Development of a Screening Test for Resistance of Cucurbits and *Cucurbita* Hybrid Rootstocks to *Monosporascus cannonballus*

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ABSTRACT

Ben Salem, I., Armengol, J., Berbegel, M., and Boughalleb-M'Hamdi, N. 2015. Development of a screening test for resistance of cucurbits and *Cucurbita* hybrid rootstocks to *Monosporascus cannonballus.* Tunisian Journal of Plant Protection 10: 23-33.

Screening test resistance of cucurbit plants to *Monosporascus cannonballus*, responsible of Monosporascus root rot and vine decline was developed. Inocula of two isolates were grown in wheat seeds medium and served for pathogenicity test on watermelon (cv. Charleston gray) using 5 inoculum densities (50, 100, 150, 200 and 250 g of infected wheat seeds/kg of peat). Disease severity was evaluated based on root disease index (RDI), plant height (PH), shoot and root fresh and dry weights (SFW, RFW, SDW, and RDW). Significant differences in RDI records were noted among the 5 inoculum densities tested as compared to the non-inoculated control, and they were negatively correlated with PH, TDW and RDW. Pathogenicity tests on Armenian cucumber (Fakous), muskmelon (cvs. Flamengo and Dziria), watermelon (cv. Charleston gray), and two *Cucurbita maxima* x *C. moschata* rootstocks (cvs. Strongtoza and Emphasis), were conducted at the inoculum density of 200 g of inoculum/kg of peat. Characteristic symptoms of the disease were reproduced and the range of responses to *M. cannonballus* corresponded to those reported by previous research. Watermelon was susceptible to the pathogen, while *Cucurbita* hybrid rootstocks were the most tolerant. Evaluation of the resistance to *M. cannonballus* of eight *Cucurbita* hybrid rootstocks was conducted in a greenhouse experiment with 200 g of inoculum/kg of peat. All rootstocks evaluated seemed to response similarly for the RDI. However, no significant difference was noted for the other evaluated parameters.

Keywords: Monosporascus root rot and vine decline of cucurbits, pathogenicity, rootstocks, soilborne pathogen

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Monosporascus cannonballus, a root-infecting *Ascomycota*, is the main pathogen associated with Monosporascus root rot and vine decline (MRRVD) of muskmelon (*Cucumis melo*), watermelon (*Citrullus lanatus*), and other cucurbits in hot arid and semi-arid regions of the world (4, 14, 26). Symptoms of MRRVD include yellowing and death of the crown leaves and a rapid decline of the vine as

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Accepted for publication 15 December 2014

the plant approaches maturity, resulting in canopy collapse. Root systems become necrotic, with numerous discrete lesions and lack secondary and tertiary feeder roots (4).

Asci of *M. cannonballus*, each containing a single ascospore, are produced within the numerous perithecia formed on the roots of affected cucurbit hosts and in culture media (4, 14). This fungus has no other reproductive spores (35). Ascospores probably function as the primary survival structure, as well as the primary inoculum for root infection (35, 36). Furthermore, Waugh *et al.* (37) indicated that the root system of a single mature cantaloupe plant infected by *M. cannonballus* could support the production of approximately 400,000 ascospores. Consequently, this pathogen has great potential to maintain and/or increase its inoculum in the soil of cucurbit crops (14).

Mertely *et al.* (29) first reported that *M. cannonballus* was pathogenic to numerous cucurbit species and that some variability in susceptibility occurred among different cultivars of *C. melo.* Studies carried out in South Korea confirmed the high susceptibility of melon, watermelon and cucumber to *M. cannonballus* (18); and susceptibility of melon was confirmed by recent studies conducted in Iran (33, 34). Strategies for managing MRRVD based on the development of *Monosporascus*-resistant cultivars have been conducted in occupied Palestine (15), Spain (16, 17, 31) and Iran (33). Significant progress toward this goal has occurred, but the results have not yet been highly successful (14).

The early, rapid, and accurate identification and quantification of *M. cannonballus* on plant roots is essential for breeding programs and to optimize strategies for disease management (30). Current methods for MRRVD assessment involve the visual scoring of root lesion severity coupled with the measurement of root biomass reduction in comparison with healthy plants (15, 16, 17). Since *M. cannonballus* ascospore germination is rare under standard laboratory conditions, active cultures of the fungus grown in a sand/oat hull medium have been used for artificial inoculations, with inoculum density determined by the enumeration of colony-forming units (CFUs) (1, 2, 5, 7, 11, 32, 34). Nevertheless, this makes artificial inoculation laborious and difficult.

Cucurbit grafting has emerged as one of the most promising strategies for managing MRRVD worldwide (13, 21, 24), but further research is needed to evaluate *Cucurbita* hybrids suitable for watermelon grafting, because the current knowledge of the response of *Cucurbita* accessions to *M. cannonballus* is limited (14). Thus, the objectives of this study were to (i) develop a test to screen for resistance of *Cucurbita* hybrid rootstocks to *M. cannonballus*, and (ii) to evaluate MRRVD resistance of eight *Cucurbita* hybrid rootstocks used for watermelon grafting.

MATERIALS AND METHODS

Isolates of *M. cannonballus*.

Two isolates of *M. cannonballus,* MT2 and MT7, obtained from diseased watermelon plants collected from Achraoui and Ouled Elaibidi, respectively, in the Kairouan region of Tunisia, were used in this study. All isolates were hyphal-tipped and stored at 25°C in darkness in plastic vials containing sterilized peat (Gramoflor GmbH & Co., Vechta, Germany). Prior to use, a small portion of the colonized peat from each plastic vial was transferred to potato dextrose agar (PDA) (Biokar-Diagnostics, Zac de Ther, France).

Inoculum density-disease severity relationship.

Each isolate of *M. cannonballus* (MT2 or MT7) was grown on sterilized medium composed of wheat seeds. For inoculum preparation, wheat seeds were soaked for 12 h in distilled water and then air dried. Seeds were transferred to 1 liter flasks, which were subsequently autoclaved on three successive days at 120°C for 1 h. Two agar plugs (1 cm diameter) of each fungal culture, grown on PDA for 6 days at 26°C, was used for inoculation of each separate flask. Flasks were incubated at 28°C for 4 weeks until complete colonization of wheat seeds by the pathogen. Flasks were shaken manually once a week to avoid clustering of inoculum.

Pre-germinated seeds of watermelon (*Citrullus lanatus*), cv. Charleston gray, were sown (five seeds/pot) in 2 liter pots containing inoculated substrate (peat + fungal inoculum). Five inoculum densities (ID) were evaluated: 0, 50, 100, 150, 200 and 250 g of each fungal inoculum/kg of peat, respectively. The experimental protocol was a completely randomized design with 15 plants per treatment and per essay. A treatment consisting of 150 g of non-inoculated sterile wheat seeds/kg of peat was included as a control. Plants were grown in a greenhouse for two months. The average air temperature during the experiment was about 27°C. The pots were spaced apart and plants were watered daily carefully to prevent soil splashing. No fertilizers were applied. The whole experiment was repeated twice.

At the end of the experiment, plants were carefully removed from each pot, and the root system was gently washed in tap water. Disease severity of Monosporascus root rot was evaluated using a root disease index (RDI) which is an adapted scale from Aegerter *et al.* (1), where 0 = No symptoms; 1 = lesions covering less than 10% of the root system; 2 = rot of secondary roots or lesions covering approximately 25% of the root system; 3 = lesions covering more than 50% of the root system and dead secondary roots; and 4 = more than 50% of the root are rotted. In addition, plant height (PH), shoot and root fresh (SFW and RFW, respectively) and dry weights (SDW and RDW, respectively) were also measured. The shoot and root dry weights were noted after drying watermelon plants at 70°C for 2 days.

Pathogenicity of *M. cannonballus* on cucurbits.

To validate the inoculation method on other cucurbits, pathogenicity tests, using 200 g of infected wheat seeds/kg of peat, were conducted with three cucurbit species: Armenian cucumber, snake melon or Fakous (*Cucumis melo* var. *flexuosus*), muskmelon, cvs. Flamengo and Dziria (*Cucumis melo*), watermelon, cv. Charleston gray (*Citrullus lanatus*), and two *Cucurbita maxima* x *Cucurbita moschata* rootstocks (cvs. Strongtoza and Emphasis). The inoculated substrate was distributed into pots (25 cm diameter). Pre-germinated seeds of the tested cucurbit species and rootstocks were planted separately (one plant per pot). Plants were grown in a greenhouse for 2 months as previously described. A quantity of 200 g of wheat seeds/kg of peat was included as a negative control for each host. The experimental protocol was a completely randomized design with ten plants per treatment and was repeated twice.

At the end of the experiment, the plants were carefully removed from the pots, and the root systems were gently washed in tap water. Each root system was rated for the severity of *M.*

cannonballus lesions using the 0 to 4 RDI scale described above. Other variables were measured to estimate the response of the cucurbits to *M. cannonballs* infection including plant height (PH) and the shoot fresh and dry weights (SFW and SDW, respectively).

Evaluation of *Cucurbita* hybrid rootstocks for resistance to *M. cannonballus*.

Eight *Cucurbita maxima* x *C. moschata* rootstocks commonly used for grafting watermelons were screened for their reaction to *M. cannonballus* (isolate MT2) in a greenhouse experiment. Five pre-germinated seeds of cvs. Argentario, Carnivor F1, Citrus F1, Emphasis, Fantasia, Kazuko F1, Nimbus, and Strongtoza were transplanted into individual 2 liter pots filled with peat inoculated with *M. cannonballus* (inoculum density of 200 g/kg of peat). Preparation of inoculum and inoculation of pre-germinated seeds of rootstocks were performed as described in the previous experiment. Two hundred g of sterile wheat seeds fungus free/kg of peat was included as non-inoculated control. Ten plants per treatment were arranged in a completely randomized design. The experiment was repeated twice. Plants were evaluated 2 months after planting using the same variables described (3).

Data analyses

In the inoculum density-disease severity relationship experiment, the RDI was analyzed with the GENMOD procedure using the multinomial distribution and the cumulative logit as link function, and means of the values were separated by χ^2 test at $P < 0.05$ using SAS program (SAS Institute, Cary, NG). The other variables: PH, SFW, SDW, RFW and RDW, were compared by analysis of variance (ANOVA) and means of the values were separated with Student´s least significant difference test at $P < 0.05$ using SPSS 12.0 for Windows (SPSS Inc., Chicago, IL, USA). Correlations among RDI and each of the other variables (PH, SFW, SDW, RFW and RDW) were analyzed using SPSS. In cucurbit and rootstock inoculation experiments, the RDI was also analyzed with the GENMOD procedure, and the reduction rate in PH, SFW and SDW relative to the controls was used to compare individual cucurbit species and rootstocks by ANOVA.

RESULTS

Inoculum density-disease severity relationship.

Data presented in Table 1 indicated that all inoculum densities of each *M. cannonballus* isolate tested at 50, 100, 150, 200, and 250 g/kg of peat induced root rot symptoms on watermelon plants whereas the control plants were symptomless. In addition, all inoculum densities of each *M. cannonballus* isolate tested significantly reduced all growth parameters i.e., plant height, fresh and dry weights of shoot and the root system. No significant differences were noted between both pathogen isolates concerning the effects of the different inoculum densities tested on root rot disease severity and their subsequent impact on growth parameters. On the other hand, the other parameters decreased with increasing inoculum density and the difference between the effects of all inoculum levels were significant. For the highest inoculum densities (150, 200 and 250 g/kg peat) there were no significant differences in all variables among *M. cannonballus* isolates (Table 1).

Table 1. Pathogenicity test of *Monosporascus cannonballus* isolates on watermelon, cv. Charleston gray, plants

Inoculum Density (g/kg peat)	Root Disease Index	Plant Height (cm)	Shoot Fresh Weight (g)	Root Fresh Weight (g)	Shoot Dry Weight (g)	Root Dry Weight (g)
Control	0.00 ± 0.00d	116.43 ± 3.20a	40.61 ± 6.80a	4.27 ± 1.05a	4.02 ± 0.57a	0.57 ± 0.13 a
			Isolate MT2			
50	0.87 ± 0.63 c	102.85 ± 4.66 a	23.39 ± 2.58 a	1.55 ± 0.42 a	1.6 ± 0.46 a	0.23 ± 0.04 a
100	1.03 ± 0.56 bc	101.03 ± 6.37 ab	21.69 ± 2.64b	1.54 ± 0.48 a	1.39 ± 0.35 b	0.21 ± 0.04 b
150	1.27 ± 0.45 ab	100.17 ± 7.18 abc	20.7 ± 2.62 bc	1.45 ± 0.33 abc	1.26 ± 0.24 bc	0.2 ± 0.04 bc
200	1.40 ± 0.62 a	97.74 ± 10.59 bcd	19.77 ± 3.84 c	1.34 ± 0.41 bcd	1.18 ± 0.21 c	0.18 ± 0.04 cd
250	1.43 ± 0.57 a	97.68 ± 8.95 bcd	19.76 ± 3.26 c	1.34 ± 0.32 bcd	1.18 ± 0.21 c	0.17 ± 0.05 d
			Isolate MT7			
50	0.90 ± 0.61 c	102.50 ± 6.34 a	21.97 ± 1.92 ab	1.50 ± 0.48 ab	1.55 ± 0.49 a	0.21 ± 0.04 ab
100	1.03 ± 0.56 bc	101.67 ± 7.57 ab	21.80 ± 2.51 b	1.49 ± 0.39 abc	1.39 ± 0.36 b	0.21 ± 0.03 ab
150	1.30 ± 0.47 ab	98.40 ± 8.92 abc	20.57 ± 2.88 bc	1.30 ± 0.22 cd	1.25 ± 0.18 bc	0.20 ± 0.03 bc
200	1.40 ± 0.62 a	96.37 ± 10.53 cd	19.34 ± 2.92 c	1.24 ± 0.29 d	1.16 ± 0.23 c	0.18 ± 0.04 cd
250	1.43 ± 0.57 a	93.60 ± 13.58 d	19.34 ± 2.56 c	1.24 ± 0.24 d	1.16 ± 0.20 c	0.18 ± 0.05 cd
P values	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000

* Apart the Root Disease Index, means ± standard error in a each column followed by the same letter are not significantly different according to Student´s Least Significant Difference test at $P < 0.05$ for each separately analyzed isolate.
* For Root Disease Index, means ± standard error in the column followed by the same letter are not significantly different according to χ^2 test at $P < 0.05$ for each separately analyzed isolate.

RDI induced by both *M. cannonballus* isolates was significantly correlated with PH (r = -0.90 and r = -0.88, for isolates MT2 and MT7, respectively), SFW (r = -0.8 and -0.78, for isolates MT2 and MT7, respectively) and SDW (P<0.05) (r = -0.77 and -0.78, for isolates MT2 and MT7, respectively) (Table 2). However, no significant correlations were found between RDI and RFW or RDW.

Pathogenicity of *M. cannonballus* on cucurbits.

There was a significant effect of *M. cannonballus* inoculation on all plant growth parameters (Table 3). The lowest RDI was recorded on the two *Cucurbita* rootstocks, being (mean ± standard error) 0.4 ± 0.51 and 0.67 ± 0.72 for cvs. Strongtoza and Emphasis, respectively, with no significant differences between them. The highest RDI was observed for watermelon (3.27 ± 0.46) which was significantly higher than all the other cucurbits. PH reduction values ranged from 28.69 ± 1.47% for the *Cucurbita* rootstock cv. Emphasis to 68.54 ± 1.98% for the watermelon (Table 3). Regarding the reduction in shoot biomass, SFW values ranged from 45.26 ± 1.31% for the *Cucurbita* rootstock cv. Strongtoza to 89.25 ± 1.45% for watermelon, while SDW values ranged from 29.59 ± 1.54% for the *Cucurbita* rootstock cv. Emphasis to 69.66 ± 1.55% for watermelon.

Table 2. Pearson´s correlation coefficient between Root Disease Index and the variables used to assess the effect of five inoculum densities of *Monosporascus cannonballus* (isolates MT2 and MT7) on watermelon, cv. Charleston gray growth

Variable	PH (cm)	SFW (g)	RFW (g)	SDW (g)	RDW (g)
RDI (MT2)	-0.90*	-0.80*	-0.75	-0.77*	-0.73
RDI (MT7)	-0.88*	-0.78*	-0.74	-0.78*	-0.72

* PH: Plant height of the plant (cm), SFW: Shoot fresh weight of the plant (g), RFW: Root fresh weight of the plant (g), SDW: Shoot dry weight of the plant (g), RDW: the root dry weight of the plant (g), RDI is the Root disease index.

Table 3. Pathogenicity of *Monosporascus cannonballus* (MT2 isolate) on different cucurbit plants

Cucurbit species	Root Disease Index	Plant height Reduction (%)	Shoot Fresh Weight Reduction (%)	Shoot Dry Weight Reduction (%)
Armenian cucumber (Fakkous)	2.13 ± 0.64 bc	50.53 ± 1.11 b	72.4 ± 1.85 b	44.32 ± 1.09 c
Muskmelon (cv. Flamengo)	1.87 ± 0.83 bcd	60.63 ± 1.27 a	70.11 ± 1.83 b	37.13 ± 1.66 cd
Muskmelon (cv. Dziria)	2.00 ± 0.65 bcde	43.89 ± 1.26 bc	59.87 ± 0.94 bc	59.03 ± 1.14 b
***Cucurbita* rootstock (cv. Strongtoza)**	0.40 ± 0.51 e	40.07 ± 1.65 c	45.26 ± 1.31 d	59.24 ± 1.77 b
***Cucurbita* rootstock (cv. Emphasis)**	0.67 ± 0.72 e	28.69 ± 1.47 d	47.91 ± 1.73 cd	29.59 ± 1.54 d
Watermelon (cv. Charleston gray)	3.27 ± 0.46 a	68.54 ± 1.98 a	89.25 ± 1.45 a	69.66 ± 1.55 a

* Apart the Root Disease Index, means ± standard error in a each column followed by the same letter are not significantly different according to Student´s Least Significant Difference test at $P < 0.05$.
* For Root Disease Index, means ± standard error in the column followed by the same letter are not significantly different according to χ^2 test at $P < 0.05$.

Evaluation of *Cucurbita* hybrid rootstocks for resistance to *M. cannonballus*.

There was a significant effect of *M. cannonballus* inoculation on all studied variables, with the exception of the RDI values, which ranged from 1.4 ± 0.52 for cv. Kasuko F1 to 3.40 ± 0.52 for cv. Argentario (Table 4). Results of PH reduction (compared to control) ranged from 45.30 ± 1.09% for cv. Fantasia to 61.39 ± 1.01% for cv. Argentario. Regarding the SFW reduction values of the rootstocks, cvs. Nimbus and Emphasis, showed the lowest values (25.88 ± 1.96% and 30.91 ± 1.22%, respectively), and the highest value was recorded with cv. Argentario (62.95 ± 1.64%). For SDW reduction rate, the lowest value corresponded to the cv. Citrus F1 (31.52 ± 1.12%) and the highest value corresponded to cv. Argentario (66.67 ± 1.28%).

Table 4. Evaluation of eight *Cucurbita maxima* x *Cucurbita moschata* rootstocks for resistance to *Monosporascus cannonballus* using MT2 isolate

Rootstocks cv.	Root Disease Index	Plant Height Reduction (%)	Shoot Fresh Weight Reduction (%)	Shoot Dry Weight Reduction (%)
Argentario	3.40 ± 0.52 [a] *	61.39 ± 1.01 a[3]	62.95 ± 1.64 a	66.67 ± 1.28 a
Carnivor F1	1.60 ± 0.52 a	60.49 ± 1.23 a	56.51 ± 1.31 a	56.84 ± 1.07 ab
Citrus F1	1.60 ± 0.52 a	56.75 ± 1.92 a	36.05 ± 1.79 bc	31.52 ± 1.12 c
Emphasis	3.20 ± 0.79 a	58.01 ± 1.45 a	30.91 ± 1.22 c	50.03 ± 1.03 abc
Fantasia	2.00 ± 1.05 a	45.30 ± 1.09 ab	40.37 ± 1.67 bc	50.24 ± 1.19 abc
Kazuko F1	1.40 ± 0.52 a	60.66 ± 1.09 a	61.19 ± 1.35 a	48.09 ± 1.93 abc
Nimbus	2.20 ± 0.42 a	54.22 ± 1.45 ab	25.88 ± 1.96 c	43.96 ± 1.99 bc
Strongtoza	2.20 ± 0.42 a	53.06 ± 1.83 ab	48.51 ± 1.22 ab	46.79 ± 1.50 bc

* Apart the Root Disease Index, means ± standard error in an each column followed by the same letter are not significantly different according to Student´s Least Significant Difference test at $P < 0.05$.

* For Root Disease Index, means ± standard error in the column followed by the same letter are not significantly different according to χ^2 test at $P < 0.05$.

DISCUSSION

Monosporascus root rot and vine decline occurred on muskmelon, watermelon, and other cucurbits worldwide and in Tunisia (1, 4, 6, 20, 23, 33). There were significant differences in root disease severity among the five inoculum densities of *M. cannonballus* tested on watermelon when compared with the non-inoculated plants. Low inoculum density levels significantly reduced plant height, and fresh and dry shoot weights of watermelon plants. These reductions were stabilized at the highest levels of inoculum densities, without significant differences among them. A similar result was obtained by Andrade *et al.* (2) who showed that on muskmelon plants, *M. cannonballus* densities from 10 to 20 CFU/g soil produced levels of disease severity from 68.7 to 74.0% and 48.4 to 51.9%, respectively, while densities from 20 to 50 CFU/g soil did not cause substantial increases in disease severity and biomass reduction. Root disease severity was positively correlated with a reduction of plant height and fresh and dry shoot weights, hence these variables were most useful for assessing MRRVD severity. A reduction of biomass after inoculation of muskmelon plants with *M. cannonballus* was reported by Merteley *et al.* (28) and Lovic *et al.* (25). Similar results were reported by Iglesias *et al.* (19) who studied the pathogenicity of *M. cannonballus* in the field and in vitro screening of *Cucumis melo* genotypes. They reported that *M. cannonballus* root severity indices were highly correlated with the aboveground disease symptoms. Thus, vine decline severity along with root damage provided a good assessment of resistance. Crosby *et al.* (15) and Dias *et al.* (16) also used a visual assessment of root disease severity and root biomass reduction for determining disease severity. Bienacki and Bruton (7) evaluated 26 plant traits for their ability to reliably reflect plant damage on muskmelon inoculated with root rot pathogens. They found that growth characteristics, such as biomass and plant height, may assist in the evaluation of the root disease caused by *M. cannonballus*.

Based on the inoculum density experiment, 200 g of inoculum/kg of peat was chosen for the various cucurbit hosts.

Characteristic symptoms of MRRVD were reproduced, and the range of responses to *M. cannonballus* corresponded with those reported by previous research (20, 22, 23, 29). Watermelon was very susceptible to the pathogen, while *Cucurbita* hybrid rootstocks cvs. Strongtoza and Emphasis were the most resistant. Merteley *et al.* (29), Kyoun *et al.* (22), Infantino *et al.* (20) and Lin *et al.* (23) reported similar responses on the majority of tested cucurbit species. Namely cucumber, squash (*Cucurbita pepo*, *C. moschata* and *C. maxima*), gourd (*Lagenaria siceraria*) and *Luffae gyptiaca* were always the most tolerant to MRRVD.

Our results showed that, in addition to cvs. Strongtoza and Emphasis, which are widely used in Tunisia to control Fusarium wilt of watermelon (9, 10), the other *Cucurbita* hybrid rootstocks showed a similar response. However, the reductions of plant height, and the shoot fresh and dry weights indicated that they are not completely resistant to the pathogen. The results of this study provided useful information to improve the inoculation methods used to evaluate sources of resistance to *M. cannonballus*. Identifying and deploying durable resistance to this pathogen is a major MRRVD management goal (14). This may be increasingly important for breeding programs in countries like Brazil, Spain and Tunisia, where continuous growth of melon and watermelon have led to increased levels of *M. cannonballus* in the soil (6, 8, 27).

Cucurbit grafting has been viewed as a mechanism to limit crop losses from soilborne diseases. Thus, *C. maxima* x *C. moschata* rootstocks provided the best results (12, 24). Nevertheless, all the *Cucurbita* hybrid rootstocks evaluated here were affected by *M. cannonballus*, thus suggesting that cucurbit grafting alone is not the most efficient solution to MRRVD because the pathogen population can still increase gradually in the soil and, once it reaches a certain level, grafted plants might lose their effectiveness (12). An integrated management program combining techniques including crop rotation, chemical, biological and other control measures (14) would ensure satisfactory disease suppression in cucurbit production. One of the major objectives of this study was to develop a test to screen for resistance of *Cucurbita* hybrid rootstocks to *M. cannonballus*.

RESUME

Ben Salem I., Armengol J., Berbegel M. et Boughalleb-M'Hamdi N. 2015. Développement d'un test de criblage de la résistance des Cucurbitacées et des porte-greffes hybrides du genre *Cucurbita* à *Monosporascus cannonballus*. Tunisian Journal of Plant Protection 10: 23-33.

Un test de criblage de la résistance des plants de cucurbitacées à *Monosporascus cannonballus*, responsable du dépérissement a été développé. Deux isolats ont été cultivés sur des grains de blé et ont servi pour le test de la pathogénie sur la pastèque (cv. Charleston gray) selon 5 densités d'inoculum (50, 100, 150, 200 et 250 g de grains de blé infectés/kg de tourbe). La sévérité de la maladie a été évaluée selon un indice de maladie racinaire (RDI), la hauteur de la plante (HP), les poids frais (SFW et RFW) et secs (SDW et RDW) des parties aérienne et racinaire. Une différence significative a été notée selon l'indice RDI entre les 5 densités d'inoculum par rapport au témoin, et une corrélation négative avec la réduction des paramètres HP, SDW et RDW a été obtenue. Les tests de pathogénie sur trois espèces de cucurbitacées: concombre arménien (Fakous), melon (cvs. Flamengo et Dziria), pastèque (cv. Charleston gris) et deux porte-greffes *Cucurbita maxima* x *C. moschata* (cvs. Strongtoza et

Emphasis), ont été effectuées à la densité de 200 g d'inoculum/kg de tourbe. Les symptômes caractéristiques de la maladie ont été reproduits et la gamme des réponses à *M. cannonballus* correspondaient à ceux rapportés dans la littérature. La pastèque s’est montrée sensible à cet agent pathogène, tandis que les porte-greffes hybrides du genre *Cucurbita* étaient les plus tolérants. Un autre essai de la résistance à *M. cannonballus* a été réalisé sur huit porte-greffes hybrides du genre *Cucurbita* en culture sous serre avec 200 g d’inoculum/kg de tourbe. Tous les porte-greffes paraissent réagir de la même façon concernant l’indice RDI et des différences non significatives pour les autres paramètres évalués ont été notées.

Mots clés: Dépérissement des cucurbitacées à *Monosporascus*, pathogènes telluriques, pathogénie, porte-greffes

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ملخص

بن سالم، ابتسام وجوزيب ارمنجول ومونكا باربجل ونعيمة بوغلاب-محمدي. 2015. تطوير طريقة اختبار مقاومة القرعيات وحوامل طعوم هجينة من الجنس *Cucurbita* ضد *Monosporascus cannonballus*.
Tunisian Journal of Plant Protection 10: 23-33.

تم تطوير تجربة لفحص اختبار مقاومة القرعيات لفطر *Monosporascus cannonballus* المتسبب في مرض تعفن الجذور. وقع استعمال عزلتين من هذا الفطر تم إنماؤهما على حب القمح واستخدمت في اختبار إمراض البطيخ الأحمر (الدلاع) (cv. Charleston gray) باعتماد خمس درجات لكثافة اللقاح (50 و 100 و 150 و 200 و 250 غرام من حب القمح المصاب/كغ من الجفت). قيمت خطورة المرض باعتماد مؤشر مرض الجذور (RDI) وارتفاع النبات (HP) والوزن الطازج (SFW وRFW) والوزن الجاف (SDW وRDW) من الأجزاء الهوائية والجذور. ولوحظ وجود فرق معنوي وفقا لمؤشر RDI بين الكثافات الخمسة مقارنة بالشاهد، تتناسب عكسيا مع المؤشرات HP، RDW وSDW. بالإضافة إلى ذلك، اختبرنا إمراض ثلاثة أنواع من القرعيات بكثافة 200 غرام من اللقاح/كغ الجفت: الخيار الأرمني (فقّوس) والبطيخ (cv. Flamengo و cv. Dziria) والبطيخ الأحمر (cv. Charleston gray) وحامليْ طعوم من تهجين *Cucurbita maxima* x *C. moschata* (cv. Strongtoza و cv. Emphasis). لاحظنا الأعراض المميزة لمرض تعفن الجذور وسلسلة التفاعلات ضد *M. cannonballus* التي تتفق مع ما ورد في الدراسات السابقة. وقد كان البطيخ الأحمر الأكثر حساسية للمرض، في حين كان حامليْ الطعوم الهجينيْن من جنس *Cucurbita* الأكثر تحملا. وتم إجراء اختبار آخر لدراسة مقاومة ثمانية حوامل طعوم من جنس *Cucurbita* في زراعة البيوت الحامية البلاستيكية بكثافة 200 غرام من اللقاح/كغ الجفت، فأظهرت جميعها تفاعلا مماثلا بالنسبة إلى مؤشر RDI، مع غياب فروق معنوية بين المؤشرات الأخرى.

كلمات مفتاحية: تدهور القرعيات الناتج عن *Monosporascus*، حوامل الطعوم، فطريات أرضية، قدرة إمراضية

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