ISSN 0100-2945 http://dx.doi.org/10.1590/0100-29452017441

CERATOCYSTIS WILT IN 'UBÁ' AND 'DURA' MANGO TREES UNDER WATER DEFICIT[1]

SAULO DAVID REZENDE DA SILVA[2], DALMO LOPES DE SIQUEIRA[3], LUIS CARLOS CHAMHUM SALOMÃO[4], PAULO ROBERTO CECON[5], ACELINO COUTO ALFENAS[6]

ABSTRACT –The occurrence of water stress in mango trees grown in orchards located in semi-arid climates in Brazil is frequent. Water stress caused to plants may predispose them to the incidence of fungal diseases. The aim of this study was to evaluate the effect of water deficit on the incidence and severity of Ceratocystis wilt in mango trees considered resistant. Seedlings of 'Ubá' and 'Dura' were kept in pots and submitted to different water stress levels and inoculated with *Ceratocystis fimbriata* isolate (CEBS15). Mortality was low in 'Ubá' plants and high in 'Dura' plants. 'Ubá' plants showed lower severity and lesion length. In 'Ubá' plants, water deficit influenced the increase in lesion length. 'Dura' plants showed greater severity and lesion length, which were not affected by increasing water stress. It was concluded that 'Ubá' variety is resistant to fungus *Ceratocystis fimbriata*, even in severe drought conditions, while 'Dura' variety was not resistant to CEBS15 isolate, even under optimum irrigation conditions.
Index terms: *Mangifera indica*, *Ceratocystis fimbriata*, stress.

MURCHA-DE-CERATOCYSTIS NAS MANGUEIRAS 'UBÁ' E 'DURA' SUBMETIDAS A DÉFICIT HÍDRICO

RESUMO – É comum a ocorrência de estresse hídrico em mangueiras cultivadas em pomares situados em regiões de clima semiárido no Brasil. O estresse causado às plantas pode predispô-las à incidência de doenças fúngicas. O objetivo deste estudo foi avaliar o efeito do déficit hídrico na incidência e severidade da Murcha-de-Ceratocystis em cultivares de mangueiras consideradas resistentes. Mudas das mangueiras 'Ubá' e 'Dura' foram mantidas em vasos e submetidas a diferentes níveis de estresse hídrico e inoculadas com o isolado (CEBS15) de *Ceratocystis fimbriata*. A mortalidade das plantas foi baixa na 'Ubá' e alta na 'Dura'. 'Ubá' apresentou menores valores de severidade e comprimento de lesão. Na 'Ubá', o déficit hídrico influenciou no aumento do comprimento da lesão. A 'Dura' apresentou maior severidade e comprimento de lesão, que não foram influenciados pelo aumento de déficit hídrico. Concluiu-se que a 'Ubá' é resistente ao fungo *Ceratocystis fimbriata*, mesmo em condições de déficit hídrico severo, enquanto a 'Dura' não foi resistente ao isolado CEBS15, mesmo em condições ótimas de irrigação.
Termos para indexação: *Mangifera indica*, *Ceratocystis fimbriata*, estresse hídrico.

[1](Paper 048-16). Received March 22, 2016. Acepted November 21, 2016.
[2]Agronomist, MSc. UFV. Plant Technology, Viçosa-MG, CEP 36570-000. Email: saulodavid@gmail.com
[3]Agronomist, DS. UFV. Associate Professor. Department of Plant Science, Viçosa- MG, 36570-000. CNPq researcher. E-mail: siqueira@ufv.br
[4]Agronomist, PhD, Prof. UFV. Department of Plant Science, Viçosa-MG , CEP: 36570-000. CNPq researcher. E-mail: lsalomao@ufv.br
[5]Agronomist. PhD. Department of Informatics, CEP: 36570-000, Viçosa-MG. CNPq researcher. E-mail: cecon@dpi.ufv.br
[6]Forest Engineer. PhD. Department of Plant Science /Bioagro, Universitário Campus, 36570-900, Viçosa, MG, Brazil. E-mail: aalfenas@ufv.br

INTRODUCTION

In locations with semi-arid climate such as northern state of Minas Gerais and the northeastern region of Brazil, the occurrence of water deficit in mango orchards is quite common, even with the use of irrigation.

Pimentel (2004) and Martins (2008) consider water deficit and salinity as the main sources of abiotic stress affecting plant production and development. According to Zambolim and Junqueira (2004), there are several sources of abiotic stress that predispose mango tree to diseases, being climate and the use of susceptible rootstock, some of them. For Waller (2013), unfavorable climatic factors can favor the primary attack of pests and pathogens and reduce resistance, making them more vulnerable to secondary attack, such as fungal diseases. Some authors have demonstrated this correlation in several cultures (SCHOENEWEISS, 1981; RISTAINO; DUNIWAY, 1989; VIDA et al., 2004; DESPREZ-LOUSTAU et al., 2006). In contrast, other authors have demonstrated the opposite (JACOBI; RIFFLE, 1989; SWART et al., 1992; MAUCH-MANI; MAUCH, 2005); therefore the environmental effect on the incidence of fungal diseases varies according to disease and climate.

As there is no fungicide registered and efficient for the control of the ceratocystis wilt agent caused by fungus *Ceratocystis fimbriata*, the most recommended control measure is the use of resistant cultivars, such as ‘Ubá’, ‘IAC 104 Dura’, ‘Kent’, ‘Manga D’água’ (ROSSETTO et al., 1996; RIBEIRO et al., 1998; TAVARES, 2004) or tolerant, such as ‘Rosa’, ‘Sabina’, ‘São Quirino’, ‘Oliveira Neto’, ‘Espada’, ‘Jasmim’, ‘Keitt’, ‘Sensation’, ‘Kent’, ‘Irwin’ and ‘Tommy Atkins’ (TAVARES, 2004). Therefore, in locations where *C. fimbriata* occurs, avoid the use of highly susceptible cultivars, such as ‘Haden’ and ‘Zill’ (ROSSETTO et al., 1996); ‘Coquinho’ and ‘IAC 137’ (GALLI et al., 2011). It is noteworthy that the varietal resistance spectrum for the ceratocystis wilt agent is high and differences in behavior between pathogen and mango cultivars are observed (Rossetti et al., 1996).

In Brazil there are no studies on the interaction between fungi colonizers of vascular tissues and water deficit in mango trees. As in several places in Brazil and in the world, mango orchards are developed in places where there is water deficit and risk of *C. fimbriata* introduction, it is important the understanding of the interaction between mango cultivars resistant to the ceratocystis wilt agent and the development of this disease under water deficit conditions.

Thus, the present work was conducted to evaluate the effect of water deficit on the incidence and severity of ceratocystis wilt in ‘Ubá’ and ‘Dura’ mango trees considered resistant to the disease agent.

MATERIAL AND METHODS

Experiments with ‘Ubá’ and ‘Dura’ were installed using screen on the sides and covered with transparent plastic of 150 microns of thickness, located in the Fruit Growing Sector of the Federal University of Viçosa, Viçosa, MG. Viçosa coordinates are 20°45’14 “S and 42°52’55” W and the altitude is 648 m a.s.l. Both experiments were conducted simultaneously, from December 19, 2012 to March 30, 2013.

‘Haden’ plants, considered to be very susceptible to the ceratocystis wilt agent, were also used in the experiments to confirm the pathogenicity of the fungus and to determine the end of experiments, which occurred after 100% mortality of plants inoculated with *C. fimbritata*. Four ‘Haden’ seedlings were used, one plant per pot, maintained under optimal irrigation conditions.

The values of high, low and average daily air temperatures, expressed in degrees Celsius (°C), and high, low and average daily air relative humidity, expressed as percentage (%) (Figure 1) were recorded inside the screen using a datalogger.

Polyembryonic ‘Ubá’ and ‘Dura’ mango seedlings of approximately one year old, coming from seeds without grafting were used. Seeds of each cultivar were obtained from a single plant to reduce the risk of variability among germinated seedlings. All seedlings were individually grown in polyethylene pots with “Holambra HS Florestal” commercial substrate, based on pinus bark and vermiculite. Pots with 12 L capacity were used, which were filled with substrate until they reached 6.8 kg.

Experiments were conducted using the 4 x 2 factorial scheme and randomized block design (RBD). The factors under study were four levels of water stress and two levels of inoculation with fungus *Ceratocystis fimbriata* (inoculated and non-inoculated). For ‘Ubá’, four replicates were used and for ‘Dura’, three replicates were used. The experimental plot was composed of a pot containing one plant.

Water stress levels were defined as 80%, 60%, 40% and 20% of the pot capacity (Cp), that is, the percentage of water retention by the substrate and pot set, as described by Souza et al. (2000), in the determination of 100% of Cp. The value of 80%

of Cp represented plants kept in pots without water deficit, while value of 20% of Cp represented plants kept in severe water deficit. The set, pot, plant and substrate were weighed daily in a digital scale, model Filizola, in order to replace the evapotranspirated water until reaching the weight value corresponding to the pot capacity defined for treatments.

Ceratocystis fimbriata isolate (CEBS15) was obtained in the Laboratory of Forest Pathology / BIOAGRO - Federal University of Viçosa, MG. Artificial inoculation was performed according to the method of Alfenas and Ferreira (2007), at 60 days after the application of water stress (DAEH) to ‘Ubá’ and ‘Dura’. The same procedure was performed in control plants; however, only the sterilized culture medium disk was inserted and without the presence of the fungus. Non-stressed ‘Haden’ plants were inoculated on the same date, using the same procedure used for ‘Ubá’ and ‘Dura’ inoculation.

Number of dead plants; average number of days between inoculation and plant death (NMDM); lesion length in the bark and wood in the longitudinal direction of the stem (cm); disease severity in the longitudinal direction of the stem, here called linear disease severity (%), and the plant height was measured from the collar to the apex (cm); area of the radial lesion (mm^2), evaluated in the cross section of the stem, performed one centimeter above the inoculation point; radial severity of the lesion, represented by the percentage of the area compromised with the colonization of the fungus in relation to the total area of the radial section were evaluated. Both area and radial severity were obtained through a computerized system for the capture of digital images and an image analyzer, WinDias 2.0 software, which differentiates healthy tissues from diseased tissues.

Leaf water potential (Ψw), expressed in MPa, was obtained using the Scholander pressure chamber (Soil Moisture Equipment Corp USA), using the seventh fully expanded leaf from the apex to the base, collected at 04:00 am. For reading the Ψw, one leaf per plant and one reading per leaf were used. Evaluations were performed at 4, 18 and 32 days after inoculation (DAI).

The stem diameter (DC) was evaluated at 0, 10, 20, 30 and 40 DAI, approximately 40 cm above the collar of plants.

The results were submitted to descriptive statistical analysis with the aid of the Systems for Genetic Statistics Analysis (SAEG) software. The Pearson correlation was used to determine the relationship between variables leaf water potential, stem diameter for the presence or absence of *C. fimbriata* in plants and the severity of longitudinal and radial lesions.

RESULTS AND DISCUSSION

There were no plant deaths in treatments where mango trees were inoculated only with the sterile culture medium disk without the presence of the fungus at any Cp level (Table 1). In ‘Ubá’, the water deficit did not favor the death of inoculated plants. The number of dead plants was low and random for this cultivar. Dead plants were submitted to 20% and 60% of Cp and in both treatments, one plant died in four inoculated, with NMDM of 29 and 36 days, respectively (Table 1). For inoculated ‘Dura’ plants, only those submitted to 60% of Cp did not die. The highest number of dead plants was observed for those maintained at 20% and 80% of Cp, with death of two in three inoculated plants. The NMDM for plants of these treatments were 25 and 24 days, respectively, that is, smaller than those found for ‘Ubá’ (Table 1).

Temperature is one of the main factors interfering in the pathogen-host interaction. Mafia et al. (2011) observed that the highest development of *C. fimbriata* in eucalyptus occurred when the temperature ranged from 18 to 28°C. Oliveira (2010) observed lower severity values in clones of *Eucalyptus spp*. when inoculation was carried out in colder seasons of the year. Figure 1 shows average temperatures during the experimental period ranging from 22 to 28°C, thus favorable to the development of the disease.

As both experiments were carried out at the same time, it could be inferred that ‘Dura’ was more affected by the ceratocystis wilt due to the higher number of dead plants and the lower NMDM, indicating higher susceptibility to the CEBS15 isolate. It was observed in inoculated and non-inoculated ‘Dura’ plants, maintained at 80% of Cp, that there was stress due to excess water, because these plants presented less vigor than plants maintained at 60% of Cp. In this case, 60% of Cp could be considered optimal for ‘Dura’. ‘Dura’ was susceptible to *Ceratocystis* under conditions of water stress (excess or absence of water). The same was observed in other water deficit systems (LEWIS JUNIOR; VAN ARSDEL, 1978; ANSELMI; PUCCINELLI, 1992; BLODGETT et al., 1997a; 1997b).

The genetic variability of the pathogen or host is an important factor to be considered as a source of variation of plant responses to water stress and fungal infection (SCHOENEWEISS, 1986). Species of the same genus may differ in susceptibility to fungi, as observed between 'Ubá' and 'Dura' in this work, where 'Ubá' remained resistant and 'Dura' was susceptible to *Ceratocystis fimbriata*.

Rossetto et al. (1996) observed that 'Ubá' plants were resistant to the IAC FITO 334-1 isolate, with 0% mortality and susceptible to IAC FITO 4905 isolate, with 60% mortality. Galli et al. (2011), using IAC FITO 13.966 and IAC FITO 13.977, *Ceratocystis* isolates found 45% mortality in 'Ubá', characterized as resistant and 15% mortality in 'Dura', considered resistant. The results found in the present work differed from results found by Rossetto et al. (1996) and Galli et al. (2005), probably due to the fact that *C. fimbriata* isolates and water conditions are different and also due to possible genetic differences among 'Ubá' accessions used (ROCHA, 2009).

Severity, length and area of lesions in the longitudinal and radial directions from the point of inoculation with *C. fimbriata*, were evaluated only for treatments whose plants were inoculated, since there was no lesion in the branches of plant of non-inoculated treatments at any Cp level. The severity of the disease caused by *C. fimbriata* in 'Ubá' plants was increasing and linear as the water availability in the substrate decreased, that is, from 80% to 20% of Cp. The same occurred with the lesion length. In this cultivar, the highest severity and the highest lesion lengths occurred in plants submitted to 20% of Cp and were of 21.52 ± 8.08% and 14.83 ± 3.85 cm, respectively (Table 2). The increase in severity and lesion length in plants maintained at 20% of Cp in relation to plants maintained at 80% of Cp was 48.01% and 44.26%, respectively.

On the other hand, for 'Dura', the lowest severity values were found for plants maintained at 20% and 60% of Cp and the highest in 40% and 80% of Cp. Plants in the absence of water deficit (80% of Cp) presented severity of 41.94 ± 26.38% and lesion length of 22.06 ± 9.03 cm. The lowest lesion length was 18.06 ± 2.17cm in plants under 20% of Cp and the highest was 22.60 ± 7.71cm in plants under 40% of Cp (Table 2). There was a 25.14% increase in lesion length only increasing the water availability in the substrate from 20% to 40% of Cp. There was also an increase in the lesion length when it increased from 60% to 80% of Cp.

Comparing the length of lesions obtained in this study with the results of other researchers is difficult due to the genetic differences between cultivars, the different fungal isolates and the environmental conditions prevailing during the conduction of experiments. When 'Kent' plants, considered resistant to *C. fimbriata* were inoculated with different isolates of this fungus, the lesion length was 15.8 cm for IAC FITO 4905 isolate (aggressive for 'Ubá') and 0.9 cm for IAC FITO 334-1 isolate (not aggressive for 'Ubá') (ROSSETTO et al., 1996). In the present study, lesions occurred in plants inoculated with CSEB15 isolate showed lesion length greater than 10 cm, even under conditions considered non-stressing. In the evaluation by Van Wyk et al. (2008), the lesion length caused by 13750 isolate in 'IAC 106 Jasmine' was 4.6 cm.

Regarding the radial severity of lesions in 'Ubá', it was observed that the progression was similar to that occurred with severity in the longitudinal direction, that is, increase of radial severity as Cp decreased. The highest radial severity value was 44.69 ± 6.63% and the lowest was 40.04 ± 5.59%, in plants under 20% and 80% of Cp, respectively (Table 2). The increment of radial severity, from 80% to 20% of Cp, was 11.61%. The radial lesion, however, decreased as Cp increased to 60% and increased from 60% to 80% of Cp (Table 2). The radial severity of 'Dura' plants varied in a similar way to those observed in 'Ubá' plants, with the highest value of 64.53 ± 0.00% found in plants maintained at 20% Cp and the lowest value of 41.97 ± 0.00% in plants maintained at 80% Cp (Table 2). The increase observed for radial severity from 80% to 20% of CP was 53.73%. The behavior of the radial lesion was similar to that found for 'Ubá' plants; however, the lesion area was larger (Table 2).

As for leaf water potential, the greatest reductions occurred in plants inoculated with *C. fimbriata* and submitted to severe water deficit. Among the cultivars tested, the lowest Ψw was found for 'Dura' at 32 DAI (Table 3). Inoculated and non-inoculated 'Ubá' plants maintained at 20% of Cp showed reductions in Ψw from 4 to 18 DAI. Following the 32 DAI, non-inoculated plants showed Ψw increase of 39.66% in relation to the Ψw value measured at 18 DAI. Inoculated plants presented continuous reduction of Ψw, ending at 32 DAI with value of -0.95 ± 0.5 MPa (Table 3). This reduction in Ψw observed in plants inoculated and maintained at 20% of Cp, when compared to non-inoculated plants and maintained without water deficit (80% of Cp), represents a reduction of 46%. At 32 DAI, on average, the Ψw value obtained in all plants, except for plants inoculated and maintained at 20% of Cp, were equal to or greater than -0.65 MPa (Table 3).

In work with 'Cogshall' mango seedlings grafted on 'Maison Rouge', Damour et al. (2009) observed significant reductions in the Ψw value from the first to the second evaluation, that is, after 2.5 months in water deficit, differing from the control. The lowest Ψw value was recorded for plants kept in pots under conditions of water deficit, 2.5 and 3.5 months after water deficit. On these two occasions, the Ψw value was approximately -0.70 ± 0.05 MP. This value was 100% lower than that recorded for the control conditions. After rehydration of these plants, Ψw value returned to values equal to those of the control. The Ψw value of leaves of non-inoculated plants and maintained under water deficit conditions of ‘Ubá’ and ‘Dura’ were similar to those found by Damour et al. (2009). Based on this similarity of results, the differences in the Ψw results found between inoculated and non-inoculated plants maintained under water deficit conditions can be explained by the colonization of sap conducting vessels of cultivars by *C. fimbriata*, leading to the reduction of Ψw to levels below -0.7 MPa (Table 3).

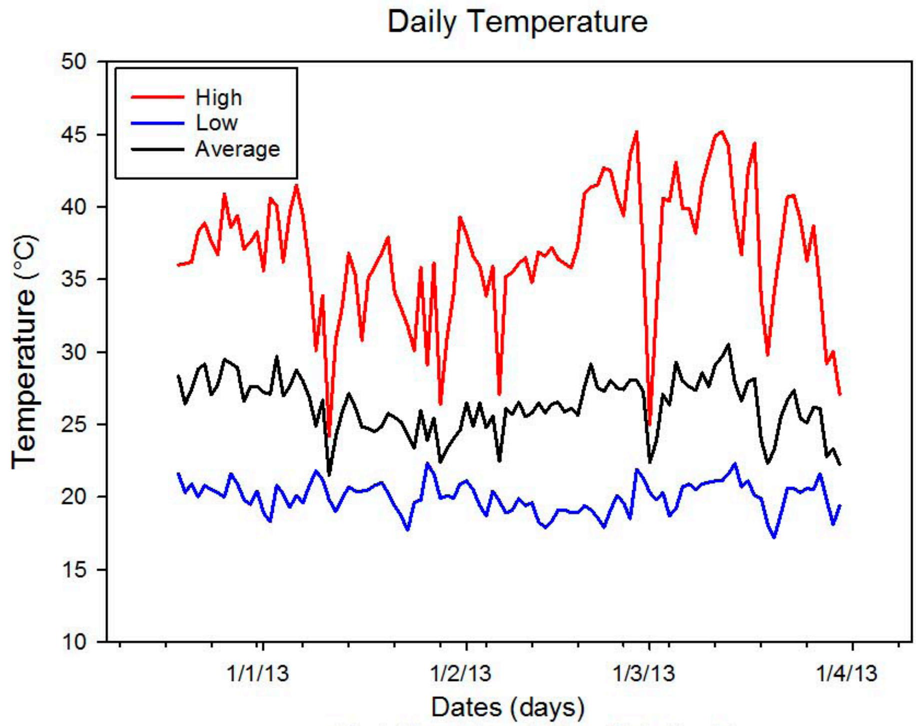
The lower the water potential value, the greater the plant dehydration. In this sense, the radial expansion capacity of the plant stem depends on the amount of water retained in tissues. If young tissues are sufficiently hydrated, there is positive cell pressure in the cell walls, with cell elongation and expansion.

In the stems of ‘Ubá’ plants, there was continuous radial expansion in all treatments, except in inoculated plants submitted to 60% of Cp, in which, at 30 DAI, a retraction of 1.32% in the radial expansion of the stem was observed, going from 7.60 ± 0.49 to 7.50 ± 0.62 mm and remaining at this value until the last evaluation conducted at 40 DAI (Table 4). The lowest increase in the radial expansion of ‘Ubá’ plant stems was observed in inoculated plants maintained at 20% of Cp, increasing from 7.88 ± 1.07 to 8.58 ± 1.04 mm, corresponding to an increase of 8.88% versus 9.73% (*DC* from 7.50 ± 0.12 to 8.23 ± 0.38 mm) of non-inoculated plants of the same Cp. The largest radial expansion occurred in non-inoculated plants maintained at 80% of Cp, with an increase of 18.13% (DC of 8.00 ± 0.63 to 9.45 ± 1.01 mm) (Table 4). The water deficit did not limit the radial expansion of the plant stem; however, it was observed that in all plants inoculated with *C. fimbriata*, there was less radial expansion in relation to their respective controls, maintained at 20%, 40%, 60% and 80% of non-inoculated Cp.

In ‘Dura’ variety, retractions in the radial expansion were observed at 10 DAI in plants inoculated and submitted to 20%, 40% and 80% of Cp, with *DC* reduction of 8.97% (*DC* from 7.36 ± 0.51 for 6.70 ± 0.82 mm), 12.33% (*DC* from 7.30 ± 0.56 for 6.40 ± 2.43 mm) and 12.15% (*DC* from 6.83 ± 1.51 to 6.0 ± 2.91 mm), respectively, up to 30 DAI (Table 4). The lowest radial expansion rate was 4.70% (*DC* from 7.23 ± 2.20 to 7.57 ± 2.08 mm) in inoculated plants submitted to 60% of Cp. The highest DC increment was observed in non-inoculated plants maintained at 80% Cp, from 6.73 ± 1.10 to 7.77 ± 0.78 mm. This increase corresponded to 15.45% of the initial value.

Even under conditions of severe water deficit (20% of Cp), there was a high increase in the radial expansion for non-inoculated plants, from 6.47 ± 0.91 to 7.40 ± 1.47 mm, which represents an increase of 14.37% of the initial value (Figure 6). In general, non-inoculated plants presented continuous radial expansion of the stem, that is, *DC* increased even under conditions of severe water deficit (20% of Cp), demonstrating that the water deficit was not cause of retraction / wilting of stems (Figure 6).

According to Schaffer et al. (2009), the radial expansion of mango trees under water deficit is continuous even under conditions of prolonged drought (period of 8 months). This fact was also demonstrated by Reich and Borchert (1988), who observed a continuous expansion in the diameter of trunks of mango trees under water deficit, whereas in several other species, the stem diameter reduced. In addition, Luvaha et al. (2008) observed that the radial expansion in the stem of mango seedlings was continuous until 42 days after water stress (DAEH), even in severe water deficit conditions, which corroborates data presented in the present investigation and helps concluding that the *DC* reductions observed in this work were not caused by the water deficit but by the action of *C. fimbriata*.



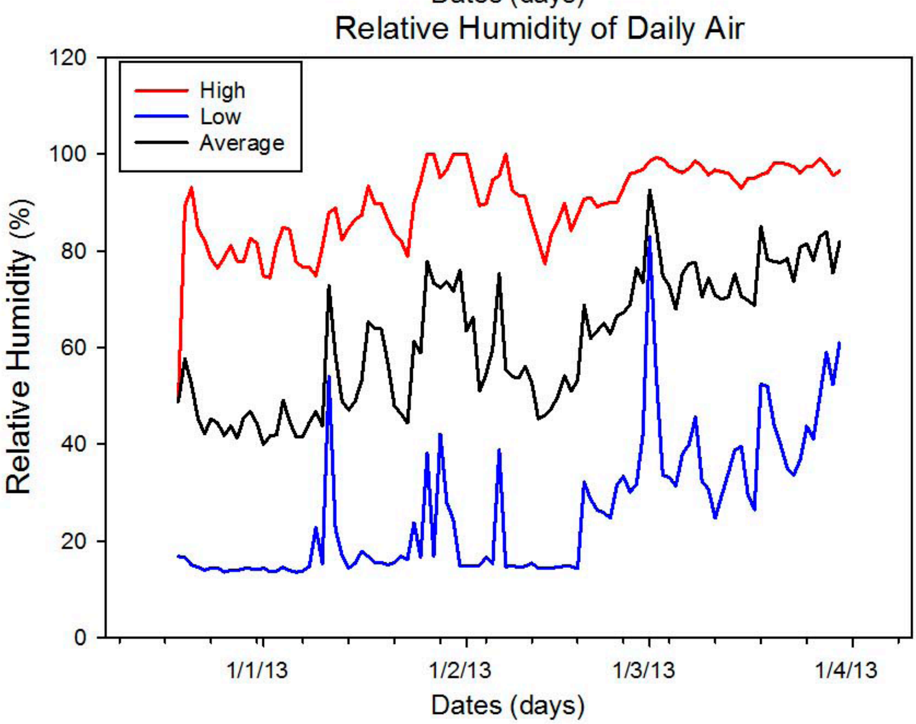


FIGURE 1 - High, low and average daily temperatures (a); high, low and average air relative humidity (b) evaluated from 12/19/2012 to 03/30/2013 at the Fruit Growing Sector of the Federal University of Viçosa, Viçosa - MG.

TABLE 1- Number of dead plants (NM) and average number of days of inoculation to death (NMDM) of 'Ubá' and 'Dura' mango trees grown at the 20, 40, 60 and 80% levels of pot capacity (Cp), in inoculated (S) and non-inoculated (N) plants with fungus *Ceratocystis fimbriata* (CEBS15 isolate) in Viçosa - MG, 2013.

Cp (%)	'Ubá' NM (Nº.)		'Ubá' NMDM (days)		'Dura' NM (Nº.)		'Dura' NMDM (dias)	
	S	N	S	N	S	N	S	N
20	1/4	0	29	0	2/3	0	25	0
40	0	0	0	0	1/3	0	19	0
60	1/4	0	36	0	0	0	0	0
80	0	0	0	0	2/3	0	24	0

TABLE 2-Linear severity of Ceratocystis wilt (SL), radial severity (SR), linear lesion lengths (CLL) and area of radial lesions (ALR) of damaged tissues. The characteristics were measured in 'Ubá' and 'Dura' cultivars cultivated under levels of 20, 40, 60 and 80% of pot capacity (Cp) in plants inoculated with the fungus *Ceratocystis fimbriata* (CEBS15 isolate) in Viçosa-MG , 2013.

Cp (%)	SL (%) rate/deviation	SR (%) rate/deviation	CLL (cm) rate/deviation	ALR (mm²) rate/deviation
		'Ubá'		
20	21.52±8.08	44.68±6.63	14.83±3.85	48.25±2.29
40	17.00±5.07	42.95±6.72	11.41±2.97	34.98±16.11
60	16.28±6.09	40.07±5.06	11.40±4.96	28.35±14.56
80	14.54±6.59	40.04±5.59	10.28±3.74	33.66±18.20
		'Dura'		
20	30.37±7.83	64.52±0.00	18.06±2.17	89.28±0.00
40	40.08±32.04	63.21±26.06	22.60±7.71	57.45±47.13
60	29.80±10.17	56.38±3.90	19.90±4.81	47.00±2.30
80	41.94±26.38	41.97±0.00	22.06±9.03	95.66±0.00

TABLE 3- Leaf water potential (MPa) of 'Ubá' and 'Dura' mango trees cultivated under levels of 20, 40, 60 and 80% of pot capacity (Cp) in plants inoculated (S) and non-inoculated (N) with fungus *Ceratocystis fimbriata* (CEBS15 isolate) in Viçosa-MG, 2013, according to the days after inoculation (DAI).

DAI	20% S	20% N	40% S	40% N	60% S	60% N	80% S	80% N
	rate/deviation	rate/deviation	rate/deviation	rate/deviation	rate/deviation	rate/deviation	rate/deviation	rate/deviation
				'Ubá'				
4	-0,53±0,15	-0,43 ±0,13	-0,65±0,31	-0,60±0,29	-0,65 ±0,19	-0,60±0,22	-0,50±0,29	-0,45 ±0,10
18	-0,65±0,13	-0,58 ±0,17	-0,70±0,20	-0,48±0,15	-0,58 ±0,26	-0,55±0,30	-0,55±0,13	-0,38 ±0,05
32	-0,95±0,50	-0,35 ±0,13	-0,50±0,29	-0,45±0,06	-0,33 ±0,19	-0,43±0,17	-0,38±0,15	-0,65 ±0,19
				'Dura'				
4	-0,77±0,21	-0,70 ±0,30	-0,77±0,21	-0,50±0,17	-0,80 ±0,40	-0,63±0,21	-0,47±0,12	-0,57 ±0,06
18	-1,43±0,15	-0,57 ±0,15	-0,97±1,07	-0,40±0,20	-0,80 ±0,20	-0,43±0,15	-1,77±1,94	-0,60 ±0,20
32	-4,87±1,01	-0,43 ±0,06	-2,07±2,54	-0,50±0,17	-0,80 ±0,20	-0,60±0,20	-2,33±2,44	-0,60 ±0,00

Pot capacity / Inoculation

TABLE 4- Stem diameter (mm) of 'Ubá' and 'Dura' mango trees grown under the levels of 20, 40, 60 and 80% of pot capacity (Cp) in plants inoculated (S) and non-inoculated (N) with fungus *Ceratocystis fimbriat*a (CEBS15 isolate) in Viçosa-MG, 2013, according to the days after inoculation (DAI)

'Ubá'								
Pot capacity								
	20%		40%		60%		80%	
Inoculation								
DAI	S	N	S	N	S	N	S	N
	rate/deviation	rate/deviation	rate/deviation	rate/deviation	rate/deviation	rate/deviation	rate/deviation	rate/deviation
0	7,88± 1,08	7,50± 0,16	7,68± 0,69	7,58± 0,13	7,33 ± 0,33	8,03± 0,39	8,45± 0,62	8,00± 0,63
10	8,33± 1,07	7,70± 0,12	8,10± 1,07	7,90± 0,32	7,43 ± 0,43	8,65± 0,70	8,60± 0,79	8,38± 0,51
20	8,38± 1,16	7,88± 0,22	8,40± 1,01	8,10± 0,26	7,60 ± 0,49	8,85± 0,62	8,83± 0,81	8,58± 0,74
30	8,53± 1,06	8,08± 0,29	8,55± 0,70	8,33± 0,35	7,50 ± 0,62	9,06± 0,59	9,20± 0,52	9,18± 1,02
40	8,58± 1,04	8,23± 0,38	8,70± 0,65	8,63± 0,28	7,50 ± 0,62	9,38± 0,64	9,38± 0,49	9,45± 1,01
'Dura'								
0	7,27± 0,87	6,47± 0,91	7,17± 0,64	7,23± 0,52	7,23± 2,20	7,87± 1,60	6,73± 1,46	6,73± 1,10
10	7,36± 0,51	6,77± 1,00	7,30± 0,56	7,47± 0,42	7,33± 2,11	7,97± 1,46	6,83± 1,51	7,10± 0,85
20	7,23± 0,45	6,97± 1,10	6,70± 1,74	7,67± 0,42	7,43± 2,03	8,00± 1,45	6,57± 2,14	7,33± 0,83
30	6,70± 0,87	7,23± 1,21	6,40± 2,43	7,80± 0,36	7,50± 2,10	8,20± 1,67	5,93± 2,83	7,43± 0,67
40	6,70± 0,87	7,40± 1,47	6,40± 2,43	7,90± 0,26	7,57± 2,08	8,50± 1,83	6,00± 2,91	7,77± 0,78

CONCLUSIONS

Water deficit is not cause of the death of 'Ubá' and 'Dura' plants inoculated with *Ceratocystis fimbriata* CEBS15 isolate.

In 'Ubá' mango trees inoculated with CEBS15 isolate, the water deficit increased the severity and length of lesions; however, plants of this cultivar had the lowest mortality and severity values, showing to be more resistant than 'Dura'.

'Dura' showed high mortality and severity values, both in water deficit conditions and in the absence of water deficit, being considered, in this case, of high susceptibility to *C. fimbriata* CEBS15 isolate.

The greatest reductions in leaf water potential were observed in plants inoculated with CEBS15 isolate and maintained in severe water deficit (20% of pot capacity - Cp).

Although severe water deficit (20% of Cp) did not cause higher mortality in 'Ubá', it gave CEBS 15 isolate favorable conditions for greater vascular damages, promoting stem diameter reduction (*DC*). There was no relationship between water deficit and *DC* reduction for 'Dura' plants, with the exception of inoculated plants maintained under conditions of 60% of Cp, and all inoculated plants showed a decrease in *DC*.

The resistance or susceptibility of 'Ubá' and 'Dura' plants is linked to the genetic diversity between pathogen and host.

ACKNOWLEDGMENTS

To Vale for funding this research and grant of scholarship to the first author.

REFERENCES

ACHUO, E.A.; PRINSEN, E.; HÖFTE, M. Influence of drought, salt stress and abscísico acid on the resistance of tomato to *Botrytis cinerea* and *Oidium neolycopersici*. **Plant Pathology**, Oxford, v.55, 178-186, 2006.

ALFENAS, A. C.; FERREIRA, F. A. Inoculação de fungos fitopatogênicos. In: ALFENAS, A. C.; MAFIA, R. G. **Métodos em fitopatologia**. Viçosa: Ed. UFV, 2007. p.116-137.

ANSELMI, N.; PUCCINELLI, P. Studies on *Armillaria* attacks on declining oak trees. In: LUISI, N.; LERARIO, P.; VANNINI, A. (Ed.). **Recent advances in Studies on oak decline**. Bari: Universita degli Studi, 1992. p.23–29.

BLODGETT, J.T.; KRUGER, E.L.; STANOSZ, G.R. Effects of moderate water stress on disease development by Sphaeropsis sapinea on red pine. **Phytopathology**, Saint Paul, v.87, p.422–428, 1997a.

BLODGETT, J.T.; KRUGER, E.L.; STANOSZ, G.R. *Sphaeropsis sapinea* and water stress in a red pine plantation in central Wisconsin. **Phytopathology**, Saint Paul, v.87, p. 429–434, 1997b.

DAMOUR, G.; VANDAME, M.; URBAN, L. Long-term drought results in a reversible decline in photosynthetic capacity in mango leaves, not just a decrease in stomatal conductance. **Tree Physiology**, Oxford, v.29, p. 675-684, 2009.

DESPREZ-LOUSTAU, M.L.; MARÇAIS, B.;NAGELEISEN, L.M.; PIOU, D.; VANNINI, A. Interactive effects of drought and pathogens in forest trees. **Annals of Forest Science**, Les Ulis, v.63, p.597-612, 2006.

GALLI, J.A.; MARTINS, A.L.; ITO, M.F.; BRAGHINI, M.T.; NARITA, N.; ROSSETTO, C.J. Seca-da-mangueira XXII. Sobrevivência de variedades poliembriônicas. **Revista Brasileira de Fruticultura**, Jaboticabal, v.33, n.4, p.1119-1126, 2011.

JACOBI, W.R.; RIFFLE, J.W. Effects of water stress on Thyronectria canker of honey locusts. **Phytopathology,** Saint Paul, v.79, p.1333–1337, 1989.

LEWIS JUNIOR, R.; VAN ARSDEL, E.P. Vulnerability of water-stressed sycamores to strains of *Botryodiplodia theobromae*. **Plant Disease**, Saint Paul, v.62, p.62–63, 1978.

LUVAHA, E.; NETONDO G.W.; OUMA, G. Effect of water deficit on the physiological and morphological characteristic of mango (*Mangifera indica*) rootstock seedlings. **American Journal of Plant Physiology**, New York, v.3, n.1, p.1-15, 2008.

MAFIA, R.G.; ALFENAS, A.C.; FERREIRA, E.M; BINOTI, D.H.B. Métodos de seleção e identificação de fontes de resistência à murcha do eucalipto causada por *Ceratocystis fimbriata*. **Revista Árvore**, Viçosa, MG, v.35, n.4, p.817-824, 2011.

MARTINS, M. O. **Aspectos fisiológicos do Nim indiano sob déficit hídrico em condições de casa de vegetação.** 2008. 84 f. Dissertação (Mestrado em Botânica) – Universidade Federal de Pernambuco, Fortaleza, 2008.

MAUCH-MANI, B.; MAUCH, F. The role of abscísico acid in plant-pathogen interaction. **Current Opinion in Plant Biology**, London, v.8, p.409-414, 2005.

OLIVEIRA, L.S.S. **Agressividade de isolados de *Ceratocystis fimbriata* em clones de *Eucalyptus* spp**. 2010. 18 f. Dissertação (Mestrado em Fitopatologia) – Universidade Federal de Viçosa, Viçosa, 2010.

PIMENTEL, C. **A relação da planta com a água**. Rio de Janeiro: Seropédica, 2004. 191p.

REICH, P.B.; BORCHERT, R. Changes with leaf age in stomatal function and water status of several tropical tree species. **Biotropica**, Washington, v.20, p.60–69, 1988.

RIBEIRO, I.J.A.; ROSSETTO, C.J.; GALLO, P.B.; BORTOLETTO, N.; SOARES, N.B.; CARVALHO, L.H.; SABINO, J.C.; MARTINS, A.L.M.; SILVEIRA, L.C.P. **Manga**: cultivar IAC 104 'Dura'. Campinas: Instituto Agronômico de Campinas, 1998. Disponível em: <http://www.iac.sp.gov.br/cultivares/inicio/Folders/Manga/IAC104Dura.htm>. Acesso em: 12 dez. 2013.

RISTAINO J.B.; DUNIWAY J.M. Effect of preinoculation and postinoculation water-stress on the severity of *Phytophthora* root rot and yield in processing tomatoes. **Plant Disease**, Saint Paul, v.73, p. 349–52, 1989.

ROCHA, A. **Identificação de embriões zigótico e nucelares de sementes e caracterização agronômica e molecular de acesso de mangueira 'Ubá'.** 2009. 117 f. Tese (Doutorado em Fitotecnia) – Universidade Federal de Viçosa, Viçosa, 2009.

ROSSETTO, C.J.; RIBEIRO, I.J.A.; IGUE, T.; GALLO, P.B. Seca-da-mangueira: XV. Resistência varietal a dois isolados de *Ceratocystis fimbriata*. **Bragantia**, Campinas, v.55, n.1, p. 117-121, 1996.

SCHAFFER, B.; URBAN, L.; LU, P.; WHILEY, A.W. Ecophysiology. In: LITZ, R.E. (Ed.). **The mango**: botany, production and uses. 2^{nd} ed. Preston: CABI, 2009. p.716.

SCHOENEWEISS, D.F. The role of environmental stress in diseases of woody plants. **Plant Disease**, Saint Paul, v. 65, n.4, 1981.

SCHOENEWEISS, D.F. Water stress predisposition to disease, an overview. In: AYRES, P.G.; BODDY, L. (Ed.). **Water, fungi and plants**. Cambridge: Cambridge University Press, 1986. p.157–174.

SOUZA, C.C.; OLIVEIRA, F.A.; SILVA, I.F.; AMORIM NETO, M.S. Avaliação de métodos de determinação de água disponível e manejo da irrigação em terra roxa sob cultivo de algodoeiro herbáceo. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v.4, n.3, p.338-342, 2000.

SWART, W.J.; CONRADIE, E.; WINGFELD M.J.; VENTER, W.B. E□ects of water stress on the development of cambial lesions caused by Cryphonectria cubensis on Eucalyptus grandis. **Plant Disease**, Saint Paul, v.76, p.744–746, 1992.

TAVARES, S.C.C.H. **Cultivo da mangueira**. Manejo integrado de doenças. Petrolina: Embrapa Semiárido, 2004. Disponível em: <http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Manga/CultivodaMangueira/doencas.htm>. Acesso em: 01 jun. 2012.

VAN WYK, M.; ROSSETTO, C.J.; ITO, M.F. BRAGHINI, M.T.; MORAES, S.A.; AL-ADAWI, A.O.; ZUCCHI, M.I.; WINGFIELD, M.J. Seca-da-Mangueira XXI. Posição filogenética do patógeno paulista e suscetibilidade de variedades. In: CONGRESSO BRASILEIRO DE FRUTICULTURA, 20., 2008, Vitória. **Anais...** Vitória: Sociedade Brasileira de Fruticultura, 2008. CD-ROM

VIDA, J.B.; ZAMBOLIM, L.; TESSMANN, D.J.; BRANDÃO-FILHO, J.U.T.; VERZIGNASSI, J.R.; CAIXETA, M.P. Manejo de doenças de plantas em cultivo protegido. **Fitopatologia Brasileira,** Brasília, DF, v.29, p. 355-372, 2004.

WALLER, M. Drought, disease, defoliation and death: forest pathogens as agents of past vegetation change. **Journal of Quaternary Science,** Harlow, v.28, n.4, p. 336-342, 2013.

ZAMBOLIM, L.; JUNQUEIRA, N.T.V. Manejo integrado de doenças da mangueira. In: ROZANE, D.E.; DAREZZO, R.J.; AGUIAR, R.L.; AGUILERA, G.H.A.; ZAMBOLIM, L. **Manga:** produção integrada, industrialização e comercialização. Viçosa: Universidade Federal de Viçosa, Viçosa, 2004. p.604.