UNIVERSIDADE FEDERAL RURAL DO SEMI-ÁRIDO
PRÓ-REITORIA DE GRADUAÇÃO
CENTRO DE CIÊNCIAS AGRÁRIAS
DEPARTAMENTO DE CIÊNCIAS AGRONÔMICAS E FLORESTAIS
CURSO DE AGRONOMIA
TRABALHO DE CONCLUSÃO DE CURSO (2025)

REACTION OF MELON HYBRIDS TO *Macrophomina* SPECIES

REAÇÃO DE HÍBRIDOS DE MELÃO À ESPÉCIE *Macrophomina*

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ABSTRACT

Macrophomina phaseolina is one of the main phytopathogens associated with root rot and vine decline in melon plants in northeastern Brazil. The management of this pathogen is challenging, as it is polyphagous and adapted to the semi-arid conditions of this region. Herein, we inoculated 10 isolates of *M. phaseolina* (Ph) and 10 of *M. pseudophaseolina* (Ps) on two melon hybrids, 'Beloro' and 'Natal', to evaluate these fungi pathogenicity on melon plants. The following variables were measured 60 days after planting: disease incidence (INC) and severity (SEV), shoot (SL) and root (RL) length, fresh shoot, and root weight (FSW and FRW), and dry shoot and root weight (DSW and DRW). The hybrid 'Beloro' had INC of 100.0% for all isolates tested. The hybrid 'Natal' had INC ranging from 14.3 to 100.0%, with the isolates Ph-A6P5 and Ps-A10P16 not causing any disease, INC (0.0%) and SEV (0.0). The mean SEV values showed that the Ph isolates caused severe damage to the hybrids 'Beloro' (4.58) and 'Natal' (3.18), being more aggressive than the Ps isolates ('Beloro' - 2.56) and ('Natal' - 0.70). Since information on the pathogenicity of Ps in melon is still very scarce, more research is needed to unveil the infective potential of this fungus.

Keywords: *Cucumis melo*. Disease severity. Incidence. Root pathogen.

RESUMO

Macrophomina phaseolina é um dos principais fitopatógenos associados à podridão radicular e declínio de videiras em plantas de melão no Nordeste do Brasil. O manejo desse patógeno é desafiador, pois é polífago e adaptado às condições semiáridas da região. Neste trabalho, inoculamos 10 isolados de *M. phaseolina* (Ph) e 10 de *M. pseudophaseolina* (Ps) em dois híbridos de melão, 'Beloro' e 'Natal', para avaliar a patogenicidade desses fungos em plantas de meloeiro. As seguintes variáveis foram medidas aos 60 dias após o plantio: incidência (INC) e severidade da doença (SEV), comprimento da parte aérea (SL) e da raiz (RL), peso fresco da parte aérea e da raiz (FSW e FRW), e peso seco da parte aérea e da raiz. (DSW e DRW). O híbrido 'Beloro' apresentou INC de 100,0% para todos os isolados testados. O híbrido 'Natal' apresentou INC variando de 14,3 a 100,0%, sendo que os isolados Ph-A6P5 e Ps-A10P16 não causaram nenhuma doença, INC (0,0%) e SEV (0,0). Os valores médios de SEV mostraram que os isolados Ph causaram danos severos aos híbridos 'Beloro' (4,58) e 'Natal' (3,18), sendo mais agressivos que os isolados Ps ('Beloro' - 2,56) e ('Natal' - 0,70). Como as informações sobre a patogenicidade do Ps no melão ainda são muito escassas, mais pesquisas são necessárias para desvendar o potencial infectante deste fungo.

Palavras-chave: *Cucumis melo*. Severidade da doença. Incidência. Patógeno radicular.

Disponibilidade https://periodicos.ufersa.edu.br/index.php/caatinga ISSN 1983-2125 (online) https://doi.org/10.1590/1983-21252025v3812875rc

INTRODUCTION

Melon (*Cucumis melo* L.) is a fruit crop belonging to the Cucurbitaceae family. Its cultivation is expanding throughout Brazil, mainly due to the activities of large agricultural companies that export part of their production (40%) to European markets. The main Brazilian melon-producing areas are in the states of Rio Grande do Norte and Ceará, accounting for over 71% of the national melon production (IBGE, 2022; KIST; CARVALHO; BELING, 2022). This production is largely due to the ideal soil and climate conditions for growing melons in the region (low rainfall, high temperatures, and high luminosity), as well as the adoption of modern technologies by the production

companies, such as hybrid seeds, high-frequency irrigation, mulching, etc. (FIGUERÊDO; GONDIM; ARAGÃO, 2017; COSTA et al., 2020).

Diseases caused by soil-borne fungi result in significant losses in melon crop production. The major concern is the pathogens belong to the *Macrophomina* genus, which have thermophilic, polyphagous, and cosmopolitan characteristics (NEGREIROS et al., 2019; 2020; SALES JÚNIOR et al., 2020). Currently, the genus *Macrophomina* has more than 700 host plants, causing different types of diseases, such as root rot and vine decline (RRVD), charcoal rot, gray stem rot, damping-off, seed damage, and stem rot, among others (LODHA; MAWAR, 2019; NEGREIROS et al., 2020; FARR; ROSSMAN, 2023).

Initial disease symptoms, caused by *Macrophomina* spp., are characterized by the appearance of watery lesions that vary in color from a light brown to a darker brown. As the disease progresses, the affected area takes on a whitish appearance, with longitudinal cracks giving the impression that the epidermis is separating from the rest of the branch. If environmental conditions are favorable, early ripening and death of host plants can occur (LODHA; MAWAR, 2019**;** NEGREIROS et al., 2019; SALES JÚNIOR et al., 2020).

The genus *Macrophomina* is represented by five species: *M. phaseolina*, *M. pseudophaseolina*, *M. euphorbiicola*, *M. vaccinii*, and *M. tecta* (SARR et al., 2014; MACHADO; PINHO; PEREIRA**,** 2019; ZHAO et al., 2019; POUDEL et al., 2021). However, only three species, *M. phaseolina*, *M. pseudophaseolina*, and *M. euphorbiicola*, have been reported in areas of Cucurbitaceae plantations in the states of Rio Grande do Norte and Ceara, Brazil (NEGREIROS et al., 2019; 2020).

Since there are no fungicide products registered for use in melon cultivation in Brazil (AGROFIT, 2024), preventive management strategies and methods to reduce the spread of these phytopathogens have been widely studied and adopted by melon producers in the region, such as the use of hybrids resistant and use of biological control with antagonistic microorganisms (BAKHSHI; SAFAIE; SHAMS-BAKHSH, 2018**;** LINHARES et al., 2020).

With the recent reports of new *Macrophomina* species in Brazil, little is known about the host range of these fungi, and studies on their pathogenicity are important for proper disease management. Given the economic importance of melons and the occurrence of *Macrophomina* species in the main cucurbit-producing regions in Brazil,

the aim of this study was to evaluate the reaction of melon hybrids to the *Macrophomina* species, *M. phaseolina* and *M. pseudophaseolina*.

MATERIAL AND METHODS

This study was carried out in a greenhouse, located in Mossoró-RN, Brazil, with geographic coordinates of 5º 11' 17" S, 37º 20' 39" W, and an altitude of 18 m. The region's climate is characterized according to Köppen's classification as BSh (hot semi-arid climate) (ALVARES et al., 2014).

Fungal isolates and melon hybrids

Twenty fungal isolates were used, 10 of which were *M. phaseolina* and 10 *M. pseudophaseolina* (Table 1). All isolates were obtained from watermelon roots with RRVD symptoms, from cucurbit production areas in the states of Rio Grande do Norte and Ceará. The isolates were identified by morphology and by partial genome sequencing using specific primers. Regions of the translation elongation factor1-alpha (TEF1-α) were used to differentiate *Macrophomina* species, with the primers for *M. phaseolina* (MpTefF-AAACACACTTTTCGCACTCCTGC, MpTefR TATGCTCGCAGAGAAGAACACGA), *M. pseudophaseolina* (MsTefF GCACACTTTTCGCGCTTCTGTA, MsTefR-TGTGCTCGCTGGGAAGAACATGA), and *M. euphorbiicola* (MeTefF-AAGCATACTTTTCGTGCTCCTGC, MeTefR-AAAGGAACATGAGTGGCCAAAAA) (SANTOS et al., 2020).

Table 1. *Macrophomina* spp. isolates used in experiment.

Macrophomina spp.	Isolates	Location
Macrophomina phaseolina	A1P9	Mossoró, RN
	A2P18	Tibau, RN
	A5P4	Mossoró, RN
	A6P5	Mossoró, RN
	A6P25	Mossoró, RN
	A11P1	Baraúna, RN
	A11P2	Baraúna, RN
	A11P17	Baraúna, RN
	A12P22	Aracati, CE
	A15P9	Baraúna, RN
Macrophomina pseudophaseolina	A5P9	Mossoró, RN
	A7P6	Upanema, RN
	A7P15	Upanema, RN
	A7P37	Upanema, RN
	A9P21	Mossoró, RN

	A9P50	Mossoró, RN
	A10P16	Apodi, RN
	A13LP2	Gov. Dix-Sept Rosado, RN
	A13QP5	Gov. Dix-Sept Rosado, RN
	A15P16	Baraúna, RN

The isolates were plated in Petri dishes containing potato dextrose agar (PDA) culture medium and kept in a B.O.D. incubator at 30 ± 2 °C for seven days for initial inoculum preparation.

Seedlings of two melon hybrids, widely grown in the region, were used: Galia (Beloro, Semillas Fitó S.A.) and Yellow (Natal RZ, Rijk Swaan). Isolates were inoculated onto the seedlings using the infested toothpick method (AMBRÓSIO et al., 2015). Toothpick tips (1.5 cm) were inserted vertically, with the tapered part of toothpicks facing upwards, into a filter paper disk with the same internal diameter as a Petri dish. The plates were then autoclaved twice, at 121 °C for 30 minutes, with a 24-hour interval between autoclaving. The PDA medium solution was then poured into these plates, up to about 4 mm from the end of the toothpicks. After the culture medium had solidified, four 0.5 cm diameter discs with fungal structures (mycelium + sclerotia) were placed on the plates, distributed equidistantly, and incubated for eight days in a B.O.D. incubator at 30 ± 2 °C for toothpick colonization.

Experiment design and evaluations

The trial was set up using a completely randomized design (CRD), using 20 *Macrophomina* isolates (10 of *M. phaseolina* and 10 of *M. pseudophaseolina*) inoculated on two melon hybrids, plus two mocks (non-inoculation treatments, one for each hybrid), with seven replicates per treatment. The experimental unit consisted of a plastic pot with one plant and trials were performed twice.

Melon hybrids were sown with three seeds per plastic pot with a capacity of 1 L, containing a mixture of soil and commercial substrate Tropstrato HT® - Hortaliça (2:1, v/v). This mixture was previously autoclaved twice at 121°C for one hour, with a 24-hour interval between autoclaves. Eight days after sowing, two plants were removed leaving just one plant per pot. Ten days after sowing, the toothpicks previously colonized with each fungal isolate were inserted into the neck of the plant at a height of 0.5 cm from the soil line, one toothpick per plant. For the mocks, only autoclaved toothpicks were used,

with no fungal inoculum. The pots with plants were kept in a greenhouse and irrigation was carried out manually.

Disease incidence (INC) and severity (SEV) of *Macrophomina* isolates were assessed on different melon hybrids 30 days after inoculation. INC was assessed by counting the number of plants with stem rot symptoms, and the data was transformed into percentages (%). To assess SEV, the diagrammatic scale of scores adapted by Ambrósio et al. (2015) was used, where 0 = asymptomatic tissue; 1 = less than 3% of stem tissues infected; 2 = 3-10% of stem tissues infected; 3 = 11-25% of stem tissues infected; 4 = 26-50% of stem tissues infected; and 5 = more than 50% of stem tissues infected. We also collected the biometric variables: shoot length (SL) and root length (RL), aided by a ruler graduated in cm; fresh shoot weight (FSW), fresh root weight (FRW), dry shoot weight (DSW), and dry root weight (DRW), measured using an analytical balance with three decimal places. The dry weights were obtained, after the end of greenhouse experiment, by placing individual parts of the plants (shoots and roots) in paper bags, which were then placed in an air circulation oven at 70 °C until they reached a constant dry weight.

After evaluations, fungal isolations were attempted from all the plants to fulfill Koch's postulates. Seven fragments (0.2 to 0.5 cm) of necrotic lesions from each symptomatic plant were cut and placed in BDA + tetracycline (0.05 g. L^{-1}). The fungal colonies recovered were identified as previously described.

Data analysis

A preliminary analysis of variance was carried out to determine whether there was a significant difference between the two repetitions of the experiments to determine if the data could be combined. The data for the response variables that did not follow normal distribution were analyzed using Kruskal-Wallis non-parametric mean comparison test. The data for the response variables that followed normal distribution were analyzed using Scott-Knott's parametric mean comparison test.

RESULTS AND DISCUSSION

Inoculation of hybrids with *Macrophomina* species had a statistically significant effect on disease incidence in the melon hybrids, Beloro ($\chi^2 = 115.5$; $p \leq 0.05$) (Table 2) and Natal ($\chi^2 = 90.1$; $p \leq 0.05$) (Table 3). In Beloro, all isolates of both *Macrophomina* species inoculated differed from the mock, all plants got infected with a disease incidence of 100%. In the Natal hybrid, only isolates A1P9, A2P18, A5P4, A6P25, A11P1, A11P2,

and A11P17 of *M. phaseolina* and A15P16 of *M. pseudophaseolina* differed from the mock, with 100% of disease incidence.

Table 2. Means of disease incidence and severity, shoot length (SL), root length (RL), fresh shoot (FSW) and root weight (FRW), and dry shoot (DSW) and root weight (DRW) of galia melon 'Beloro' plants inoculated with *Macrophomina* spp.

Treatment	Beloro Hybrid			
	Incidence		Severity	
	Rank[1]	Mean (%)[2]	Rank[1]	Mean[2]
PH- A1P9	75.0 b	100.0	103.9 cd	4.9
PH- A2P18	75.0 b	100.0	98.3 b-d	4.7
PH- A5P4	75.0 b	100.0	109.5 d	5.0
PH- A6P5	75.0 b	100.0	109.5 d	5.0
PH- A6P25	75.0 b	100.0	109.5 d	5.0
PH- A11P1	75.0 b	100.0	109.5 d	5.0
PH- A11P2	75.0 b	100.0	90.8 b-d	4.5
PH- A11P17	75.0 b	100.0	109.5 d	5.0
PH- A12P22	75.0 b	100.0	98.3 b-d	4.7
PH- A15P9	75.0 b	100.0	43.9 a-d	2.0
PS- A5P9	75.0 b	100.0	79.7 a-d	3.9
PS- A7P6	75.0 b	100.0	69.2 a-d	3.5
PS- A7P15	75.0 b	100.0	57.5 a-d	2.5
PS- A7P37	75.0 b	100.0	27.0 ab	1.1
PS- A9P21	75.0 b	100.0	48.0 a-d	2.5
PS- A9P50	75.0 b	100.0	31.7 a-c	1.5
PS- A10P16	75.0 b	100.0	29.9 a-c	1.5
PS- A13LP2	75.0 b	100.0	58.0 a-d	2.7
PS- A13QP5	75.0 b	100.0	48.0 a-d	2.5
PS- A15P16	75.0 b	100.0	82.5 b-d	3.9
Mock	5.0 a	0.0	5.0 a	0.0
χ^2	115. 5	-	98.1	-

Treatment	SL[2,3] (cm)	RL[2,3] (cm)	FSW[2,3] (g)	FRW[2,3] (g)	DSW[2,3] (g)	DRW[2,3] (g)
PH- A1P9	19.8 b	24.5 a	12.3 d	4.5 c	1.6 b	0.5 b
PH- A2P18	24.0 b	25.8 a	14.0 c	3.8 c	1.7 b	0.7 b
PH- A5P4	25.2 a	19.0 b	16.0 b	4.9 b	1.9 a	1.2 a
PH- A6P5	24.0 b	25.0 a	17.2 b	5.7 b	1.8 a	1.0 a
PH- A6P25	20.8 b	22.8 a	12.5 d	3.5 c	1.4 b	0.6 b
PH- A11P1	21.9 b	20.9 b	12.6 d	2.8 c	1.7 b	0.4 b
PH- A11P2	23.4 b	24.8 a	16.8 b	4.4 c	1.8 b	0.6 b
PH- A11P17	21.2 b	24.7 a	14.5 c	3.0 c	1.8 b	0.4 b
PH- A12P22	28.2 a	27.0 a	20.3 a	5.1 b	2.0 a	0.7 a
PH- A15P9	27.5 a	24.2 a	22.2 a	6.5 a	2.2 a	1.0 a
PS- A5P9	28.2 a	21.5 b	20.5 a	5.9 b	2.1 a	0.8 a
PS- A7P6	27.2 a	21.2 b	16.9 b	5.4 b	2.0 a	0.6 b
PS- A7P15	23.2 b	24.8 a	10.9 d	5.0 b	1.6 b	0.4 b
PS- A7P37	21.8 b	24.0 a	10.8 d	4.3 c	1.6 b	0.5 b

PS- A9P21	24.2 b	23.0 a	12.1 d	4.0 c	1.8 b	0.4 b
PS- A9P50	23.5 b	22.8 a	13.5 c	4.9 b	1.8 a	0.6 b
PS- A10P16	23.0 b	23.5 a	11.2 d	5.8 b	1.7 b	0.6 b
PS- A13LP2	22.8 b	23.8 a	11.2 d	4.9 b	1.6 b	0.7 b
PS- A13QP5	23.8 b	21.8 b	15.2 c	7.1 a	1.8 a	0.8 a
PS- A15P16	21.2 b	20.2 b	14.7 c	7.6 a	1.6 b	0.9 a
Mock	29.8 a	27.5 a	23.6 a	7.8 a	2.7 a	1.3 a
CV (%)	13.8	17.0	20.5	24.9	14.4	22.5

PH= *Macrophomina phaseolina*. PS = *M. pseudophaseolina*. χ^2 = significant chi-square values. CV (%) = coefficient of variation of the experiment. [1]Values followed by the same letter in the same column do not differ statistically by the Kruskal-Wallis non-parametric test. ($p \leq 0.05$). [2]Average values from the two experiments, with seven replicates (pots) per treatment and one plant per replicate, for each experiment. [3]Values followed by the same letter in the same column do not differ statistically by the Scott-Knott test ($p \leq 0.05$).

Table 3. Means of disease incidence and severity, shoot length (SL), root length (RL), fresh shoot (FSW) and root weight (FRW), and dry shoot (DSW) and root weight (DRW) of yellow melon 'Natal RZ' plants inoculated with *Macrophomina* spp.

Treatment	Natal Hybrid			
	Incidence		Severity	
	Rank[1]	Mean (%)[2]	Rank[1]	Mean[2]
PH- A1P9	107.0 b	100.0	122.5 d	5.0
PH- A2P18	107.0 b	100.0	106.5 a-d	3.5
PH- A5P4	107.0 b	100.0	122.5 d	5.0
PH- A6P5	37.0 a	0.0	37.0 a	0.0
PH- A6P25	107.0 b	100.0	119.7 cd	4.9
PH- A11P1	107.0 b	100.0	113.9 b-d	4.3
PH- A11P2	107.0 b	100.0	104.2 a-d	3.3
PH- A11P17	107.0 b	100.0	122.5 d	5.0
PH- A12P22	57.0 ab	28.6	50.0 a-c	0.3
PH- A15P9	57.0 ab	28.6	53.5 a-d	0.5
PS- A5P9	57.0 ab	28.6	50.0 a-c	0.3
PS- A7P6	47.0 ab	14.3	43.5 ab	0.2
PS- A7P15	47.0 ab	14.3	43.5 ab	0.2
PS- A7P37	57.0 ab	28.6	51.7 a-d	0.5
PS- A9P21	57.0 ab	28.6	50.0 a-c	0.3
PS- A9P50	47.0 ab	14.3	43.5 ab	0.2

PS- A10P16	37.0 a	0.0		37.0 a	0.0	
PS- A13LP2	47.0 ab	14.3		43.5 ab	0.2	
PS- A13QP5	77.0 ab	57.1		65.3 a-d	0.8	
PS- A15P16	107.0 b	100.0		115.2 b-d	4.3	
Mock	37.0 a	0.0		37.0 a	0.0	
χ^2	90.1	-		113.3	-	
Treatment	SL[2,3] (cm)	RL[2,3] (cm)	FSW[2,3] (g)	FRW[2,3] (g)	DSW[2,3] (g)	DRW[2,3] (g)
PH- A1P9	28.2 d	18.5 a	5.1 d	1.4 d	0.6 d	0.0 c
PH- A2P18	42.8 c	21.8 a	8.3 d	2.0 d	1.2 d	0.3 c
PH- A5P4	42.0 c	19.8 a	8.9 d	1.6 d	1.4 d	0.3 c
PH- A6P5	52.8 b	19.5 a	12.4 c	2.7 c	1.8 c	0.3 c
PH- A6P25	49.5 c	19.0 a	10.4 c	2.5 d	1.5 d	0.3 c
PH- A11P1	58.8 b	19.5 a	13.6 c	3.2 c	1.8 c	0.3 c
PH- A11P2	55.5 b	22.9 a	13.3 c	1.9 d	2.0 b	0.4 c
PH- A11P17	58.8 b	24.0 a	18.6 b	3.3 c	2.4 b	0.5 b
PH- A12P22	54.2 b	24.8 a	16.9 b	4.4 b	2.4 b	0.6 b
PH- A15P9	46.0 c	21.5 a	9.1 d	3.1 c	1.2 d	0.1 c
PS- A5P9	60.8 a	21.8 a	22.9 a	5.7 a	3.1 a	1.3 a
PS- A7P6	65.2 a	19.8 a	18.2 b	2.8 c	2.7 b	0.4 c
PS- A7P15	65.8 a	24.8 a	18.2 b	3.2 c	2.4 b	0.9 b
PS- A7P37	67.8 a	23.0 a	17.0 b	3.4 c	2.5 b	0.3 c
PS- A9P21	43.5 c	22.8 a	6.8 d	1.9 d	1.2 d	0.4 c
PS- A9P50	49.5 c	20.5 a	8.3 d	1.8 d	1.1 d	0.2 c
PS- A10P16	62.8 a	21.2 a	17.2 b	3.3 c	2.4 b	0.6 b
PS- A13LP2	63.2 a	25.8 a	21.2 a	5.6 a	2.7 b	1.4 a
PS- A13QP5	65.0 a	22.5 a	24.1 a	4.3 b	3.2 a	0.6 b
PS- A15P16	62.2 a	22.0 a	21.7 a	3.5 c	2.9 a	0.5 b
Mock	67.2 a	25.8 a	24.4 a	5.8 a	3.3 a	1.5 a
CV (%)	17.8	21.7	26.7	28.8	25.5	29.8

PH = *Macrophomina phaseolina*. PS = *M. pseudophaseolina*. χ^2 = significant chi-square values. CV (%) = coefficient of variation of the experiment. [1]Values followed by the same letter in the same column do not differ statistically by the Kruskal-Wallis non-parametric test. ($p \leq 0.05$). [2]Average values from the two experiments, with seven replicates (pots) per treatment and one plant per replicate, for each experiment. [3]Values followed by the same letter in the same column do not differ statistically by the Scott-Knott test ($p \leq 0.05$).

Regarding the severity of stem rot, inoculation with *Macrophomina* species also had a statistically significant effect for both hybrids tested, 'Beloro' ($\chi^2 = 98.1$; $p \leq 0.05$) (Table 2) and 'Natal' ($\chi^2 = 113.3$; $p \leq 0.05$) (Table 3). For the hybrid Beloro, all the treatments inoculated with *M. phaseolina* isolates differed from the mock, with the exception of A15P9. The treatments inoculated with *M. pseudophaseolina* did not differ from the mock, with the exception of A15P16. The highest disease severity in this hybrid was induced by isolates A5P4, A6P5, A6P25, A11P1, and A11P17 of *M. phaseolina*

(5.0), and A5P9 and A15P16 of *M. pseudophaseolina* (3.9). For the hybrid Natal, the treatments inoculated with *M. phaseolina* isolates differed from the mock, with the exception of A2P18, A6P5, A11P2, A12P22, and A15P9. The treatments inoculated with *M. pseudophaseolina* did not differ from the mock, with the exception of A15P16. The highest disease severity in this hybrid was induced by isolates A1P9, A5P4, and A11P17 of *M. phaseolina* (5.0), and A15P16 of *M. pseudophaseolina* (4.3).

The results above indicate that both *Macrophomina* species can infect the melon hybrids tested; however, *M. phaseolina* induced a higher disease incidence and severity than *M. pseudophaseolina*. This may be because the melon hybrids, Beloro and Natal, are more susceptible to *M. phaseolina* than to *M. pseudophaseolina*, an indication that, probably, the two hybrids have different resistance genes to both isolates. Detailed genomic studies combined with bioassays need to be conducted to test this plausible hypothesis. Detailed genomic studies combined with bioassays need to be conducted to test this plausible hypothesis. Similar differences in *Macrophomina* species virulence were also observed by Negreiros et al. (2019), where isolates of *M. phaseolina* showed the highest values of disease incidence and severity when compared to *M. pseudophaseolina* after inoculation on melon seedlings. Furthermore, according to Iqbal and Mukhtar (2014), the high variation in disease incidence and severity found in isolates of *M. pseudophaseolina* may be related to the specialization of species to the growing conditions of each region (IQBAL; MUKHTAR, 2014). Similar trends were observed in studies by Abd-Elsalam (2010) on *M. phaseolina* in cotton, they classified it into three distinct categories: susceptible, moderately susceptible, and resistant.

For the variables SL, RL, FSW, FRW, DSW, and DRW there were significant differences between *Macrophomina* isolates for both melon hybrids, Beloro and Natal, according to the Scott-Knott test ($p \leq 0.05$), except for RL in the hybrid 'Natal' ($p > 0.05$) (Tables 2 and 3). For SL, in ‘Beloro’ hybrid, all treatments differed from the mock (29.8 cm), with the exception of isolates A5P4, A12P22, and A15P9 (25.2, 28.2, and 27.5 cm, respectively) of *M. phaseolina*, and A5P9 and A7P6 (28.2 and 27.2 cm, respectively) of *M. pseudophaseolina*. However, in the 'Natal' hybrid, the *M. pseudophaseolina* isolates tested did not differ from the mock (67.2 cm), with the exception of A9P21 and A9P50 (43.5 and 49.5 cm, respectively). Regarding RL, in 'Beloro' hybrid, isolates A5P4 and A11P1 (19.0 and 20.9 cm, respectively) of *M. phaseolina*, and A5P9, A7P6, A13QP5, and A15P16 of *M. pseudophaseolina* (21.5, 21.2, 21.8, and 20.2 cm, respectively) differed from the mock (27.5 cm). The other isolates did not differ from the mock.

Cavalcante et al. (2020), studying the pathogenicity of *Monosporascus* species on cucurbits, also observed a reduction in SL and RL on inoculated plants when compared to the mock. Soil-borne fungi can colonize the plant root in response to root exudates at any time during cultivation, penetrate the cortex and endodermis and spread systemically via mycelium and conidia carried by transpiration stream in the xylem (ZHAO et al., 2014). The roots of plants are severely affected, with a reduction in both their length and volume. With the root system affected by pathogens, the absorption of water and nutrients necessary for the plant's development is reduced, compromising the productivity and quality of the fruits.

Regarding the hybrid 'Beloro', only isolates A12P22 and A15P9 (20.3 and 22.2 g, respectively) of *M. phaseolina* and A5P9 (20.5 g) of *M. pseudophaseolina* did not differ from the mock (23.6 g) for FSW. While for the 'Natal' hybrid, only isolates A5P9, A13LP2, A13QP5, and A15P16 (22.9, 21.2, 24.1, and 21.7 g, respectively) of *M. pseudophaseolina* did not differ from the mock (24.4 g). With regard to FRW, in the hybrid 'Beloro', only isolates A15P9 (6.5 g) of *M. phaseolina*, and A13QP5 and A15P16 (7.1 and 7.6 g, respectively) of *M. pseudophaseolina* did not differ from the mock. In the hybrid 'Natal', only the isolates A5P9 and A13LP2 (5.7 and 5.6 g, respectively) of *M. pseudophaseolina* did not differ from the mock (5.8 g).

For DSW, in the hybrid 'Beloro', isolates A5P4, A6P5, A12P22 and A15P9 (1.9, 1.8, 2.0, and 2.2 g, respectively), of *M. phaseolina*, and A5P9, A7P6, A9P50 and A13QP5 (2.1, 2.0, 1.8, and 1.8 g, respectively), of *M. pseudophaseolina*, did not differ from the mock (2.7 g). In the 'Natal' hybrid, only isolates A5P9, A13QP5 and A15P15 (3.1, 3.2 and 2.9 g, respectively) of *M. pseudophaseolina* did not differ from the mock (3.3 g). Regarding DRW, in the hybrid 'Beloro', isolates A5P4, A6P5, A12P22 and A15P9 (1.2, 1.0, 0.7 and 1.0 g, respectively), of *M. phaseolina*, and A5P9, A13QP5 and A15P16 (0.8, 0.8 and 0.9 g, respectively), of *M. pseudophaseolina*, did not differ from the mock (1.3 g). In the 'Natal' hybrid, only isolates A5P9 and A13LP2 (1.3 and 1.4 g, respectively) of *M. pseudophaseolina* did not differ from the mock (1.5 g).

These biometric variables have been reported as being useful for verifying the severity of diseases caused by other root pathogens in cucurbits, where differences were also observed in the root system and aerial part of inoculated plants (CASTRO et al., 2020; CAVALCANTE et al., 2020). The results of this study show the wide pathogenic variability that exists among *Macrophomina* spp. isolates, which can pose a threat to the melon hybrids used in production fields. Therefore, further research is needed to

understand the interaction between these pathogens and the various plant genotypes as well as the factors that influence this relationship, for field applications.

CONCLUSION

Isolates of both *Macrophomina* species (*M. phaseolina* and *M. pseudophaseolina*) were pathogenic to melon hybrids 'Beloro' and 'Natal', with isolates of *M. phaseolina* being more aggressive than those of *M. pseudophaseolina*.

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