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Scientific Article

Reaction of two melon hybrids to *Macrophomina phaseolina* and *M. pseudophaseolina*

Reação de dois híbridos de melão a *Macrophomina phaseolina* e *M. pseudophaseolina*

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ABSTRACT - *Macrophomina phaseolina* is a major phytopathogen linked to root rot and vine decline in melon plants in northeastern Brazil. Managing this pathogen is difficult due to its polyphagous nature and adaptation to the semi-arid conditions of the region. In this study, we inoculated 10 isolates each of *M. phaseolina* (Ph) and *M. pseudophaseolina* (Ps) onto two melon hybrids, 'Beloro' and 'Natal RZ', to assess their pathogenicity. Sixty days post-planting, we measured disease incidence (INC) and severity (SEV), shoot (SL) and root length (RL), fresh shoot and root weight (FSW and FRW), and dry shoot and root weight (DSW and DRW). The hybrid 'Beloro' exhibited a 100% INC across all tested isolates. The 'Natal RZ' hybrid showed INC ranging from 14.3 to 100.0%, with the Ph-A6P5 and Ps-A10P16 isolates causing no disease (INC and SEV of 0.0). Average SEV indicated that Ph isolates were more aggressive, causing severe damage to both 'Beloro' (4.58) and 'Natal RZ' (3.18), compared to Ps isolates, which showed lower severity scores in 'Beloro' (2.56) and 'Natal RZ' (0.70). Given the limited information on the pathogenicity of Ps in melon, further research is essential to determine the infectious 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 ramas 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 RZ', para avaliar a patogenicidade desses fungos em 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 RZ' 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 RZ' (3,18), sendo mais agressivos que os isolados Ps ('Beloro' - 2,56) e ('Natal RZ' - 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.

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INTRODUCTION

Melon (*Cucumis melo* L.), a member of the Cucurbitaceae family, is increasingly cultivated across Brazil, particularly driven by large agricultural enterprises that export about 40% of their yield to European markets. The primary melon-producing states in Brazil are Rio Grande do Norte and Ceará, which contribute over 71% of national production (IBGE, 2022; KIST; CARVALHO; BELING, 2022). This production thrives due to the region's optimal soil and climatic conditions low rainfall, elevated temperatures, and intense sunlight combined with the adoption of advanced agricultural technologies such as hybrid seeds, high-frequency irrigation, and mulching (FIGUERÊDO; GONDIM; ARAGÃO, 2017; COSTA et al., 2020).

Diseases caused by soil-borne fungi, particularly those from the *Macrophomina* genus, pose significant threats to melon production. These pathogens are noted for their thermophilic, polyphagous, and cosmopolitan nature (NEGREIROS et al., 2019; 2020; SALES JÚNIOR et al., 2020). The genus affects over 700 host plants, causing various 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 symptoms of *Macrophomina* spp. infections include watery lesions

that vary in color from light to dark brown. As the disease progresses, the affected areas turn whitish with longitudinal cracks, making it appear that the epidermis is separating from the branch. Under favorable conditions, these infections can lead to premature ripening and death of the plants (LODHA; MAWAR, 2019; NEGREIROS et al., 2019; SALES JÚNIOR et al., 2020).

Currently, five species are recognized within the *Macrophomina* genus: *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), but only *M. phaseolina*, *M. pseudophaseolina*, and *M. euphorbiicola* have been identified in cucurbit plantations in Rio Grande do Norte and Ceará (NEGREIROS et al., 2019; 2020).

In Brazil, no fungicides are currently registered for use in melon crops (AGROFIT, 2024). Consequently, preventive management strategies, such as the use of resistant hybrids and biological control with antagonistic microorganisms, have become critical and are widely implemented by melon producers (BAKHSHI; SAFAIE; SHAMS-BAKHSH, 2018; LINHARES et al., 2020). Moreover, recent reports of *Macrophomina* species in Brazil highlight the limited understanding of these fungi's host range; therefore, conducting studies on their pathogenicity is crucial for effective disease management.

Given the economic significance of melons and the presence of *Macrophomina* species in major cucurbit-producing regions, this study aims to evaluate the response of melon hybrids to *M. phaseolina* and *M. pseudophaseolina*.

MATERIAL AND METHODS

This study was conducted in a greenhouse in Mossoró, Rio Grande do Norte, Brazil, at geographic coordinates 5º 11' 17" S, 37º 20' 39" W, and an altitude of 18 meters. The region's climate is classified as BSh (hot semi-arid) according to the Köppen classification system (ALVARES et al., 2014).

Fungal isolates and melon hybrids

Twenty fungal isolates were utilized in this study, comprising 10 isolates each of *M. phaseolina* and *M. pseudophaseolina*, sourced from the fungal collection at the Phytopathology Laboratory of Universidade Federal Rural do Semi-Árido (Table 1). All isolates were derived from watermelon roots exhibiting RRVD symptoms collected from cucurbit production areas in Rio Grande do Norte and Ceará. These isolates were identified both morphologically and through partial genome sequencing using specific primers.

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

Macrophomina spp.	Isolates	Location[a]
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

[a]Ceará state = CE and Rio Grande do Norte state = RN (Brazil).

The isolates were cultured on potato dextrose agar (PDA) in Petri dishes and incubated in a B.O.D. incubator at 30 ± 2 °C for seven days to prepare the initial inoculum. Seedlings of two widely grown melon hybrids in the region, Galia (Beloro, Semillas Fitó S.A.) and Yellow (Natal RZ, Rijk Swaan), were used due to their high yield potential and adaptation to local climatic conditions. The infested toothpick method was employed for inoculation (AMBRÓSIO et al., 2015).

Toothpick tips, measuring 1.5 cm, were inserted vertically with the tapered end facing upwards into a filter paper disk matching the internal diameter of a Petri dish. These plates were autoclaved twice at 121 °C for 30 minutes, with a 24-hour interval between sessions. PDA medium was then poured into these plates to about 4 mm from the toothpick ends. After the medium solidified, four 0.5 cm diameter discs containing fungal structures (mycelium + sclerotia) were placed on the plates, spaced equidistantly, and incubated for eight days at 30 ± 2 °C in a B.O.D. incubator to facilitate toothpick colonization.

Experiment design and evaluations

The experiment was conducted using a completely randomized design (CRD), involving 20 *Macrophomina* isolates (10 *M. phaseolina* and 10 *M. pseudophaseolina*), inoculated on two melon hybrids, with two control (control) treatments (non-inoculated, one for each hybrid). Each treatment had seven replicates, and the experiment was conducted twice.

Melon hybrids were planted with three seeds in each 1-liter plastic pot containing a 2:1 volume mixture of soil and commercial substrate Tropstrato HT® - Hortaliça. This mixture was sterilized by autoclaving at 121°C for one hour, with a 24-hour interval between sessions. Eight days post-sowing, two seedlings were removed, leaving one plant per pot. Ten days post-sowing, toothpicks previously colonized with each fungal isolate were inserted into the plant's neck at 0.5 cm above the soil line. For control treatments, sterilized, non-colonized toothpicks were used. The pots were maintained in a greenhouse where temperature and humidity ranged from 22-33°C and 51-97%, respectively, with manual irrigation.

Thirty days after inoculation, disease incidence (INC) and severity (SEV) were evaluated. INC was determined by counting plants with stem rot symptoms and converting this data into percentage terms. SEV was rated using a diagrammatic scale adapted by Ambrósio et al. (2015), with scores from 0 (asymptomatic tissue) to 5 (more than 50% of stem tissues infected).

Biometric variables measured included shoot length (SL) and root length (RL) using a ruler, and fresh and dry weights of shoots and roots (FSW, FRW, DSW, DRW) using an analytical balance. Dry weights were obtained by drying plant parts in an air circulation oven at 70°C until a constant weight was achieved.

Post-evaluation, fungal isolations from all plants were attempted to fulfill Koch's postulates. Necrotic lesion fragments (0.2 to 0.5 cm) from symptomatic plants were cultured on BDA + tetracycline (0.05 g. L^{-1}). The recovered fungal colonies were identified following previously described methods.

Data analysis

A preliminary analysis of variance (ANOVA) was performed to check for significant differences between the two experimental repetitions, which would determine the feasibility of combining the data. For response variables that did not conform to a normal distribution, the Kruskal-Wallis non-parametric mean comparison test was utilized. Conversely, response variables that followed a normal distribution were analyzed using the Scott-Knott parametric mean comparison test.

RESULTS AND DISCUSSION

Inoculation of melon hybrids with *Macrophomina* species significantly affected disease incidence, as evidenced by statistical analysis. In the 'Beloro' hybrid, there was a pronounced effect ($\chi2 = 115.5$; $p \leq 0.05$) noted in Table 2, with all isolates from both *Macrophomina* species differing from the control; all plants showed a disease incidence of 100%. For the 'Natal RZ' hybrid, isolates A1P9, A2P18, A5P4, A6P25, A11P1, A11P2, and A11P17 of *M. phaseolina*, and A15P16 of *M. pseudophaseolina* showed a significant deviation from the control treatment ($\chi2 = 90.1$; $p \leq 0.05$), as listed in Table 3, with each recording 100% disease incidence.

Inoculation of 'Beloro' and 'Natal RZ' melon hybrids with *Macrophomina* species significantly influenced stem rot severity ($\chi2 = 98.1$, $p \leq 0.05$ for 'Beloro' and $\chi2 = 113.3$, $p \leq 0.05$ for 'Natal RZ'; Tables 2 and 3, respectively). In the 'Beloro' hybrid, all treatments involving *M. phaseolina* and *M. pseudophaseolina* isolates showed significant deviations from the control treatments. *M. phaseolina* isolates A5P4, A6P5, A6P25, A11P1, and A11P17 caused the greatest severity in 'Beloro' (score of 5.0), as well as *M. pseudophaseolina* isolates A5P9 and A15P16 (score of 3.9). In the 'Natal RZ' hybrid, all *M. phaseolina* isolates except A6P5 showed a significant difference from the control, while only *M. pseudophaseolina* isolate A10P16 differed from the control. The highest severity in 'Natal RZ' was caused by *M. phaseolina* isolates A1P9, A5P4, and A11P17 (score of 5.0), and *M. pseudophaseolina* isolate A15P16 (score of 4.3).

These findings suggest that both species can infect the melon hybrids assessed; however, *M. phaseolina* induced higher disease incidence and severity compared to *M. pseudophaseolina*. This difference may indicate that these hybrids have varying levels of susceptibility to both species, potentially due to different resistance genes. To further explore it, detailed genomic studies and bioassays are recommended.

Supporting this observation, Negreiros et al. (2019) noted similar variances in virulence between *Macrophomina* species, with *M. phaseolina* isolates demonstrating higher disease incidence and severity than *M. pseudophaseolina* in melon seedlings. Iqbal and Mukhtar (2014) also highlighted a significant variation in disease incidence and severity among isolates of *M. pseudophaseolina*, which may be attributable to the species' adaptation to specific regional growing conditions. Abd-Elsalam (2010) further categorized *M. phaseolina* in cotton into three distinct susceptibility categories: susceptible, moderately susceptible, and resistant.

Table 2. Averages of disease incidence, disease severity, shoot length (SL), root length (RL), fresh shoot weight (FSW), fresh root weight (FRW), dry shoot weight (DSW), and dry root weight (DRW) for the Galia melon hybrid 'Beloro' 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
Control	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
Control	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. [1]Averages followed by the same lowercase letter within columns do not differ statistically by the Kruskal-Wallis non-parametric test ($p \leq 0.05$). [2]Averages from both experiments, with seven replicates (pots) per treatment and one plant per replicate. [3]Averages followed by the same lowercase letter within columns do not differ statistically by the Scott-Knott test ($p \leq 0.05$).

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

Treatment	'Natal RZ'			
	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
Control	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
Control	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. 1Averages followed by the same lowercase letter within columns do not differ statistically by the Kruskal-Wallis non-parametric test ($p \leq 0.05$). 2Averages from both experiments, with seven replicates (pots) per treatment and one plant per replicate. 3Averages followed by the same lowercase letter within columns do not differ statistically by the Scott-Knott test ($p \leq 0.05$).

Significant differences were found in SL, RL, FSW, FRW, DSW, and DRW across *Macrophomina* isolates for both 'Beloro' and 'Natal RZ' melon hybrids, according to the Scott-Knott test ($p \leq 0.05$), except for RL in the 'Natal RZ' hybrid which showed no significant difference ($p > 0.05$) as noted in Tables 2 and 3.

In the 'Beloro' hybrid, all treatments significantly altered SL from the control value of 29.8 cm, except for *M. phaseolina* isolates A5P4, A12P22, and A15P9 (25.2, 28.2, and 27.5 cm, respectively), and *M. pseudophaseolina* isolates A5P9 and A7P6 (28.2 and 27.2 cm, respectively). For the 'Natal RZ' hybrid, the *M. pseudophaseolina* isolates did not show significant deviation from the control value of 67.2 cm, except for isolates A9P21 and A9P50, which measured 43.5 and 49.5 cm, respectively.

Concerning RL in the 'Beloro' hybrid, the measurements for *M. phaseolina* isolates A5P4 and A11P1 were 19.0 and 20.9 cm, respectively, and for *M. pseudophaseolina* isolates A5P9, A7P6, A13QP5, and A15P16 were 21.5, 21.2, 21.8, and 20.2 cm, respectively—all showing significant reductions from the control measurement of 27.5 cm.

Other isolates in the study did not show significant differences from the control for both hybrids. This mirrors the findings by Cavalcante et al. (2020), who noted similar reductions in SL and RL among cucurbits inoculated with *Monosporascus* species, compared to controls. Soil-borne fungi, such as those from the *Macrophomina* and *Monosporascus* genera, can colonize plant roots throughout the growth period. These fungi respond to root exudates, enabling them to penetrate the root cortex and endodermis and spread systemically through the plant's xylem via mycelium and conidia carried by the transpiration stream (ZHAO et al., 2014). Such infections severely impact the root system, leading to a reduction not only in length but also in volume. This compromised root system adversely affects the plant's ability to absorb water and essential nutrients, critically undermining plant growth, fruit development, and quality, as well as overall productivity.

For the 'Beloro' hybrid, FSW measurements showed that only *M. phaseolina* isolates A12P22 and A15P9, which weighed 20.3 and 22.2 grams respectively, and *M. pseudophaseolina* isolate A5P9 at 20.5 grams, were like the control, which weighed 23.6 grams. Conversely, in the 'Natal RZ' hybrid, *M. pseudophaseolina* isolates A5P9, A13LP2, A13QP5, and A15P16, weighing 22.9, 21.2, 24.1, and 21.7 grams respectively, did not show significant differences from the control weight of 24.4 grams.

Regarding FRW, in the 'Beloro' hybrid, only *M. phaseolina* isolate A15P9 at 6.5 grams and *M. pseudophaseolina* isolates A13QP5 and A15P16, weighing 7.1 and 7.6 grams respectively, were comparable to the control. In the 'Natal RZ' hybrid, the weights of *M. pseudophaseolina* isolates A5P9 and A13LP2, at 5.7 and 5.6 grams respectively, also did not differ significantly from the control weight of 5.8 grams.

For the 'Beloro' hybrid, the DSW of several isolates showed no significant difference from the control, which weighed 2.7 g. Specifically, *M. phaseolina* isolates A5P4, A6P5, A12P22, and A15P9 recorded weights of 1.9, 1.8, 2.0, and 2.2 g respectively, and *M. pseudophaseolina* isolates A5P9, A7P6, A9P50, and A13QP5 recorded weights of 2.1, 2.0, 1.8, and 1.8 g respectively. In the 'Natal RZ' hybrid, only *M. pseudophaseolina* isolates A5P9, A13QP5, and A15P15, with weights of 3.1, 3.2, and 2.9 g respectively, were like the control weight of 3.3 g.

Regarding DRW, in the 'Beloro' hybrid, *M. phaseolina* isolates A5P4, A6P5, A12P22, and A15P9 had weights of 1.2, 1.0, 0.7, and 1.0 g respectively, and *M. pseudophaseolina* isolates A5P9, A13QP5, and A15P16 had weights of 0.8, 0.8, and 0.9 g, respectively. These values did not significantly differ from the control weight of 1.3 g. In the 'Natal RZ' hybrid, *M. pseudophaseolina* isolates A5P9 and A13LP2, weighing 1.3 and 1.4 g respectively, also did not differ significantly from the control weight of 1.5 g.

Biometric variables have been crucial to assessing the severity of diseases caused by root pathogens in cucurbits, as demonstrated by differences in both root and shoot of inoculated plants (CASTRO et al., 2020; CAVALCANTE et al., 2020). Our results highlight a significant pathogenic variability among *Macrophomina* spp. isolates, which poses a substantial threat to melon hybrids in production fields. Therefore, further research is needed to elucidate potential interactions between these pathogens and various plant genotypes, as well as potential environmental and genetic factors influencing these interactions. Such understanding is essential for developing field applications and management strategies. Currently, no melon hybrids show resistance to *Macrophomina* species, underscoring the urgent need for breeding programs focused on enhancing resistance traits in melon cultivars.

CONCLUSION

Isolates of both *Macrophomina* species, *M. phaseolina* and *M. pseudophaseolina*, proved pathogenic to the melon hybrids 'Beloro' and 'Natal RZ'. Among these, isolates of *M. phaseolina* exhibited greater aggressiveness compared to those of *M. pseudophaseolina*.

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