

Charcoal rot severity and yield components of common bean cultivars inoculated with *Macrophomina phaseolina*

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ABSTRACT

Zanella, E.J.; Berghetti, J.; Scheidt, B.T.; Casa, R.T.; Bogo, A.; Gonçalves, M.J.; Martins, F.C. Charcoal rot severity and yield components of common bean cultivars inoculated with *Macrophomina phaseolina*. *Summa Phytopathologica*, v.46, n.4, p.299-304, 2020.

Macrophomina phaseolina is a soilborne pathogen with a wide range of hosts and its control through agricultural practices is difficult. The aim of this study was to quantify the severity of root rot (SRR) caused by *M. phaseolina* in common bean cultivars and its impact on yield components. The experiments were carried out under greenhouse conditions with the common bean cultivars 'ANFC-9 Agro Norte', 'BRS Esteio', 'BRS Estilo', 'BRS Pérola', 'FTS Soberano', 'IPR Campos Gerais', 'IPR Tangará', 'IPR Tuiuiú', 'IPR Uirapuru' and 'TAA Dama'. Three isolates of *M. phaseolina* obtained from infected plants of common bean, soybeans and maize were inoculated in the common bean cultivars. In the phenological stage R9 of grain harvest maturity, the SRR and the yield components of root dry mass (RDM), number of pods per plant

(NPP), number of grains per plant (NGP) and grain mass per plant (GMP) were assessed. All common bean cultivars were susceptible to *M. phaseolina*, showing a reduction in NPP, NGP and GMP. SPR was greater than 75%, regardless of the origin of isolates. Considering the average of cultivars, there was a significant decrease of 54.3% in RDM, compared to control treatments. The cultivars 'IPR Tangará', 'ANFC-9 Agro Norte', 'BRS Esteio', 'BRS Pérola' and 'FTS Soberano' had a decrease in at least one yield component, while a reduction occurred in all components for cultivar 'IPR Tangará'. There was an average decrease in NPP, NGP and GMP of 7.9%, 7.6% and 7.2%; 13.4%, 12.8% and 6.7%; and 14.2%, 12.9% and 10.1%, considering the isolates obtained from beans, soybeans and maize, respectively.

Keywords: *Phaseolus vulgaris*, genetic resistance, soilborne fungi.

RESUMO

Zanella, E.J.; Berghetti, J.; Scheidt, B.T.; Casa, R.T.; Bogo, A.; Gonçalves, M.J.; Martins, F.C. Severidade da podridão de carvão e componentes de produção de cultivares de feijão comum inoculadas com *Macrophomina phaseolina*. *Summa Phytopathologica*, v.46, n.4, p.299-304, 2020.

Macrophomina phaseolina é um patógeno de solo com uma grande variedade de hospedeiros e de difícil controle por práticas culturais. O objetivo deste estudo foi quantificar a severidade da podridão das raízes (SPR) causada por *M. phaseolina* em cultivares de feijoeiro comum e seu impacto nos componentes de produção. Os experimentos foram conduzidos em casa de vegetação com as cultivares de feijão comum ANFC-9 Agro Norte, BRS Esteio, BRS Estilo, BRS Pérola, FTS Soberano, IPR Campos Gerais, IPR Tangará, IPR Tuiuiú, IPR Uirapuru e TAA Dama. Três isolados de *M. phaseolina* obtidos de plantas infectadas de feijão, soja e milho foram inoculados nas cultivares de feijão. No estágio fenológico R9 da maturidade da colheita de grãos foram avaliados o SPR e os componentes de produção de massa seca de raízes (MSR), número

de legumes por planta (NLP), número de grãos por planta (NGP) e massa de grãos por planta (MGP). Todas as cultivares de feijão foram suscetíveis a *M. phaseolina*, apresentando redução no NLP, NGP e MGP. A SPR foi superior a 75%, independentemente da origem dos isolados. Na média das cultivares houve decréscimo significativo de 54,3% na MSR quando comparadas aos tratamentos controle. As cultivares IPR Tangará, ANFC-9 Agro Norte, BRS Esteio, BRS Pérola e 'FTS Soberano' obtiveram redução em pelo menos um dos componentes da produção enquanto a cultivar IPR Tangará em todos. Observou-se decréscimo médio de NLP, NGP e MGP de 7,9%, 7,6% e 7,2%; 13,4%, 12,8% e 6,7%; e 14,2%, 12,9% e 10,1%, considerando os isolados obtidos de feijão, soja e milho, respectivamente.

Palavras-chave: *Phaseolus vulgaris*, resistência genética, fungos de solo.

Common beans are susceptible to different pathogens such as anthracnose (*Colletotrichum lindemuthianum* (Sacc. & Magn.) Br. & Cav.), white mold (Bary *Sclerotinia sclerotiorum* (lib.)), rust (*Uromyces appendiculatus* (Pers.) Unger.), angular leaf spot (*Phaeoisariopsis griseola* (Sacc.) Ferraris), and root rot complex (4). Among root rot are dry root rot (*Fusarium solani* (Mart.) Sacc), Fusarium wilt (*F. oxysporum* Schlecht), rhizoctoniosis (*Rhizoctonia solani* Kuhn) and charcoal rot (*Macrophomina phaseolina* (Tassi) Goid). The latter is considered one of the most prevalent pathogens in Brazil.

M. phaseolina is a cosmopolitan pathogen with a wide range of

hosts and over 500 different species, including economic crops, such as bean (*P. vulgaris* L.), maize (*Zea mays* L.), soybean (*Glycine max* (L.) Merrill), sorghum (*Sorghum bicolor* (L.) Moench), peanut (*Arachis hypogaea* L.), sunflower (*Helianthus annuus* L.) and cotton (*Gossypium hirsutum* L.) (7, 11, 13, 18).

Roots and stems are the main parts affected by this pathogen, which can infect plants at any time of the growing season. Most infection may occur early in the season, but typical symptoms will only develop after flowering, when plants become stressed (3, 9, 11). *M. phaseolina* produce microsclerotia which can remain free in the

soil as a major source of primary inoculum (7, 14, 16). The favorable conditions for root infection are soil compaction and water restriction periods (3, 15).

Yield reductions of 5% to 50% have been reported for the soybean crop, according to the environmental conditions and the genotype susceptibility (13, 16, 27). The authors observed that bean plants artificially inoculated with *M. phaseolina* showed 60% grain yield decrease when compared to plants naturally grown in infested soils.

Agricultural practices such as crop rotation is unviable to reduce the incidence of *M. phaseolina* due to its wide range of hosts and inoculum survival in the soil (3, 22). Using a resistant cultivar is the major control strategy (6, 12, 13, 16). However, in Brazil, there are few studies of genotype resistance in beans.

The pathogen variability, as regards pathogenicity and aggressiveness, is critical since *M. phaseolina* has a wide range of host species, indicating that the fungus is heterogeneous in isolates. Moreover, attempts to classify fungal isolates into subgroups based on their morphology and pathogenicity are not consistent (16, 19).

The aim of this study was to quantify the severity of root rot (SRR) caused by *M. phaseolina* in common bean cultivars and its impact on yield components.

MATERIAL AND METHODS

Experiments were carried out during 2017 and 2018 at the laboratory and greenhouse of Santa Catarina State University, Lages Municipality, Santa Catarina State, Brazil.

Three *M. phaseolina* isolates, MEMR31, MEMR57 and MEMR89, were obtained from infected root tissue of 'BRS MG Madrepérola' bean, 'BMX Lança IPRO' soybean, and 'P1630H' maize hybrid, respectively. The inoculum of isolates was multiplied in potato-dextrose-agar (PDA) medium incubated in a Biochemical Oxygen Demand (BOD), at 28°C, for 10 days. Pure *M. phaseolina* colonies were ground in a blender, following the ratio of 10 Petri dishes (90 mm) for each 500 mL distilled water plus one drop of Tween 20 (0.1 mL). The final inoculum concentration was adjusted on a hemocytometer to 3×10^4 mL⁻¹ microsclerotia.

A 250-mL unfiltered inoculum suspension was sprayed with a hand sprayer into a 0.5-kg substrate and sand mixture at the ratio of 2.3:1. The "final product" (substrate plus inoculum) was placed in 8-L plastic pots, homogenized and stored in a greenhouse for ten days until the sowing date. Water irrigation was performed every three days to improve fungal colonization on the substrate. N-P-K chemical fertilization was added to the substrate according to the Soil Analysis and Fertility Commission for the states of Rio Grande do Sul and Santa Catarina, based on the expected yield of 4,000 kg ha⁻¹ (5).

Ten common bean genotypes were assessed: 'ANFC 9 Agro Norte', 'BRS Esteio', 'BRS Estilo', 'BRS Pérola', 'FTS Soberano', 'IPR Campos Gerais', 'IPR Tangará', 'IPR Tuiuiú', 'IPR Uirapurú' and 'TAA Dama'. Six seeds were sown per pot, and thinning was conducted three days after seedling emergence, keeping two final plants per pot. Experimental design was completely randomized with four replicates and each pot as an experimental unit. Controlled irrigations were performed to maintain the normal growth and development of plants, aiming at grain production.

Yield components were assessed in phenological stage R9 (grain harvest maturity), as follows: i) number of pods per plant (NPP), by counting and manually removing pods from all plants; ii) number of

grains per plant (NGP), by manual trailing, separation and counting of grains; iii) grain mass per plant (GMP), by drying the grains in an air circulation oven at 60°C until constant weight was obtained in an analytical scale; iv) severity of root rot (SRR), and v) root dry mass (RDM) (10). To assess SRR and RDM, all plants were removed from the pots and their root system was carefully washed in running water to remove the substrate. The roots were dipped in white-bottomed trays containing water for visualization and quantification of SRR, according to an adaptation of the diagrammatic scale (1), as follows: 1) Absence of symptoms, healthy plant, 0% severity; 2) Slight root discoloration, lesions limited to 10% tissue; 3) 25% root tissue showing lesions, decreased number and volume of secondary roots; 4) 50% root tissue showing lesions, visible microsclerotia, and 5) 75% root tissue showing lesions, root system with minimal roots. The qualitative rate of the diagrammatic scale was adapted by adding equidistant intervals of 25% severity, where: 1) 0 to 25% severity; 2) 25% to 50% severity; 3) 50% to 75% severity, and 4) 75% to 100% severity. The root system was cut, separated from the aerial part, kept in paper bags and dried in an air circulation oven until constant weight was reached in subsequent weighing for obtaining the RDM data.

Data were studied by analysis of variance (ANOVA) in a factorial scheme, according to *F* test ($p < 0.05$), using the SISVAR 5.6 program (8). Treatments were subjected to means test ($p < 0.05$) with Scott-Knott and Tukey's test for the cultivar and isolate factors, respectively.

RESULTS AND DISCUSSION

All common bean cultivars were susceptible to *M. phaseolina*, showing different levels of severity of root rot (SRR) and a reduction in most yield components such as number of pods per plant (NPP), number of grains per plant (NGP) and grain mass per plant (GMP), regardless of the origin of bean, soybean or maize isolates.

The variation factor (I) of *M. phaseolina* isolates was statistically significant for the yield components NPP and root dry mass (RDM). However, NPP and GMP did not show significant differences among isolates (Table 1). NGP was significant lower when the common bean cultivars were inoculated with the *M. phaseolina* isolates MEMR31 from bean (56.1) and MEMR57 from soybean (56.5), compared to plants inoculated with the isolate MEMR89 from maize (60.4) (Table 2).

Table 1. Analysis of variance for the yield parameters: number of pods per plant (NPP), number of grains per plant (NGP), grain mass per plant (GMP) and root dry mass (RDM) evaluated in common bean cultivars inoculated with different isolates of *Macrophomina phaseolina*. Lages/SC, Brazil.

Variation Factor	NPP	NGP	GMP	RDM
Isolates (I)	0.02 ^{ns}	3.40*	0.93 ^{ns}	61.15*
Cultivars (C)	4.94*	9.96*	8.73*	25.71*
I x C	0.89 ^{ns}	2.54*	2.08*	6.25*
CV (%)	14.17	14.21	15.39	19.58

*Significant at 5% probability of error; ^{ns} not significant.

The yield component that showed the greatest decrease was RDM, regardless of the origin of the isolate. The plants produced, on average, 1.31 g less RDM, compared to the control plot, showing a reduction of 54.3%. MEMR31 and MEMR57 from bean and soybean,

respectively, were the most aggressive isolates and did not show any statistical difference. Plants inoculated with MEMR31 and MEMR57 produced, on average, 0.95 g RDM and were statistically different from plants inoculated with MEMR89 from maize, which produced 1.41 g RDM (Table 2).

The origin of *M. phaseolina* isolates tested in this study was tropical and subtropical regions of Brazil and, according to Muñoz-Cabañas et al. (19), isolates from these regions showed greater aggressiveness to common bean cultivars, when compared to isolates from arid regions of Mexico. Almeida et al. (2), Prabhu et al. (21), Sánchez et al. (23), Sarkar and Mandal (24) and Sexton et al. (25) reported that *M. phaseolina* isolates from the same or different hosts had significant genetic variability, which can explain the differences found in this study between MEMR31 (bean) and MEMR57 (soybean), when compared to MEMR89 (maize). MEMR31 and MEMR57 did not show any significant difference in aggressiveness and led to the most reduced RDM, compared to MEMR89, which suggests that isolates from the same botanical family (Fabaceae) present similar aggressiveness.

There was no significant difference between the yield components

NPP and GMP regarding the isolate variation factor (I). The effect of the three isolates on NPP and GMP was a reduction of 7.6% and 12.4%, respectively, when compared to the control plot (Table 2). All yield components showed significant differences regarding the cultivar variation factor (C). Thus, the yield features of each common bean cultivar were taken into account, although *M. phaseolina* infection affected the yield components at different intensity degrees.

There was no significant difference among isolates when NPP was assessed. However, the cultivars ‘ANFC-9 Agro Norte’, ‘BRS Estilo’, ‘BRS Pérola’, ‘IPR Campos Gerais’, ‘IPR Tuiuiu’ and ‘IPR Uirapurú’ showed higher NPP when compared to ‘BRS Esteio’, ‘FTS Soberano’, ‘IPR Tangará’ and ‘TAA Dama’. ‘IPR Tangará’ was the only cultivar that was significantly influenced by *M. phaseolina* isolates, presenting a reduction of 24.6% in NPP when compared to the control plot (Table 3).

The common bean cultivars showed a significant difference for the yield parameter NGP; inoculated plants produced 11% less NGP when compared to the control plot. The most productive and significantly different non-inoculated cultivars were ‘BRS Esteio’ (81.7 grains/plant¹) and ‘IPR Uirapurú’ (79.1 grains/plant¹). ‘BRS Esteio’ showed

Table 2. Number of pods per plant (NPP), number of grains per plant (NGP), grain mass per plant (GMP) and root dry mass (RDM) of common bean cultivars inoculated with isolates of *Macrophomina phaseolina* from different hosts. Lages/SC, Brazil.

Isolate	NPP (pods.plant ⁻¹)	NGP (grains.plant ⁻¹)	GMP (g.plant ⁻¹)	RDM (g.root ⁻¹)
MEMR31(bean)	14.11 B	56.14 C	13.40 B	0.94 C
MEMR57(soybean)	14.16 B	56.50 C	13.59 B	0.95 C
MEMR89 (maize)	14.22 B	60.45 B	14.03 B	1.41 B
Average ¹	14.16	57.70	13.67	1.10
Control	15.32 A	64.82 A	15.61 A	2.41 A
Reduction(%) ²	7.6	11.0	12.4	54.4

¹Overall average of the three isolates; ²Reduction: $100 - [(Average^1 / Control) * 100]$; Means followed by different capital letters in the column differ statistically from each other according to Scott-Knott test ($p < 0.05$).

Table 3. Number of pods per plant (NPP) and number of grains per plant (NGP) of common bean cultivars inoculated (I) or not (NI) with *Macrophomina phaseolina* isolates. Lages/SC, Brazil.

Cultivars	NPP (pods.plant ⁻¹)			NGP (grains.plant ⁻¹)		
	I	NI	Reduction ¹	I	NI	Reduction
ANFC-9 Agro Norte	14.58 Aa	16.12 Aa	9.5	57.21 Cb	64.25 Ba	11.0
BRS Esteio	12.96 Ba	13.87 Aa	6.6	62.50 Bb	81.75 Aa	23.5
BRS Estilo	14.37 Aa	14.12 Aa	-1.8	55.87 Ca	52.50 Ca	-6.4
BRS Pérola	14.87 Aa	16.75 Aa	11.2	56.25 Cb	68.87 Ba	18.3
FTS Soberano	12.83 Ba	15.37 Aa	16.5	51.00 Db	63.62 Ba	19.8
IPR Campos Gerais	16.75 Aa	16.75 Aa	0.0	61.71 Ba	59.87 Ca	-3.1
IPR Tangará	11.96 Bb	15.87 Aa	24.7	45.25 Db	58.12 Ca	22.1
IPR Tuiuiu	14.50 Aa	14.37 Aa	-0.9	58.79 Ca	65.37 Ba	10.1
IPR Uirapurú	15.46 Aa	16.50 Aa	6.3	73.46 Aa	79.12 Aa	7.1
TAA Dama	13.37 Ba	13.50 Aa	1.0	54.92 Ca	54.75 Ca	-0.3
Average	14.16 a	15.32 a	7.6	57.69 a	64.82 a	11.0

¹Reduction (%): $100 - [(I/NI) * 100]$; Means followed by different uppercase letters in the column and lowercase letters on the row differ statistically from each other according to Scott-Knott test ($p < 0.05$).

a decrease of 23.5% in NGP, the highest percentage, compared to the control plot (Table 3).

Inoculated plants had, on average, a reduction of 12.4% in GMP, when compared to the control plot. 'FTS Soberano' showed the lowest GMP, 10.21 g.plant⁻¹, but produced 12.36 g.plant⁻¹ when not inoculated and did not differ from 'IPR Tuiuiu', 13.39 g.plant⁻¹, and 'TAA Dama', 14.79 g.plant⁻¹. All cultivars presented a decrease in GMP, which ranged from 1.8% to 24.2%. 'IPR Tangará' had a reduction of 24.2% and was considered the most susceptible cultivar considering GMP (Table 4). In general, plants inoculated with *M. phaseolina*, regardless of the origin of the isolate, showed a decrease of 54.3% in RDM, ranging from 34.0% to 70.0%. The cultivars 'BRS Esteio' and 'IPR Uirapurú' showed the greatest and smallest reduction in RDM, 70.0% and 34.0%, respectively (Table 4).

Plants inoculated with isolates of *M. phaseolina* manifested symptoms of longitudinal black lesions in the root tissue and stem, producing dark mycelium and microsclerotia. In addition, the infected roots were apparently smaller and without secondary roots. The observed symptoms corroborate the data obtained by Méndez-Aguilar et al. (17). There was a significant difference in the plant growth rate among all common bean cultivars, evidencing distinct behaviors regarding flowering, leaf senescence and plant death. In general, plants inoculated with *M. phaseolina* showed premature leaf fall and early maturation, resulting in early plant death. There was a reduction in the development cycle for all cultivars, ranging from three to 23 days. Compared to the control, the cultivar that most hastened its development cycle due to infection by the pathogen was 'TAA Dama' (Figure 1). This behavior is not atypical and was already observed for infected soybean plants (20, 26). Plants inoculated with *M. phaseolina* isolates showed, on average, a 13-day cycle reduction, when compared to the control plot.

NGP was significant for the interaction between isolate (I) and cultivar (C). There was no significant difference between the isolates MEMR31 and MEMR57; however, they significantly differed from

MEMR89. Cultivars inoculated with MEMR89 produced, on average, 4.31 and 3.95 more grains than cultivars inoculated with MEMR31 and MEMR57, representing 7.1% and 6.5% of their production, respectively. The general behavior of cultivars in relation to isolates was similar. However, the most susceptible cultivar to MEMR31 was 'BRS Esteio', which also had different behaviors towards the other two isolates (MEMR57 and MEMR89). MEMR89 from maize was the least aggressive isolate to all common bean cultivars (Table 5).

There was an interaction between isolate (I) and cultivar (C) factors for the yield component RDM. The isolates MEMR31 and MEMR57 were more aggressive in reducing RDM, significantly differing from MEMR89. Cultivars inoculated with MEMR89 produced a 0.47 higher RDM than cultivars inoculated with MEMR31 and MEMR57. The isolate MEMR89 was least aggressive to the cultivars 'BRS Pérola', 'FTS Soberano', 'IPR Tangará', 'IPR Tuiuiu' and 'TAA Dama'. In addition, MEMR31 was most aggressive to 'BRS Esteio' and 'IPR Uirapurú' (Table 5).

All cultivars were highly susceptible to *M. phaseolina* isolates because the epidemiological parameter SRR showed no statistical variance among factors/treatments. The SRR level was superior to 75% for all factors/treatments, indicating high disease intensity (Table 6). The results of SRR evaluation evidence the efficiency of the methodology adopted in this study and can be helpful for further experiments and bioassays with the objective of assessing bean germplasm banks or genotypes to *M. phaseolina*.

The SRR above 75% obtained in this study can be explained by the inoculation condition. The favorable environmental conditions and the inoculation methodology in a greenhouse, compared to field conditions, were responsible for the higher disease severity found for the common bean cultivars. Experiments conducted under greenhouse conditions tend to offer favorable conditions for the pathogen development and the genetic expression of genotypes, since these conditions are not easily applicable in the field, leading to discrepancy between results obtained

Table 4. Grain mass per plant (GMP) and root dry mass (RDM) of common bean cultivars inoculated (I) or not (NI) with *Macrophomina phaseolina* isolates. Lages/SC, Brazil.

Cultivars	GMP (g.plant ⁻¹)			RDM (g.root ⁻¹)		
	I	NI	Reduction ¹	I	NI	Reduction
ANFC-9 Agro Norte	14.35 Ba	15.73 Aa	8.8	0.69 Db	1.34 Ea	48.5
BRS Esteio	13.54 Bb	17.63 Aa	23.2	1.42 Bb	4.74 Aa	70.0
BRS Estilo	16.16 Aa	16.45 Aa	1.8	1.33 Bb	2.70 Ca	50.7
BRS Pérola	13.26 Bb	16.32 Aa	18.8	1.15 Cb	3.33 Ba	65.5
FTS Soberano	10.21 Da	12.36 Ba	17.4	1.14 Cb	2.50 Ca	54.4
IPR Campos Gerais	15.12 Aa	15.63 Aa	3.3	0.77 Db	1.20 Ea	35.8
IPR Tangará	12.86 Cb	17.01 Aa	24.2	1.14 Cb	2.00 Da	43.0
IPR Tuiuiu	11.68 Ca	13.39 Ba	12.8	1.05 Cb	1.93 Da	45.6
IPR Uirapurú	15.48 Aa	16.83 Aa	8.0	1.63 Ab	2.47 Ca	34.0
TAA Dama	14.06 Ba	14.79 Ba	4.9	0.69 Db	1.89 Da	63.5
Average	13.67 a	15.61 a	12.4	0.69 b	1.34 a	48.5

¹Reduction (%): 100-[(I/NI) 100]; Means followed by different uppercase letters in the column and lowercase letters on the row differ statistically from each other according to Scott-Knott test (p<0.05).

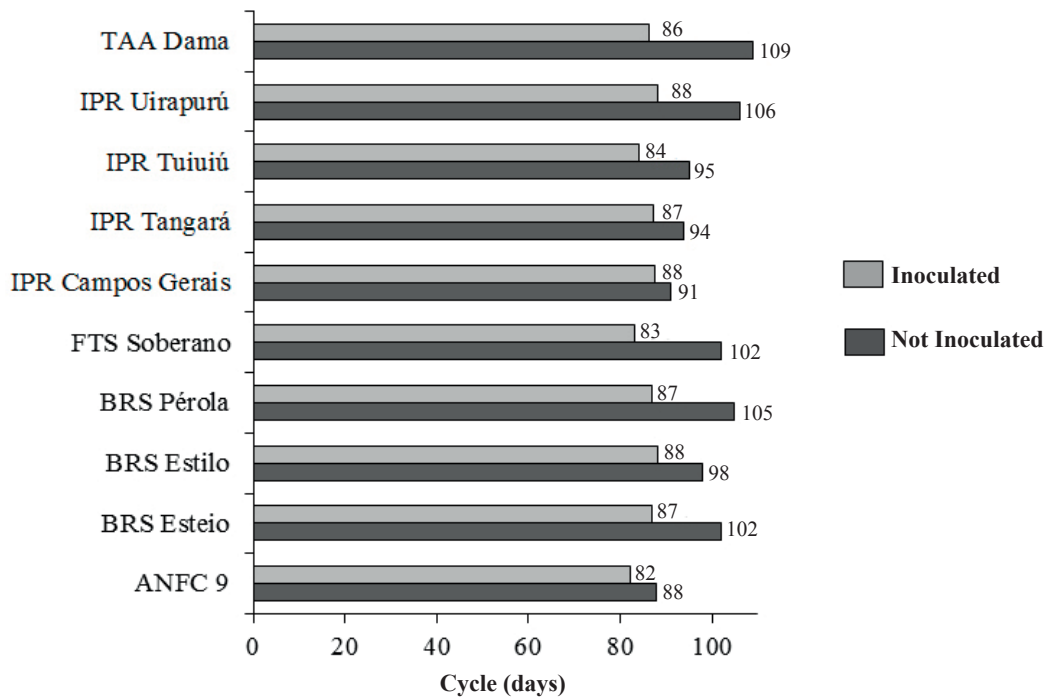


Figure 1. Average developmental cycle of common bean cultivars in relation to plants inoculated or not with *Macrophomina phaseolina* isolate. Lages/SC, Brazil.

Table 5. Split analysis of variance for number of grains per plant (NGP: grains.plant⁻¹) of common bean cultivars related to *Macrophomina phaseolina* isolates and cultivars. Lages/SC, Brazil.

Cultivars	Isolates		
	MEMR31	MEMR57	MEMR89
ANFC-9 Agro Norte	60.12 Aa*	50.37 Ba	61.12 Ca
BRS Esteio	46.00 Bc	62.87 Ab	78.62 Aa
BRS Estilo	54.62 Aa	54.50 Ba	58.50 Ca
BRS Pérola	59.25 Aa	56.37 Ba	53.12 Ca
FTS Soberano	50.87 Ba	55.75 Ba	46.37 Da
IPR Campos Gerais	64.50 Aa	55.87 Ba	64.75 Ba
IPR Tangará	40.12 Ba	50.75 Ba	44.87 Da
IPR Tuiuiú	56.62 Aa	54.25 Ba	65.50 Ba
IPR Uirapurú	71.75 Aa	73.12 Aa	75.50 Aa
TAA Dama	57.50 Aa	51.12 Ba	56.12 Ca
Average	56.1 b	56.5 b	60.4 a
ANFC-9 Agro Norte	0.88 Ba	0.51 Da	0.68 Da
BRS Esteio	1.12 Ab	1.54 Aa	1.62 Ba
BRS Estilo	1.28 Aa	1.31 Ba	1.40 Ba
BRS Pérola	0.80 Bb	0.62 Db	2.01 Aa
FTS Soberano	1.10 Ab	0.72 Dc	1.61 Ba
IPR Campos Gerais	0.72 Ba	0.62 Da	0.95 Ca
IPR Tangará	0.68 Bc	1.14 Bb	1.61 Ba
IPR Tuiuiú	0.90 Bb	0.94 Cb	1.31 Ba
IPR Uirapurú	1.32 Ab	1.72 Aa	1.86 Aa
TAA Dama	0.63 Bb	0.40 Db	1.04 Ca
Average	0.94 b	0.95 b	1.41 a

*Means followed by different uppercase letters in the column and lowercase letters on the row differ statistically from each other according to Scott-Knott test ($p < 0.05$).

Table 6. Severity of root rot caused by *Macrophomina phaseolina* in common bean cultivars. Lages/SC, Brazil.

Cultivars	Severity (%)	Reaction
ANFC-9 Agro Norte	75-100	Susceptible
BRS Esteio	75-100	Susceptible
BRS Estilo	75-100	Susceptible
BRS Pérola	75-100	Susceptible
FTS Soberano	75-100	Susceptible
IPR Campos Gerais	75-100	Susceptible
IPR Tangará	75-100	Susceptible
IPR Tuiuiú	75-100	Susceptible
IPR Uirapurú	75-100	Susceptible
TAA Dama	75-100	Susceptible

under these two environmental conditions.

All assessed common bean cultivars are susceptible to *M. phaseolina*, showing a reduction in NPP, NGP and GMP and different SRR level, regardless of the origin of isolates.

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