ENH1081

UF UNIVERSITY of FLORIDA
IFAS Extension

Host Plant Resistance to *Fusarium* Tuber Rot in Commercial Caladium Cultivars[1]

Z. Deng, N.A. Peres, and B.K. Harbaugh[2]

Introduction

Caladiums (*Caladium* x *hortulanum*) are ornamental aroids widely used in landscapes, especially in the southern United States, and in production of pot plants worldwide. The production of tubers is primarily through propagating pieces of "seed" tubers. Tuber quality is therefore critical for field production of tubers as well as for whole tubers used for landscaping or for production of potted plants in the greenhouse. *Fusarium* tuber rot, caused by *Fusarium solani*, has been the most destructive disease affecting caladium tuber quality and quantity (Knauss, 1975). Over the last decade, this disease has caused a steady decline in tuber yield of many cultivars in Florida and has led in part to the elimination of a number of commercial cultivars (McGovern, 2004). Chemical control of this disease using fungicides has had limited success. Tissue culture has been used to eliminate *Fusarium* from "seed" tubers, resulting in an increase in tuber yield and quality and plant performance, but these beneficial effects may be lost within several years because of natural re-infection when the tissue-culture-derived seed pieces are planted in the field. Identification and utilization of host plant disease resistance has become an important component for integrated management of *Fusarium* tuber rot in caladium. The following studies were conducted to determine if there are any commercial cultivars that possess host plant resistance to *Fusarium* tuber rot (Goktepe et al., 2007).

Identification of Optimal Temperatures to Screen Caladium Tubers for Host Plant Resistance

Temperature has been recognized as an important factor in the development of diseases caused by *Fusarium* spp. Many *Fusarium*-induced diseases are favored by temperatures between 24 and 30°C, probably due to the fact that this temperature range is optimum for mycelial growth of many *Fusarium* species. We examined the effects of temperature (13, 18, 23, 28, or 33°C) on mycelial growth of *F. solani* on agar and the ability of *F. solani* isolates to cause tissue rot in caladium tubers. An isolate is a pure culture produced from an individual organism that has been recovered from the diseased tissue.

1. This document is ENH1081, one of a series of the Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date October 22, 2007. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.
2. Z. Deng, assistant professor; B.K. Harbaugh, professor, Gulf Coast Research and Education Center; N. A. Peres, assistant professor, Plant Pathology Department, Gulf Coast Research and Education Center, Wimauma, FL, Cooperative Extension Service, IFAS, University of Florida, Gainesville 32611.

We determined that the optimal temperature to produce the greatest mycelial growth on agar would be at 30.5°C (Fig. 1). However, when tubers were inoculated with *Fusarium*, lower temperatures (13 or 18°C) were more conducive to disease development, with the largest lesions observed at 13°C (Fig. 2). Tuber tissue texture changed sometimes when tubers were incubated at this temperature. Caladiums are tropical plants and their tubers are sensitive to temperatures below 15°C. The tissue texture change might result from cold damage at 13°C. Thus, 18°C appeared to be a safe temperature to allow rapid disease (tuber rot) progress while not causing cold injury to tubers.

When inoculated tubers were incubated at 25 to 30°C, suberin formed around the inoculated sites and the infected tissue walled off from healthy tissue. Marousky and Raulston (1973) found that suberin formation in caladium was greatest at 32°C and was inhibited at 10 or 15°C. Studies in other plants have indicated that suberin formation may be one of the major defense responses to pathogen infection. We suspect that at higher temperatures caladium tubers are able to seal off infected areas and slow down or stop penetration of *F. solani* hyphae, thus limiting tuber rot.

These results could also be applied to caladium storage. That is, since caladium tubers are more susceptible to *Fusarium* tuber rot at low temperatures, it is important to store and transport tubers at an appropriate temperature (21°C).

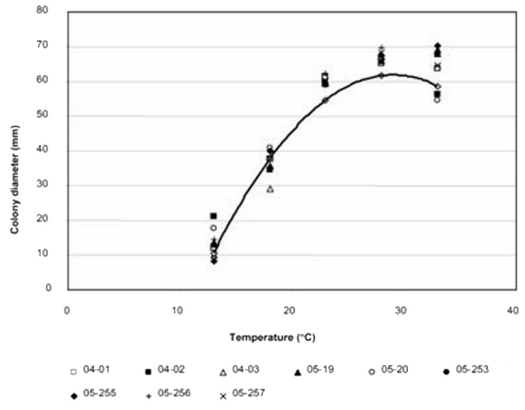

Figure 1. In vitro growth of nine isolates of *Fusarium solani* at five temperatures (13, 18, 23, 28, and 33°C).

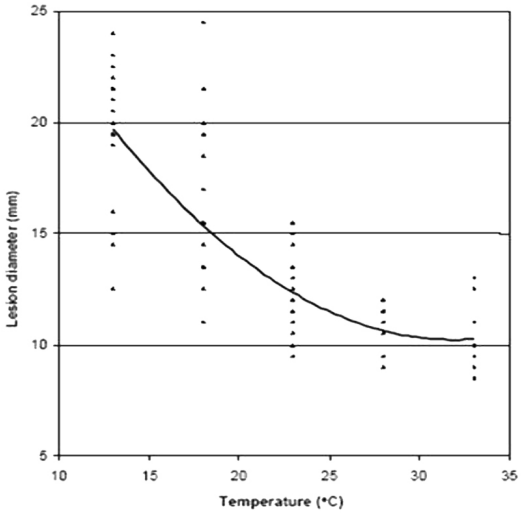

Figure 2. Lesion diameter (mm) of *Fusarium* tuber rot after inoculation with *Fusarium solani* isolate 05-20 and incubation at five temperatures (13, 18, 23, 28, and 33°C) for two weeks.

Identification of Aggressive *Fusarium* Isolates for Evaluating Caladium Cultivars for Resistance to *Fusarium* Tuber Rot

To determine if *Fusarium* isolates varied in their ability to rot caladium tubers and if cultivars responded differently to infection by different isolates, two cultivars were infected with nine *Fusarium* isolates. The nine isolates varied considerably in their aggressiveness, which was significantly influenced by the caladium cultivar (Table 1). For example, isolate 04-03 was the second most aggressive isolate on 'Frieda Hemple', but was among the least aggressive on 'Candidum'. Isolates 05-20 and 05-257 were highly aggressive on both cultivars, and they may be good candidates for future screening work.

Grower observations suggest that 'Frieda Hemple' is more susceptible to tuber rot than 'Candidum'. In our tests, the average diameter of rotted tissue ranged from 10.2 to 17.7 mm for 'Frieda Hemple', whereas on 'Candidum', the diameter ranged from 7.8 to 11.4 mm. The differences in lesion diameter between 'Frieda Hemple' and 'Candidum' were significant for all isolates tested except 05-255. These results indicate that our testing procedures are applicable to grower situations and also confirm grower observations that cultivars differ in resistance to *Fusarium* tuber rot.

Table 1. Diameter of rotted tuber tissue seven days after inoculation of caladium tubers with nine *Fusarium solani* isolates.

	Lesion diameter (mm) on two cultivars	
Isolate	Frieda Hemple	Candidum
04-01	12.6	10
04-02	12.5	10.3
04-03	14.9	8.3
05-19	11.3	9.2
05-20	17.7	11.4
05-253	10.2	7.8
05-255	11.2	9.9
05-256	10.3	8.7
05-257	13.5	10.4

Evaluating Commercial Cultivars for Resistance to *Fusarium* Tuber Rot Using Aggressive Isolates

Seventeen major commercial caladium cultivars, 'Aaron', 'Candidum', 'Candidum Jr.', 'Carolyn Whorton', 'Fannie Munson', 'Florida Cardinal', 'Florida Sweetheart', 'Frieda Hemple', 'Gingerland', 'Miss Muffet', 'Postman Joyner', 'Red Flash', 'Red Frill', 'Rosebud', 'White Christmas', 'White Queen', and 'White Wing', were inoculated with three aggressive isolates; 04-03, 05-20, and 05-257. Cultivars were ranked from 1 to 17 within each isolate, with the rank of '1' assigned to the cultivar with the smallest lesion. The total rank sum (TRS) from all three isolates was then transformed to a normalized total rank by dividing the TRS by 51, the highest possible TRS, and multiplied by 100. Cultivars were placed into four categories based on the normalized total rank: resistant (with a normalized rank between 1% and 25%), moderately resistant (25% to 50%), susceptible (50% to 75%), or highly susceptible (75% to 100%).

Five cultivars ('Candidum', 'Rosebud', 'White Christmas', 'Florida Sweetheart', and 'Aaron') were placed in the "resistant" category with the normalized total rank ranging from 11.8% to 24.5% (Table 2). Two cultivars ('White Wing' and 'Red Flash') were placed in the moderately resistant group with the normalized total rank from 43.1% to 45.1%. Six cultivars ('Candidum Jr.', 'White Queen', 'Red Frill', 'Florida Cardinal', 'Miss Muffet', and 'Postman Joyner') were placed in the susceptible category with the normalized total rank ranging from 52.9% to 70.6%. Four cultivars were placed in the highly susceptible group ('Fannie Munson', 'Gingerland', 'Frieda Hemple', and 'Carolyn Whorton') with a normalized total rank from 82.4% to 100.0%. The severity of the disease on 'Carolyn Whorton' was much greater than on all other cultivars, with most of its entire tuber surface infected by *Fusarium* (Fig. 3).

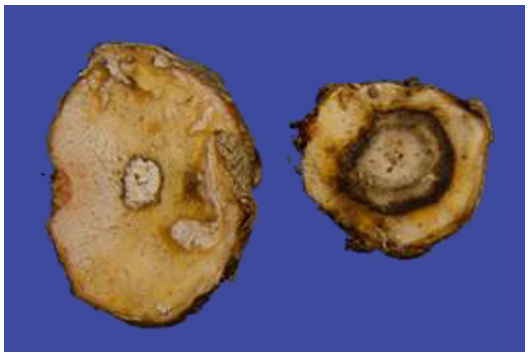

Figure 3. *Fusarium* tuber rot in tubers of 'Candidum' (left), a resistant cultivar, and 'Carolyn Whorton' (right), a highly susceptible cultivar. Tubers were cut in half, inoculated at the center of the cut surface with *F. isolate* 05-20, and incubated at 18°C for 2 weeks.

References

Goktepe, F., T. Seijo, Z. Deng, B.K. Harbaugh, N.A. Peres, and R.J. McGovern. 2007. Toward breeding for resistance to *Fusarium* tuber rot in caladium: inoculation technique and sources of resistance. HortScience 42:1135-1139.

Knauss, J.F. 1975. Description and control of *Fusarium* tuber rot of caladium. Plant Disease Report 59:975-979.

McGovern, R.J. 2004. Fighting *Fusarium*. Greenhouse Grower 22:146-150.

Marousky, F.J. and J.C. Raulston. 1973. Influence of temperature and duration of curing, storage, shipping and forcing periods on caladium growth. Proceedings of the Florida State Horticultural Society 86:363-368.

Table 2. Lesion diameter (mm) on 17 caladium cultivars inoculated with three isolates of *Fusarium solani*.

Cultivar	*F. solani* isolates						Total rank sum	Normalized total rank	Resistance category
	04-03		05-20		05-527				
	Diameter	Rank	Diameter	Rank	Diameter	Rank			
Candidum	9.6	4	11.3	1	11.2	1	6	11.8	Resistant
Rosebud	9.4	1.5	13.9	4	11.6	2	7.5	14.7	Resistant
White Christmas	9.4	1.5	14	5	11.7	3.5	10	19.6	Resistant
Florida Sweetheart	9.5	3	12.5	3	11.8	5	11	21.6	Resistant
Aaron	10.1	7	12.1	2	11.7	3.5	12.5	24.5	Resistant
White Wing	9.9	6	15	7	12.4	9	22	43.1	Moderately resistant
Red Flash	10.6	11	14.6	6	12	6	23	45.1	Moderately resistant
Candidum Junior	10.2	8	15.5	9	13.9	10	27	52.9	Susceptible
White Queen	10.3	9.5	15.4	8	14.2	11	28.5	55.9	Susceptible
Red Frill	9.7	5	15.8	12	14.5	13	30	58.8	Susceptible
Florida Cardinal	11.3	12	15.6	10.5	13.1	9	31.5	61.8	Susceptible
Miss Muffet	12.4	14	16.3	14	12.3	7	35	68.6	Susceptible
Postman Joyner	10.3	9.5	15.6	10.5	16.1	16	36	70.6	Susceptible
Fannie Munson	12.8	15	19.1	15	14.3	12	42	82.4	Highly susceptible
Gingerland	13	16	16.2	13	14.7	14	43	84.3	Highly susceptible
Frieda Hemple	11.4	13	20.3	16	15.1	15	44	86.3	Highly susceptible
Carolyn Whorton	15	17	23.9	17	20.4	17	51	100.0	Highly susceptible