]; R = resistant; S = susceptible; CV = Coefficient of variation; RF = reproduction factor; [1] indicates susceptible host.

was observed for most genotypes inoculated with *Meloidogyne* sp.0. Interaction between factors was verified by the evaluation of FMRS. In case of the effect of inoculation on FMRS within each genotype, interaction between factors was verified and a significant increase was observed in the genotypes BMX Icone IPRO, TECIRGA 6070 RR, and BMX Valente RR, inoculated with *Meloidogyne* sp.0. For

Table 3 - Response of soybean genotypes to *Meloidogyne graminicola*.

Genotypes	---Nematode---		
	Number of galls**	RF	Response
ARROZ[1]	393.17a*	19.81a	
BRS 246 RR	22b	0.43b	R
PELBR11-6038 RR	12.5c	0.38c	R
PELBR11-6001 RR	11.67c	0.31d	R
PELBR10-6005 RR	11.17c	0.30d	R
BMX APOLO RR	9.5d	0.29d	R
PELBR11-6028 RR	8.83d	0.28d	R
PF11651	7.5e	0.26e	R
PF103251	6.17e	0.25e	R
PELBR11-6035 RR	5.83e	0.24e	R
PELBR10-6050 RR	5e	0.24e	R
PELBR11-6042 RR	3.33f	0.23e	R
PELBR10-6017 RR	3.17f	0.20f	R
PELBR11-6007 RR	3f	0.16f	R
PELBR10-6016 RR	2.67f	0.15f	R
PELBR10-6049 RR	1.67f	0.06g	R
CV (%)	8.24	3.01	

*Means followed by the same letter in the same column are not significantly different, based on the Scott & Knott test at 5%; ** original values transformed into [√ (x + 0.5)]; R = resistant; S = susceptible; CV = Coefficient of variation; RF = reproduction factor; [1] indicates susceptible host.

M. javanica, the effects were significant only for genotypes and inoculation.

Gall formation was evident in all soybean genotypes inoculated with *M. javanica*. In plants inoculated with *Meloidogyne* sp.0, lower NG values were recorded for all genotypes. Based on RF analysis, all tested genotypes were found to be susceptible to *M. javanica* and resistant to *Meloidogyne* sp.0 (Table 2).

In the second experiment (Table 3), root galls were observed in all soybean genotypes; however, they presented reduced RF values (0.06 > RF <0.43).

ASMUS and FERRAZ (2001) studied the relationship between *M. javanica* and soybean and reported little influence of *M. javanica* on the leaf chlorophyll content. The FMRS results of the present study were similar to those reported by these authors, and also to those of CARNEIRO et al. (1999), who found that the increase in FMRS was associated with the formation of root galls and the emergence of secondary roots.

Despite the reports of *M. graminicola* pathogenicity in soybean (LONG et al., 2017), the genotypes evaluated in the present study were resistant (0.06 > RF < 0.43). The genotypes included in this experiment, which assessed their susceptibility to the two root-knot nematode species, are currently cultivated in lowland regions, in rotation with irrigated rice. This study confirmed that these genotypes can be safely cultivated in this region, as they are resistant to both *Meloidogyne* sp.0 and *M. graminicola*.

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DECLARATION OF CONFLICT OF INTERESTS

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

JVAF, CBG, ACBO and LAYM conceived and designed the performed experiments. LAYM, DB, EH, ELN performed the experiments. The authors CBG and LAYM performed the statistical analysis. LAYM, JVAF and CBG prepared the manuscript. All authors reviewed and approved the final version of the manuscript.

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