Characterization of adaptability components of Brazilian isolates of *Macrophomina pseudophaseolina*

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Abstract

Macrophomina pseudophaseolina is a new *Macrophomina* species reported on different crop and weed species in Brazil, India and Senegal, but to date there are no studies about its adaptability components. In this work a collection of 62 *M. pseudophaseolina* isolates obtained from roots of the weed species *Trianthema portulacastrum* and *Boerhavia diffusa* collected in Northeastern Brazil, was used to: i) study the effect of temperature and salinity on mycelial growth, ii) to determine their sensitivity to the fungicide carbendazim, and iii) to assess their aggressiveness on melon and watermelon seedlings. Results showed variability among *M. pseudophaseolina* isolates. The optimum temperature for mycelial growth ranged between 26.4 and 38.1ºC. NaCl reduced the *in vitro* growth of all isolates, which were also highly sensitive to the fungicide carbendazim, exhibiting EC_{50} values ranging from 0.013 to 0.089 mg L^{-1} a.i.

Disease severity values on melon and watermelon seedlings showed that *M. pseudophaseolina* isolates were more aggressive in melon than in watermelon. Information about adaptability components of *M. pseudophaseolina* obtained in this study could be incorporated on breeding programs for melon and watermelon crops.

KEYWORDS: *Boerhavia diffusa*, fungicide sensitivity, mycelial growth, pathogenicity test, *Trianthema portulacastrum*

1 INTRODUCTION

The genus *Macrophomina* (Botryosphaeriaceae, Ascomycota) has a worldwide distribution and it has been described in more than 750 host plant species, many of which are economically important crops (Farr and Rossman 2019).

For long time *M. phaseolina* was the only species included in this genus (Farr and Rossman 2019). However, recent studies have revealed the existence of three new *Macrophomina* species: *M. pseudophaseolina* (Sarr et al. 2014), *M. euphorbiicola* (Machado et al. 2019), and *M. vaccinni* (Zhao et al. 2019).

Macrophomina phaseolina is a well-known plant pathogen, causing several types of diseases, such as *damping-off*, seed rot, root rot, charcoal rot and gray stem rot, being more aggressive in subtropical and tropical countries with semi-arid climate (Dhingra and Sinclair 1978; Wrather et al. 2001; Gupta et al. 2012). Moreover, *M. phaseolina* can survive in soil for many years, in seeds and/or crop residues, by forming microsclerotia as resistance structures (Dhingra and Sinclair 1978; Gupta et al. 2012).

The three recently described *Macrophomina* species, *M. pseudophaseolina*, *M. euphorbiicola*, and *M. vaccinni*, are examples about how advances in fungal phylogenetic

studies are allowing the identification of new species in fungal populations worldwide (Sarr et al. 2014; Machado et al. 2019; Zhao et al. 2019). The species *M. pseudophaseolina* was described in Senegal, in 2014, associated with *Vigna unguiculata*, *Arachis hypogaea*, *Hibiscus sabdarifa* and *Abelmoschus esculentus* (Sarr et al., 2014). In Brazil, this new *Macrophomina* species was first reported on *A. hypogaea*, *Gossypium hirsutum*, *Ricinus communis*, *Manihot esculenta*, and also associated with *Jatropha curcas* seeds (Brito et al. 2019; Machado et al. 2019). Later *M. pseudophaseolina* was also found on roots of two weed species, *Trianthema portulacastrum* and *Boerhavia diffusa*, which are prevalent in melon fields located at the main cucurbit producing and exporting regions of northeastern Brazil (Negreiros et al. 2019). Recently, *M. pseudophaseolina* has been reported on *Coleus forskohlii* in India (Mastan et al. 2019).

For any new fungal species, studies about its adaptability components have become important, as they allow the characterization of isolates collections (Lannou 2012). Moreover, competitive capacity between fungal populations can be indirectly inferred through components of adaptability (Zhan and McDonald 2013). Since adaptability is relative, it should be estimated by measuring characters that restrict some adaptative advantage among individuals. Phenotypic markers such as mycelial growth at different temperatures, reproductive potential, salinity and fungicide sensitivity and aggressiveness are useful to evaluate the variability of adaptability in fungal plant pathogen populations (Antonovics and Alexander 1989; Lannou 2012).

To date, there are no studies about adaptability components of *M. pseudophaseolina.* Therefore, this work aims to investigate the adaptability components of a collection of 62 *M. pseudophaseolina* isolates obtained from roots of the weed species *T. portulacastrum* and *B. diffusa* collected in Northeastern Brazil, with the following objectives: i) to study the effect of temperature and salinity on mycelial growth, ii) to

determine their sensitivity to the fungicide carbendazim, and iii) to assess their aggressiveness on melon and watermelon seedlings.

2 MATERIALS AND METHODS

2.1 Fungal isolates

In this study, 62 *M. pseudophaseolina* isolates obtained in 2015 from asymptomatic roots of the weed species *T. portulacastrum* and *B. diffusa*, collected in melon and watermelon fields located at, Mossoró and Assú (Rio Grande do Norte-RN State), and Icapuí (Ceará-CE State), were used (Table 1). These weed species were selected based on their prevalence in melon and watermelon fields in RN and CE, Brazil. All isolates were hyphal-tipped and preserved using two different methods: on sandy-organic substrate and by Castellani's method with distilled water (Medeiros et al. 2015; Gonçalves et al. 2016). These isolates were identified as belonging to the species *M. pseudophaseolina* by Negreiros et al. (2019) and are deposited at the culture collection of Phytopathogenic Fungi "Prof. Maria Menezes" (CMM) at the Universidade Federal Rural de Pernambuco (Recife, Pernambuco, Brazil). Prior to use, all isolates were maintained and grown in Petri plates with Potato-Dextrose-Agar (PDA; Merck KGaA, Darmstadt, Germany) plates at 30ºC in darkness.

2.2 Effect of temperature on mycelial growth of *M. pseudophaseolina*

The mycelial growth of all isolates was determined using cultures grown on PDA. Mycelial plugs (8 mm in diameter) obtained from the growing edge of 7-day-old colonies

were transferred to the center of PDA plates (one plug per plate), which were then incubated in the dark at the temperatures of 25, 30, 35, 40, and 45 ± 1ºC for seven days, with four replicates of each isolate and temperature combination. The colony diameter of each isolate for all temperatures was daily measured along two perpendicular axes and the data were used to calculate the Mycelial Growth Rate (MGR) as mm per day (mm d^{-1}). The experiment was set up as a completely randomized design. The experiment was conducted twice. A preliminary ANOVA analysis was performed to determine whether there were significant differences between the two repetitions of the experiment and whether the data could be combined. Then, one-way analysis of variance (ANOVA) was conducted with the data obtained from MGR. The optimum temperature for MGR of each isolate was plotted against temperature and a curve was fitted by a cubic polynomial regression ($y=a+bx+cx^2+dx^3$) using TABLECURVE 2D v. 5.01 (SYSTAT Software, Inc., 2002). The mean MGR of all isolates at each temperature were compared by Scott-Knott at the 5% significance level using SISVAR v. 5.6 (Ferreira 2011).

2.3 Effect of salinity on mycelial growth of *M. pseudophaseolina*

The effect of salinity on mycelial growth of all isolates *in vitro* was determined on PDA adjusted to the following sodium chloride (NaCl) concentrations: 0, 250, 500, 750, and 1000 mM (Cervantes-García et al. 2003). Mycelial plugs (8 mm in diameter) obtained from the growing edges of colonies were transferred to the center of PDA plates (one plug per plate) amended with the NaCl concentrations. The plates were sealed and incubated in the dark at 30ºC for seven days. The experiment was set up as a completely randomized design, with five replicates per each treatment. The average diameter of the fungal colony was daily measured and data were used to calculate the Mycelial Growth

Rate (MGR) of the colony (Mayek-Pérez et al. 1997). The experiment was conducted twice. A preliminary ANOVA was performed to determine whether there were significant differences between the two repetitions of the experiment and whether the data could be combined. Then, one-way analysis of variance (ANOVA) was performed with MGR data, and means were compared by Scott-Knott at the 5% significance level using SISVAR v. 5.6 (Ferreira 2011). The means of NaCl concentrations of all isolates were subjected to a regression analysis using TABLECURVE 2D v. 5.01 (SYSTAT Software, Inc., 2002).

2.4 Sensitivity of *M. pseudophaseolina* to the fungicide carbendazim

The *M. pseudophaseolina* mycelial sensitivity to the fungicide carbendazim (methyl-2-benzimidazole carbamate) was determined *in vitro* (Tonin et al. 2013). The treatments included five levels of carbendazim concentration: 0.01, 0.10, 1, 10 and 100 mg L^{-1} a.i. PDA plates without fungicide addition, were used as controls. A 7-day old mycelial plug (8 mm diameter) from each *M. pseudophaseolina* isolate was placed in the center of the Petri dishes containing each concentration of the fungicide and were incubated at 30 ± 1ºC in darkness for seven days. A complete randomized experimental design was used, each treatment with five replicates per fungicide concentration and isolate. The colony diameters (mm) were measured in two perpendicular directions, when the fungal growth in the control treatment reached the edge of the plate. The experiment was conducted twice. A preliminary ANOVA was performed to determine whether there were significant differences between the two repetitions of the experiment and whether the data could be combined. The SPSS version 22.0 was used to determine the half maximal effective concentration (EC_{50}) for the mycelial growth for each isolate of *M.*

150 *pseudophaseolina*. The method was based on linear regression by plotting values of Log-
151 Probit.
152
153 **2.5 Pathogenicity and aggressiveness on melon and watermelon seedlings**
154
155 The aggressiveness of the *M. pseudophaseolina* isolates was determined using a
156 toothpick method (Ambrósio et al. 2015) on melon and watermelon seedlings. Twelve
157 mm long toothpicks were placed, with the sharpened end up, in holes made in a 90 mm
158 diameter filter paper. The toothpicks were then placed in a Petri plates and autoclaved at
159 121ºC for 30 min, for 2 days with an interval of 24 h. Then, 20 mL of potato dextrose
160 agar streptomycin (PDAS) was added to each toothpick-containing Petri plate. Once
161 solidified, each PDAS plate was inoculated with four mycelial plugs (8 mm in diameter)
162 of each isolate of *M. pseudophaseolina* and then were incubated at 30 ± 2ºC in the dark
163 for 7 days. Seeds of melon (cv. 'Gladial') and watermelon (cv. 'Crimson Sweet') were
164 germinated in a 'Tropstrato HT®' commercial substrate previously autoclaved. The plants
165 were daily irrigated to drainage with tap water and were not fertilized during the
166 experiment. The seedlings of melon and watermelon were inoculated 10 days after sowing
167 (DAS) by inserting the toothpicks colonized with mycelia and microsclerotia of the
168 corresponding isolate in each hypocotyl, one cm above the soil. Non infested and
169 autoclaved toothpicks were used as negative controls. The inoculated plants were
170 maintained in a greenhouse at an average temperature of 35°C for 30 days, under natural
171 daylight conditions. Thirty days after inoculation, the aggressiveness of the isolates was
172 assessed as disease severity based on the modified version of the rating scale described
173 by Ambrósio et al. (2015), where, 0 = symptomless, 1 = less than 3 % of shoot tissues
174 infected, 2 = 3–10% of shoot tissues infected, 3 = 11–25% of shoot tissues infected, 4 =

26–50% of shoot tissues infected and 5 = more than 50% of shoot tissues infected. Seven small fragments (0.2–0.5 cm) of necrotic lesions from each symptomatic plant were cut and placed on PDAS in an attempt to recover the inoculated fungi and complete Koch's postulates. The experiment was arranged in a completely randomized design with five replicates per treatment (isolate) and one plant per replicate. The experiment was conducted twice. A preliminary ANOVA was performed to determine whether there were significant differences between the two repetitions of the experiment and whether the data could be combined. Disease incidence was determined as the total number of infected plants from each *Macrophomina* species and expressed as percentage. Disease severity results were analyzed with the nonparametric Kruskal–Wallis test at the probability level of 5% using the software Assistat, version 7.7 (Silva and Azevedo 2016).

3 RESULTS

3.1 Effect of temperature on mycelial growth of *Macrophomina pseudophaseolina*

The mycelial growth rates (MGR) significantly differed ($p \leq 0.05$) among the 62 *M. pseudophaseolina* isolates in PDA, and are shown in Table 2. The cubic polynomial regression ($y=a+bx+cx^2+dx^3$) selected to describe the mycelial growth at different temperatures fitted the data with $R^2 > 0.90$ for all the isolates. The optimum growth temperatures for all isolates ranged between 26.4 (CMM4765) and 38.1ºC (CMM4820) (Table 2). Using the Scott-Knott univariate grouping test, a high variability of mycelial growth rate was observed between isolates, three groups of isolates at 25ºC, five groups at 30, 35 and 40ºC were revealed (Table 2). At 25ºC, the mean MGR was 7.5 mm d^{-1} and the values of this variable ranged from 4.3 (CMM4810) to 10.7 mm d^{-1} (CMM4779).

MGR values of ≥ 8 mm d^{-1} were observed in 37.1% of the isolates incubated at 25ºC. At 30ºC, the mean MGR was 9.1 mm d^{-1} and the values ranged between 5.2 (CMM4814) and 13.1 mm d^{-1} (CMM4771). MGR ≥ 8 mm d^{-1} were observed in 83.9% of the isolates. At 35ºC, the mean MGR was 10.1 mm d^{-1}, the values ranged between 2.3 (CMM4814) and 20.5 mm d^{-1} (CMM4795 and CMM4797), and 59.7% of the isolates showed MGR ≥ 8 mm/day. At 40ºC, the mean MGR was 5.1 mm d^{-1}, the values ranged between 1.0 (CMM4823) and 18.7 mm d^{-1} (CMM4820), and 30.6% of the isolates showed MGR ≥ 8 mm/day. None of the isolates were able to grow on PDA at 45°C.

3.2 Effect of salinity on mycelial growth of *M. pseudophaseolina*

The scatter plot of the effect of salinity on MGR of the 62 *M. pseudophaseolina* isolates is shown in Figure 1. The NaCl concentrations adjusted means of the all isolates were subjected to a regression analysis, and showed significant positive correlations ($p < 0.01$). As the NaCl concentration was increased, MGR of all *M. pseudophaseolina* isolates were reduced *in vitro* on PDA.

Statistically significant effects of the 62 *M. pseudophaseolina* isolates for each NaCl concentration on MGR were observed ($p < 0.001$). Using the Scott-Knott univariate grouping test, four groups of isolates at 0, 250, and 750 mM, two groups of isolates at 500 mM, and six groups at 1000 mM, were revealed (Table 2). At 0 mM, the mean GR was 8.7 mm d^{-1} and the values of this variable ranged from 5.2 (CMM4814) to 11.6 mm d^{-1} (CMM4821). At 250 mM, the mean MGR was 2.7 mm d^{-1} and the values ranged between 1.0 (CMM4775) and 4.5 mm d^{-1} (CMM4812). This concentration showed 69.0% reduction in the MGR in relation to the concentration of 0 mM. At 500 mM, the mean MGR was 1.0 mm d^{-1}, the values ranged between 0.6 (CMM4816) and 1.8 mm d^{-1}

225 (CMM4773), and 88.5% of reduction of the MGR. At 750 mM, the mean MGR was 0.7
226 mm d^{-1}, the values ranged between 0.3 (CMM4789 and CMM4797) and 1.1 mm d^{-1}
227 (CMM4768 and CMM4782), and showed 91.9% of reduction in the MGR in relation of
228 the concentration of 0 mM. At 1000 mM, the mean MGR was 0.4 mm d^{-1}, the values
229 ranged between 0.1 (CMM4765 and CMM4797) and 0.9 mm d^{-1} (CMM4782), and
230 showed 95.4% of reduction of the MGR.
231
232 **3.3 Sensitivity of *M. pseudophaseolina* to fungicide carbendazim**
233
234 The effects of different concentrations of carbendazim on mycelial radial growth
235 of the 62 *M. pseudophaseolina* isolates are shown in Table 3. By measuring the *M.*
236 *pseudophaseolina* colony diameter in each treatment, regression equations for log-probit
237 were adjusted and the EC_{50} values were calculated. The mean EC_{50} was 0.057 mg L^{-1} a.i.
238 and the values of this variable ranged from 0.013 to 0.089 mg L^{-1} a.i. of carbendazim.
239
240 **3.4 Pathogenicity and aggressiveness on melon and watermelon seedlings**
241
242 The inoculation with *M. pseudophaseolina* isolates caused significant statistical
243 effect on disease severity in melon seedlings ($\chi^2 = 142$; $p < 0.05$) and watermelon
244 seedlings ($\chi^2 = 120.4$; $p < 0.05$) (Table 3). Per cent recovery of the inoculated isolates
245 from the necrotic tissues of symptomatic plants was higher than 90%, and the reisolates
246 were confirmed to be the same previously inoculated. No isolates were obtained from the
247 negative controls for each crop. In melon, the highest disease severity mean (1.8) was
248 produced by isolate CMM-4826, while in watermelon isolates CMM-4808 and CMM-
249 4823 produced the highest disease severity mean (0.6). Thus, these were considered to be

the most aggressive isolates for each cucurbit species. The lowest disease severity mean (0.2) was produced by isolates CMM4807, CMM4808 and CMM4823, while in watermelon isolates CMM4790, CMM4802, CMM4814, CMM4815 and CMM4822 presented the highest disease severity mean (0.2), thus, they were considered the least aggressive isolates for each cucurbit species. In melon, the isolates CMM4771, CMM4776, CMM4777, CMM4778, CMM4779, CMM4780, CMM4788, CMM4798, CMM4805, CMM4806 and CMM4824 presented intermediate aggressiveness, with disease severity mean values ranging from 0.4 to 1.2, the other isolates were not pathogenic (Table 3). In watermelon, the isolate CMM4801 (0.4) presented intermediate aggressiveness, the other were not pathogenic to this crop (Table 3). In general, the *M. pseudophaseolina* isolates studied, regardless of the host of origin, were more aggressive to melon (0.21) than to watermelon (0.04), considering the average of all isolates for each crop species (Table 3).

4 DISCUSSION

This research, conducted with 62 isolates of *M. pseudophaseolina,* revealed variability regarding mycelial growth at different temperatures and salinity concentrations, their sensitivity to carbendazim, and their aggressiveness to melon and watermelon seedlings.

The optimum temperature for mycelial growth of *M. pseudophaseolina* isolates varied between 26.4 and 38.1ºC. These values are in contrast with the results obtained by Sarr et al. (2014), who showed optimal growth range between 30 and 36ºC for *M. pseudophaseolina* isolates obtained from *A. esculentus*, *A. hypogaea*, *H. sabdariffa* and *V. unguiculata*, in Senegal. The optimum temperature for mycelial growth of *M.*

pseudophaseolina found in our study fits with the typical soil temperatures at planting and the average soil temperatures, 22.6ºC (28.2 ºC) 33.8ºC, during watermelon and melon reproductive growth stages at RN and CE states, Northeastern Brazil (Castellane and Cortez 1995; Figueirêdo et al. 2017). Therefore, our results suggest that Brazilian *M. pseudophaseolina* isolates may be adapted to root infection in the early growth stages and during subsequent plant development under heat and drought stress conditions.

Regarding salinity, our study showed that NaCl reduced the *in vitro* growth of all *M. pseudophaseolina* isolates. The NaCl concentration of 250 mM caused more than a 50% reduction of *M. pseudophaseolina* mycelial growth. Similar results were reported in *M. phaseolina* by Cervantes-García et al. (2003) and Tijerina-Ramírez et al. (2014). These authors indicated that this fungus spent more energy to obtain water molecules as the NaCl concentration increased, reducing the mycelial growth of the fungus under *in vitro* conditions. Similarly, in our case increasing the NaCl concentration reduced mycelial growth of *M. pseudophaseolina in vitro*, probably because NaCl trapped water molecules available in the BDA medium for the fungus; being the osmotic potential lower in the fungal cell compared to the conditions of the BDA medium.

The *M. pseudophaseolina* isolates were highly sensitive to the fungicide carbendazim, exhibiting EC_{50} values ranging from 0.013 to 0.089 mg L^{-1} a.i. The efficacy of the fungicide carbendazim at low concentrations (<1 mg L^{-1}) *in vitro* was already proved by Tonin et al. (2013) for the species *M. phaseolina*. The EC_{50} is specific and constant for a particular chemical agent and to a particular pathogen, and a low EC_{50} value indicates a high fungicidal action or fungicidal power (Reis et al. 2010). These results indicate that the use of carbendazim is a measure that could be suggested for the management of charcoal stem rot (Ndiaye et al. 2015). In Brazil, carbendazim is currently authorized for some seed treatments (Agrofit 2020).

Disease severity values on melon and watermelon obtained in this study were useful for discriminating among isolates of *M. pseudophaseolina* and confirmed that this species is more aggressive in melon than in watermelon. This knowledge should be considered if breeding programs for resistance to charcoal rot of melon and watermelon are going to incorporate this new species. The *M. pseudophaseolina* isolates were re-isolated from all symptomatic plants, fulfilling Koch's postulates. *Macrophomina pseudophaseolina* was previously reported as aggressive in cowpea varieties in Senegal (Ndiaye et al. 2015). The pathogenicity in melon and watermelon of *M. pseudophaseolina* was already determined by Negreiros et al. (2019) using a more reduced set of 10 isolates. These authors also found that disease severity caused by *M. pseudophaseolina* was higher in melon than in watermelon.

Information about adaptability components of *M. pseudophaseolina* obtained in this study could be incorporated on breeding programs for melon and watermelon crops.

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Tables Captions

TABLE 1 List of *Macrophomina pseudophaseolina* isolates used in this study

TABLE 2 Optimum temperature and mean mycelial growth rate at 25, 30, 35, and 40 ºC, and mycelial growth rate at 0, 250, 500, 750, and 1000 mM of NaCl, of *Macrophomina pseudophaseolina* isolates from northeastern Brazil

TABLE 3 Regression equation and 50% inhibitory concentration of mycelium growth (EC_{50}) for log Probit analysis by fungicide carbendazim, and disease severity and incidence induced to melon and watermelon seedlings by 62 isolates of *Macrophomina pseudophaseolina* from northeastern Brazil

Figure Captions

FIGURE 1 Scatter plot of average relative growth rate (RGR) of 62 isolates of *Macrophomina pseudophaseolina* on potato-dextrose-agar adjusted to different NaCl concentrations

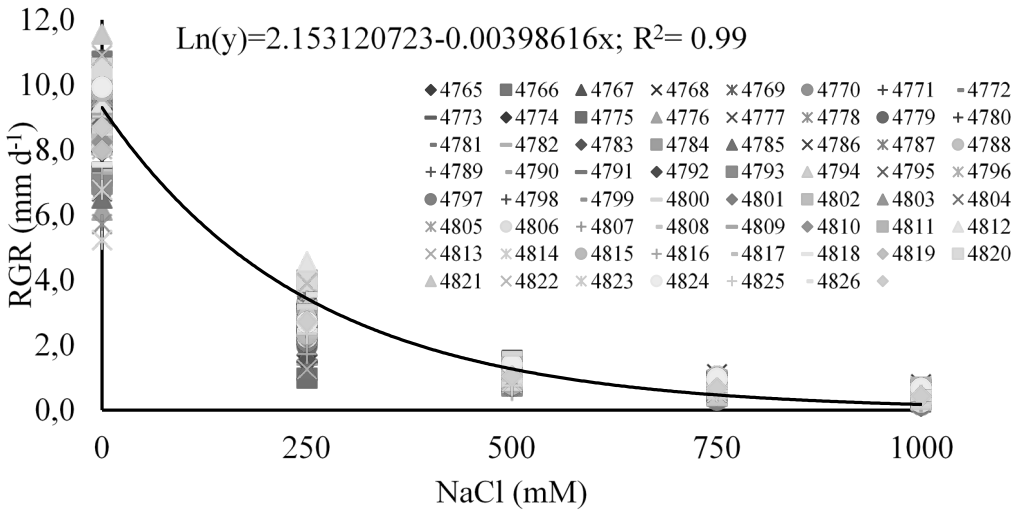

FIGURE 1 Scatter plot of average relative growth rate (RGR) of 62 isolates of *Macrophomina pseudophaseolina* on potato-dextrose-agar adjusted to different NaCl concentrations

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TABLE 1 List of *Macrophomina pseudophaseolina* isolates used in this study

Strain number (CMM)[a]	Host	Location[b]
4765, 4766, 4767, 4768	*Trianthema portulacastrum*	Brazil, CE, Icapuí
4769, 4770, 4771, 4772, 4773, 4774, 4775, 4776, 4777, 4778	*Trianthema portulacastrum*	Brazil, RN, Assú
4779, 4780, 4781, 4782, 4783, 4784, 4785, 4786, 4787, 4788	*Trianthema portulacastrum*	Brazil, RN, Mossoró
4789, 4790, 4791, 4792, 4793, 4794, 4795, 4796, 4797, 4798, 4799, 4800, 4891, 4892, 4893, 4894, 4810, 4811, 4812, 4813	*Boerhavia diffusa*	Brazil, RN, Assú
4814, 4815, 4816, 4817, 4818, 4819 4820, 4821, 4822, 4823, 4824, 4825, 4826	*Boerhavia diffusa*	Brazil, RN, Mossoró

[a]CMM - Culture Collection of Phytopathogenic Fungi "Prof. Maria Menezes" of the Universidade Federal Rural de Pernambuco (Recife, PE, Brazil).

[b]Ceará state = CE and Rio Grande do Norte state = RN.

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TABLE 2 Optimum temperature and mean mycelial growth rate at 25, 30, 35, and 40 ºC, and mycelial growth rate at 0, 250, 500, 750, and 1000 mM of NaCl, of *Macrophomina pseudophaseolina* isolates from northeastern Brazil

Isolates (CMM)[a]	Optimum temperature (°C)	Temperature Mycelial Growth Rate (mm d^{-1}) ± SE[b]				Salinity Mycelial Growth Rate (mm d^{-1}) ± SE[b]				
		25ºC	30ºC	35ºC	40ºC	0	250	500	750	1000
4765	26.4	9.5 ± 0.2 a	9.0 ± 0.4 c	4.5 ± 0.1 e	2.2 ± 0.1 e	10.5 ± 0.2 a	1.7 ± 0.1 d	0.9 ± 0.1 b	0.7 ± 0.1 c	0.1 ± 0.1 f
4787	26.8	8.5 ± 0.1 a	8.6 ± 0.3 d	4.3 ± 0.1 e	2.1 ± 0.1 e	8.5 ± 0.1 c	2.5 ± 0.2 c	1.2 ± 0.2 a	0.6 ± 0.1 c	0.3 ± 0.1 d
4777	26.8	6.7 ± 0.1 b	6.9 ± 0.3 e	3.4 ± 0.1 e	1.7 ± 0.1 e	6.7 ± 0.1 d	3.1 ± 0.2 b	1.3 ± 0.1 a	0.7 ± 0.1 c	0.4 ± 0.1 d
4769	26.8	8.2 ± 0.7 a	8.4 ± 0.7 d	4.2 ± 0.2 e	2.1 ± 0.1 e	8.2 ± 0.7 c	3.3 ± 0.5 b	1.1 ± 0.1 b	0.7 ± 0.1 a	0.4 ± 0.1 d
4773	26.8	8.5 ± 0.6 a	8.7 ± 0.9 d	4.3 ± 0.2 e	2.2 ± 0.2 e	8.5 ± 0.6 c	4.1 ± 0.2 a	1.8 ± 0.1 a	0.8 ± 0.1 b	0.3 ± 0.1 e
4784	26.8	8.9 ± 0.3 a	9.1 ± 0.6 c	4.6 ± 0.1 e	2.3 ± 0.1 e	8.9 ± 0.3 b	2.5 ± 0.4 c	1.0 ± 0.1 b	0.8 ± 0.1 b	0.5 ± 0.1 c
4766	26.8	9.3 ± 0.4 a	9.5 ± 1.9 c	4.7 ± 0.5 e	2.4 ± 0.2 e	9.3 ± 0.4 b	2.5 ± 0.4 c	0.9 ± 0.1 b	0.7 ± 0.1 c	0.5 ± 0.1 c
4779	27.1	10.7 ± 1.0 a	11.3 ± 1.7 b	5.6 ± 0.4 e	2.8 ± 0.2 e	10.8 ± 1.0 a	2.0 ± 0.2 d	1.2 ± 0.1 b	0.9 ± 0.2 a	0.3 ± 0.1 e
4780	27.1	8.3 ± 0.2 a	8.8 ± 0.7 d	4.4 ± 0.2 e	2.2 ± 0.1 e	8.4 ± 0.2 c	2.7 ± 0.3 c	1.1 ± 0.1 b	0.8 ± 0.1 a	0.5 ± 0.1 c
4781	27.3	8.3 ± 0.3 a	9.0 ± 0.5 c	4.5 ± 0.1 e	2.2 ± 0.1 e	8.3 ± 0.3 c	2.2 ± 0.1 c	1.0 ± 0.1 b	0.7 ± 0.3 a	0.4 ± 0.1 d
4783	27.3	9.0 ± 0.5 a	9.7 ± 0.9 c	4.8 ± 0.2 e	2.4 ± 0.1 e	9.0 ± 0.5 b	1.5 ± 0.2 d	0.9 ± 0.1 b	0.5 ± 0.1 d	0.2 ± 0.1 e
4786	27.6	8.2 ± 0.1 a	9.1 ± 0.8 c	4.6 ± 0.2 e	2.3 ± 0.1 e	8.3 ± 0.1 c	2.5 ± 0.2 c	0.9 ± 0.1 b	0.9 ± 0.1 b	0.3 ± 0.1 d

4772	27.6	9.1 ± 1.0 a	10.1 ± 0.8 c	5.1 ± 0.2 e	2.5 ± 0.2 e	9.1 ± 1.0 b	1.4 ± 0.2 d	1.0 ± 0.1 b	0.9 ± 0.1 b	0.5 ± 0.1 c
4785	27.9	6.5 ± 0.7 b	7.6 ± 3.4 e	3.8 ± 0.8 e	1.9 ± 0.4 e	6.5 ± 0.7 d	1.2 ± 0.1 d	0.8 ± 0.1 b	0.7 ± 0.1 c	0.4 ± 0.1 d
4774	28.0	8.0 ± 0.3 a	9.3 ± 0.3 d	4.7 ± 0.1 e	2.3 ± 0.1 e	8.0 ± 0.3 c	1.5 ± 0.2 d	1.0 ± 0.1 b	0.9 ± 0.1 b	0.4 ± 0.1 d
4767	28.0	8.9 ± 1.4 a	10.4 ± 0.8 c	5.2 ± 0.2 e	2.6 ± 0.1 e	8.9 ± 1.4 b	3.1 ± 0.3 b	1.3 ± 0.1 a	0.7 ± 0.1 c	0.6 ± 0.1 b
4776	28.1	6.2 ± 0.1 c	7.3 ± 0.7 e	3.7 ± 0.2 e	1.8 ± 0.2 e	6.2 ± 0.2 d	1.7 ± 0.2 d	1.1 ± 0.1 a	0.9 ± 0.1 b	0.5 ± 0.1 c
4770	28.2	6.8 ± 0.1 b	8.2 ± 0.5 d	4.1 ± 0.1 e	2.1 ± 0.1 e	6.8 ± 0.1 d	2.6 ± 0.5 c	1.0 ± 0.1 b	0.8 ± 0.1 a	0.5 ± 0.1 c
4768	28.2	8.4 ± 0.7 a	10.2 ± 0.9 c	5.1 ± 0.2 e	2.5 ± 0.1 e	8.4 ± 0.7 c	2.7 ± 0.3 c	1.3 ± 0.1 a	1.1 ± 0.1 a	0.8 ± 0.1 a
4788	28.2	8.9 ± 0.4 a	10.9 ± 2.0 b	5.4 ± 0.5 e	2.7 ± 0.2 e	8.9 ± 0.4 b	2.9 ± 0.2 b	1.4 ± 0.2 a	1.0 ± 0.1 a	0.6 ± 0.1 b
4771	28.5	10.1 ± 0.3 a	13.1 ± 1.8 a	6.5 ± 0.4 e	3.2 ± 0.2 e	10.1 ± 0.2 a	3.4 ± 0.4 b	0.9 ± 0.1 b	0.7 ± 0.1 c	0.3 ± 0.1 d
4778	28.7	5.7 ± 0.1 c	7.7 ± 0.7 e	3.8 ± 0.2 e	1.9 ± 0.2 e	5.7 ± 0.3 d	2.3 ± 0.3 c	0.9 ± 0.1 b	0.8 ± 0.1 c	0.3 ± 0.1 e
4782	28.8	7.9 ± 0.8 a	10.9 ± 0.2 b	5.4 ± 0.1 e	2.7 ± 0.1 e	7.9 ± 0.8 c	2.1 ± 0.9 c	1.2 ± 0.3 a	1.1 ± 0.1 a	0.9 ± 0.1 a
4775	28.9	7.2 ± 0.3 b	10.3 ± 1.6 c	5.1 ± 0.4 e	2.6 ± 0.4 e	7.2 ± 0.2 d	1.0 ± 0.1 d	0.9 ± 0.1 b	0.9 ± 0.1 b	0.6 ± 0.1 b
4823	29.8	7.3 ± 0.3 b	6.8 ± 1.0 e	10.8 ± 1.5 d	1.0 ± 0.1 e	6.8 ± 0.5 d	3.4 ± 0.1 b	0.9 ± 0.1 b	0.6 ± 0.1 d	0.4 ± 0.1 d
4792	30.0	7.3 ± 0.6 b	9.3 ± 1.8 c	10.2 ± 0.9 d	1.9 ± 0.1 e	9.3 ± 0.9 b	3.2 ± 1.2 b	0.9 ± 0.1 b	0.7 ± 0.1 c	0.3 ± 0.1 e
4796	30.2	6.1 ± 0.3 c	8.0 ± 0.8 d	8.8 ± 1.9 e	2.2 ± 0.1 e	8.1 ± 0.4 c	2.8 ± 0.4 c	1.0 ± 0.1 b	0.8 ± 0.1 c	0.5 ± 0.1 c
4791	30.5	7.7 ± 0.1 b	11.0 ± 0.9 b	13.3 ± 1.2 c	2.3 ± 0.1 e	11.0 ± 0.5 a	3.2 ± 0.2 b	1.6 ± 0.1 a	0.8 ± 0.1 c	0.5 ± 0.1 c
4794	30.5	5.9 ± 1.2 c	9.2 ± 1.4 c	10.7 ± 1.8 d	2.0 ± 0.2 e	9.2 ± 0.7 b	3.4 ± 0.2 b	1.1 ± 0.1 a	0.7 ± 0.1 c	0.4 ± 0.1 d
4824	30.5	7.2 ± 0.6 b	9.9 ± 0.3 c	12.7 ± 0.8 c	2.1 ± 0.1 e	10.0 ± 0.1 b	2.7 ± 0.1 c	1.4 ± 0.1 a	1.0 ± 0.1 b	0.6 ± 0.1 b

4811	30.7	6.9 ± 0.1 b	9.9 ± 0.5 c	13.1 ± 0.8 c	2.1 ± 0.2 e	9.9 ± 0.2 b	4.0 ± 0.2 a	1.3 ± 0.1 a	0.8 ± 0.1 c	0.7 ± 0.1 b
4790	30.9	6.9 ± 0.3 b	8.2 ± 0.6 d	10.5 ± 0.1 d	3.3 ± 0.2 e	8.3 ± 0.3 c	2.7 ± 0.4 c	0.9 ± 0.1 b	0.5 ± 0.1 d	0.3 ± 0.1 d
4806	31.2	7.4 ± 0.2 b	8.1 ± 0.9 d	15.0 ± 1.1 b	2.1 ± 0.1 e	8.1 ± 0.5 c	2.2 ± 0.3 c	0.8 ± 0.1 b	0.5 ± 0.1 d	0.2 ± 0.1 e
4789	31.3	7.0 ± 0.3 b	8.5 ± 0.6 d	15.6 ± 0.1 b	2.1 ± 0.2 e	8.5 ± 0.3 c	2.7 ± 0.3 c	0.8 ± 0.1 b	0.3 ± 0.1 d	0.2 ± 0.1 e
4817	31.8	6.4 ± 0.5 c	9.8 ± 1.6 c	16.9 ± 1.4 b	3.2 ± 0.3 e	9.9 ± 0.8 b	2.3 ± 0.1 c	1.4 ± 0.1 a	0.8 ± 0.1 c	0.6 ± 0.1 c
4807	31.8	6.8 ± 0.2 b	10.0 ± 0.7 c	14.8 ± 0.5 b	4.3 ± 0.1 d	10.0 ± 0.3 b	3.0 ± 0.2 b	1.2 ± 0.1 a	0.7 ± 0.1 c	0.3 ± 0.1 e
4826	32.0	8.2 ± 0.3 a	8.5 ± 1.1 d	15.8 ± 2.7 b	3.8 ± 0.5 d	8.5 ± 0.5 c	3.5 ± 0.5 b	0.9 ± 0.1 b	0.5 ± 0.1 d	0.5 ± 0.1 c
4801	32.6	7.4 ± 0.1 b	8.6 ± 0.2 d	9.7 ± 0.2 d	5.9 ± 1.3 d	8.6 ± 0.1 c	3.8 ± 0.1 a	1.5 ± 0.1 a	0.5 ± 0.1 d	0.3 ± 0.1 d
4795	32.8	6.3 ± 0.7 c	9.1 ± 0.9 c	20.5 ± 0.1 a	4.2 ± 0.4 d	9.1 ± 0.4 b	2.5 ± 0.2 c	1.1 ± 0.1 a	0.4 ± 0.1 d	0.2 ± 0.1 e
4797	32.9	8.3 ± 0.3 a	9.6 ± 0.7 c	20.5 ± 0.1 a	4.9 ± 0.7 d	9.6 ± 0.4 b	2.1 ± 0.1 c	0.7 ± 0.1 b	0.3 ± 0.1 d	0.1 ± 0.1 f
4810	32.9	4.3 ± 1.4 c	8.3 ± 0.7 d	17.1 ± 1.8 b	4.2 ± 0.6 d	8.3 ± 0.3 c	2.2 ± 0.2 c	0.8 ± 0.1 b	0.5 ± 0.1 d	0.4 ± 0.1 d
4814	33.1	5.4 ± 0.9 c	5.2 ± 0.4 e	2.3 ± 0.3 e	4.1 ± 0.2 d	5.2 ± 0.2 d	3.1 ± 0.4 b	0.8 ± 0.1 b	0.5 ± 0.1 d	0.3 ± 0.1 d
4818	33.5	7.4 ± 0.1 b	7.6 ± 1.5 e	11.1 ± 0.8 d	5.5 ± 1.6 d	7.6 ± 0.8 c	2.4 ± 0.4 c	0.8 ± 0.1 b	0.6 ± 0.1 c	0.3 ± 0.1 e
4821	34.1	7.3 ± 1.3 b	11.6 ± 1.2 b	12.5 ± 0.5 c	9.5 ± 2.4 c	11.6 ± 0.6 a	3.1 ± 0.1 b	1.2 ± 0.1 a	0.5 ± 0.1 d	0.3 ± 0.1 d
4815	34.8	7.5 ± 0.3 b	9.8 ± 1.3 c	19.9 ± 0.6 a	8.5 ± 0.4 c	9.8 ± 0.6 b	2.3 ± 0.2 c	1.7 ± 0.9 a	0.6 ± 0.1 c	0.4 ± 0.1 d
4802	35.1	5.9 ± 0.7 c	8.4 ± 0.5 d	14.9 ± 0.9 b	9.4 ± 1.3 c	8.4 ± 0.3 c	2.9 ± 0.2 b	1.2 ± 0.1 a	0.7 ± 0.1 c	0.3 ± 0.1 d
4805	35.1	7.1 ± 0.7 b	9.6 ± 0.6 c	15.1 ± 0.4 b	8.9 ± 0.4 c	9.6 ± 0.3 b	3.6 ± 0.1 a	0.9 ± 0.1 b	0.7 ± 0.1 c	0.5 ± 0.1 c
4825	35.3	7.2 ± 1.2 b	9.0 ± 0.4 c	12.1 ± 0.4 c	8.5 ± 0.6 c	9.1 ± 0.2 b	2.3 ± 0.2 c	0.7 ± 0.1 b	0.6 ± 0.1 c	0.5 ± 0.1 c

4822	35.4	7.5 ± 0.3 b	10.9 ± 2.3 b	14.5 ± 0.5 b	10.5 ± 1.2 b	10.9 ± 1.2 a	3.9 ± 0.3 a	1.0 ± 0.1 b	0.5 ± 0.1 d	0.4 ± 0.1 d
4798	35.6	7.7 ± 0.2 b	10.1 ± 0.4 c	15.7 ± 0.4 b	10.1 ± 1.4 c	10.2 ± 0.2 a	3.4 ± 0.1 b	1.1 ± 0.1 a	0.6 ± 0.1 d	0.3 ± 0.1 d
4819	35.7	5.4 ± 0.9 c	8.0 ± 0.4 d	9.6 ± 1.8 d	8.2 ± 2.1 c	8.0 ± 0.2 c	2.8 ± 0.2 c	0.9 ± 0.1 b	0.8 ± 0.1 c	0.5 ± 0.1 c
4804	36.0	5.3 ± 1.6 c	9.5 ± 1.0 c	19.1 ± 1.4 a	12.3 ± 0.7 b	9.6 ± 0.5 b	3.2 ± 0.1 b	0.9 ± 0.1 b	0.5 ± 0.1 d	0.5 ± 0.1 c
4813	36.0	6.9 ± 0.2 b	9.6 ± 1.0 c	10.7 ± 0.8 d	10.1 ± 0.3 c	9.7 ± 0.5 b	1.2 ± 0.2 d	1.1 ± 0.1 a	0.5 ± 0.1 d	0.4 ± 0.1 d
4803	36.1	9.3 ± 0.8 a	9.7 ± 1.0 c	15.9 ± 0.8 b	11.8 ± 1.0 b	9.7 ± 0.5 b	3.0 ± 0.2 b	0.9 ± 0.1 b	0.4 ± 0.1 d	0.4 ± 0.1 d
4816	36.4	7.3 ± 0.5 b	7.3 ± 0.4 e	11.3 ± 0.3 d	8.0 ± 0.3 c	7.3 ± 0.2 d	1.7 ± 0.1 d	0.6 ± 0.1 b	0.4 ± 0.1 d	0.2 ± 0.1 e
4808	36.4	7.5 ± 0.2 b	7.4 ± 2.5 e	13.0 ± 0.8 c	8.35 ± 0.2 c	7.4 ± 1.2 d	3.7 ± 0.1 a	0.8 ± 0.1 b	0.6 ± 0.1 c	0.4 ± 0.1 d
4799	36.5	7.7 ± 0.3 b	8.7 ± 0.5 d	14.1 ± 0.5 b	10.2 ± 0.4 c	8.7 ± 0.3 b	2.4 ± 0.2 c	1.1 ± 0.1 a	0.8 ± 0.1 c	0.6 ± 0.1 b
4812	36.7	7.9 ± 0.5 a	9.5 ± 1.4 c	15.8 ± 0.5 b	11.7 ± 0.7 b	9.5 ± 0.7 b	4.5 ± 0.1 a	1.2 ± 0.1 a	0.7 ± 0.1 c	0.4 ± 0.1 d
4809	36.9	8.0 ± 0.5 a	9.0 ± 0.5 c	14.8 ± 1.9 b	11.7 ± 1.2 b	9.1 ± 0.2 b	3.0 ± 0.1 b	1.0 ± 0.1 b	0.7 ± 0.1 c	0.4 ± 0.1 d
4800	37.1	8.1 ± 0.3 a	9.7 ± 0.5 c	13.5 ± 0.6 c	12.5 ± 2.1 b	9.7 ± 0.3 b	3.2 ± 0.1 b	1.2 ± 0.1 a	0.7 ± 0.1 c	0.5 ± 0.1 c
4793	37.3	6.6 ± 0.7 b	6.9 ± 1.4 e	9.9 ± 2.1 d	9.3 ± 0.7 c	6.9 ± 0.7 d	2.5 ± 0.7 c	0.7 ± 0.1 b	0.6 ± 0.1 c	0.6 ± 0.1 c
4820	38.1	8.7 ± 0.2 a	10.5 ± 0.6 b	14.9 ± 1.2 b	18.7 ± 0.6 a	10.5 ± 0.3 a	3.9 ± 1.0 a	0.9 ± 0.1 b	0.7 ± 0.1 c	0.5 ± 0.1 c
Mean	31.4	7.5	9.1	10.1	5.1	8.7	2.7	1.0	0.7	0.4
CV (%)		16.7	12.3	17.7	27.9	12.7	25.1	15.1	20.2	23.6

[a] CMM - Culture Collection of Phytopathogenic Fungi “Prof. Maria Menezes” of the Universidade Federal Rural de Pernambuco (Recife, PE, Brazil).

[b] Values are the mean of 10 measurements. SE = Standard Error of the Mean. Values with the same letter within a column (± standard error) are not significantly different according to Scott-Knott test at 5% probability.

TABLE 3 Regression equation and 50% inhibitory concentration of mycelium growth (EC_{50}) for log Probit analysis by fungicide carbendazim, and disease severity and incidence induced to melon and watermelon seedlings by 62 isolates of *Macrophomina pseudophaseolina* from northeastern Brazil

	Fungicide Carbendazim		**Melon**			**Watermelon**		
Isolates (CMM)[a]	Regression equation[b]	EC_{50}[c] (mg L^{-1} a.i.)	Disease Severity		Disease Incidence (%)	Disease Severity		Disease Incidence (%)
			Rank	Mean[e]		Rank	Mean[e]	
4782	y = 15.295x + 78.772	0.013	139.5	0.0	0.0	149.0	0.0	0.0
4791	y = 15.769x + 77.120	0.019	139.5	0.0	0.0	149.0	0.0	0.0
4800	y = 17.663x + 74.048	0.019	139.5	0.0	0.0	149.0	0.0	0.0
4822	y = 16.707x + 76.890	0.025	139.5	0.0	0.0	180.0	0.2	20.0

4821	y = 16.782x + 76.666	0.026	139.5	0.0	0.0	149.0	0.0	0.0
4768	y = 16.856x + 76.142	0.028	139.5	0.0	0.0	149.0	0.0	0.0
4798	y = 16.463x + 75.469	0.028	198.9	0.4	40.0	149.0	0.0	0.0
4788	y = 16.703x + 75.193	0.031	204.7	1.2	40.0	149.0	0.0	0.0
4815	y = 16.591x + 75.097	0.031	139.5	0.0	0.0	180.0	0.2	20.0
4789	y = 16.791x + 74.410	0.035	139.5	0.0	0.0	149.0	0.0	0.0
4786	y = 17.119x + 74.711	0.036	139.5	0.0	0.0	149.0	0.0	0.0

4797	y = 16.868x + 74.251	0.036	139.5	0.0	0.0	149.0	0.0	0.0
4811	y = 17.601x + 74.967	0.038	139.5	0.0	0.0	149.0	0.0	0.0
4819	y = 17.830x + 74.995	0.040	139.5	0.0	0.0	149.0	0.0	0.0
4820	y = 18.029x + 75.070	0.041	139.5	0.0	0.0	149.0	0.0	0.0
4775	y = 17.733x + 74.075	0.044	139.5	0.0	0.0	149.0	0.0	0.0
4794	y = 17.846x + 74.183	0.044	139.5	0.0	0.0	149.0	0.0	0.0
4779	y = 18.061x + 74.247	0.045	172.2	0.6	20.0	149.0	0.0	0.0

4771	y = 18.984x + 75.438	0.046	172.6	0.8	20.0	149.0	0.0	0.0
4805	y = 18.025x + 73.738	0.048	198.9	0.4	40.0	149.0	0.0	0.0
4807	y = 17.823x + 73.119	0.050	169.2	0.2	20.0	149.0	0.0	0.0
4778	y = 17.398x + 72.355	0.052	171.6	0.4	20.0	149.0	0.0	0.0
4792	y = 17.881x + 72.842	0.053	139.5	0.0	0.0	149.0	0.0	0.0
4774	y = 17.601x + 72.262	0.054	139.5	0.0	0.0	149.0	0.0	0.0
4813	y = 18.801x + 73.778	0.054	139.5	0.0	0.0	149.0	0.0	0.0

4825	y = 18.410x + 73.275	0.054	139.5	0.0	0.0	149.0	0.0	0.0
4817	y = 18.817x + 73.752	0.055	139.5	0.0	0.0	149.0	0.0	0.0
4824	y = 18.623x + 73.528	0.055	228.6	0.6	60.0	149.0	0.0	0.0
4812	y = 18.640x + 73.385	0.056	139.5	0.0	0.0	149.0	0.0	0.0
4773	y = 18.425x + 72.860	0.057	139.5	0.0	0.0	149.0	0.0	0.0
4783	y = 17.983x + 72.368	0.057	139.5	0.0	0.0	149.0	0.0	0.0
4804	y = 18.448x + 72.882	0.057	139.5	0.0	0.0	149.0	0.0	0.0

4780	y = 18.743x + 72.889	0.060	203.7	0.8	40.0	149.0	0.0	0.0
4781	y = 19.078x + 73.188	0.061	139.5	0.0	0.0	149.0	0.0	0.0
4806	y = 19.018x + 72.780	0.063	173.3	1.0	20.0	149.0	0.0	0.0
4809	y = 18.371x + 71.908	0.064	139.5	0.0	0.0	149.0	0.0	0.0
4814	y = 17.592x + 70.965	0.064	139.5	0.0	0.0	180.0	0.2	20.0
4796	y = 18.652x + 72.099	0.065	139.5	0.0	0.0	149.0	0.0	0.0
4793	y = 18.475x + 71.504	0.069	139.5	0.0	0.0	149.0	0.0	0.0

4799	y = 18.771x + 71.741	0.069	139.5	0.0	0.0	149.0	0.0	0.0
4795	y = 19.212x + 72.199	0.070	232.7	1.4	60.0	149.0	0.0	0.0
4766	y = 20.121x + 73.124	0.071	139.5	0.0	0.0	149.0	0.0	0.0
4769	y = 19.293x + 72.072	0.072	139.5	0.0	0.0	149.0	0.0	0.0
4802	y = 19.095x + 71.823	0.072	139.5	0.0	0.0	180.0	0.2	20.0
4776	y = 18.089x + 70.522	0.073	171.6	0.4	20.0	149.0	0.0	0.0
4777	y = 18.329x + 70.664	0.075	173.3	1.0	20.0	149.0	0.0	0.0

4808	y = 18.455x + 70.812	0.075	169.2	0.2	20.0	242.0	0.6	60.0
4767	y = 19.174x + 71.487	0.076	139.5	0.0	0.0	149.0	0.0	0.0
4816	y = 19.306x + 71.627	0.076	139.5	0.0	0.0	149.0	0.0	0.0
4823	y = 19.658x + 72.009	0.076	169.2	0.2	20.0	242.0	0.6	60.0
4826	y = 19.593x + 71.910	0.076	292.1	1.8	100.0	149.0	0.0	0.0
4810	y = 19.425x + 71.640	0.077	139.5	0.0	0.0	149.0	0.0	0.0
4784	y = 20.137x + 72.312	0.078	139.5	0.0	0.0	149.0	0.0	0.0

4787	y = 19.873x + 72.038	0.078	139.5	0.0	0.0	149.0	0.0	0.0
4772	y = 20.175x + 72.196	0.079	139.5	0.0	0.0	149.0	0.0	0.0
4790	y = 18.531x + 70.466	0.079	139.5	0.0	0.0	180.0	0.2	20.0
4818	y = 19.930x + 71.831	0.080	139.5	0.0	0.0	149.0	0.0	0.0
4765	y = 19.511x + 70.997	0.084	139.5	0.0	0.0	149.0	0.0	0.0
4770	y = 19.438x + 70.885	0.084	139.5	0.0	0.0	149.0	0.0	0.0
4785	y = 19.874x + 71.391	0.084	139.5	0.0	0.0	149.0	0.0	0.0

4803	y = 19.944x + 71.326	0.085	139.5	0.0	0.0	149.0	0.0	0.0
4801	y = 19.678x + 70.684	0.089	261.7	1.4	80.0	211.0	0.4	40.0
Mean		0.057	-	0.21		-	0.04	
[d]χ^2			142.0			120.4		

[a]CMM - Culture Collection of Phytopathogenic Fungi "Prof. Maria Menezes" of the Universidade Federal Rural de Pernambuco (Recife, PE, Brazil). [b] y = percentage of mycelial growth inhibition; x = fungicide concentration. [c] Calculated by the concentration equation (mg L^{-1}) for log probit analysis. [d] χ^2 = chi-square value significant at 5% by Kruskal-Wallis test. [e]Media of ten repetitions (plants).