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Screening *Spathiphyllum* Species and Cultivars for Resistance to *Cylindrocladium spathiphylli*

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Abstract. **Of 4 *Spathiphyllum* species and 5 cultivars tested for sensitivity to *Cylindrocladium spathiphylli* root and petiole rot, 3 demonstrated resistance. *Spathiphyllum floribundum*, *S. floribundum* 'Mini', and *S. cannifolium* were resistant, whereas all others tested were susceptible. Twenty hybrids from a cross of *S. lechlerianum* × *S. floribundum* also were tested and found resistant to *C. spathiphylli*, indicating potential for development of new *Spathiphyllum* cultivars resistant to this serious pathogen.**

Spathiphyllum spp. are popular foliage plants because of their attractive foliage and growth habit, white fragrant flowers, and tolerance of interior environments. However, in the past 5 years, production of *Spathiphyllum* by some Florida growers has been reduced severely by a root and petiole rot caused by the fungus *C. spathiphylli* Schoulties, El-Gholl et Alfieri (2–4). Initial symptoms of Cylindrocladium root and petiole rot include wilting and chlorosis of lower leaves, which eventually turn necrotic, with rotted petiole bases causing detachment from the main plant (2, 3). Research during the past 5 years has not produced a totally effective means of chemical control and, once found, infected plants must be destroyed to prevent the spread of disease (1). In a previous report, *S. floribundum* (Lind. et Andre N.E. Br.) appeared to be resistant to *C. spathiphylli*, while 5 other sources were susceptible (4). We present results of tests conducted to determine additional potential sources of resistance to *C. spathiphylli* to be used in a breeding program to develop resistant hybrids.

In each experiment, the following conditions remained constant. Plants were established in steam-treated (1.5 hr at 88°C) potting medium consisting of Canadian peat and pine bark (1:1) (v/v) amended with 4.2 kg dolomite, 4.4 kg Osmocote (19N-6P-12K), and 0.9 kg Micromax (microelement source) per m^3. Plants were grown in a shaded greenhouse with a maximum light level of 250 ± 10 $\mu mol \cdot s^{-1} \cdot m^{-2}$ under natural photoperiod and a temperature range of 15°–33°. Ten ml of a mycelial slurry, made by blending a 2-week-old culture (1 plate) of *C. spathiphylli* on V-8 juice agar medium (18% V-8 juice, cleared with 4.5g $CaCO_3$ per liter of medium) with 200 ml sterilized deionized water, was used to inoculate each pot. Disease ratings of tops or roots were made visually on the following scale: 1 = no disease symptoms; 2 = 1–25% diseased; 3 = 26–50% diseased; 4 = 51–75% diseased; and 5 = 76–100% diseased, usually dead. Data were not transformed prior to statistical analyses. The commercial cultivars tested included *S.* 'Tasson', *S.* 'Mauna Loa', *S.* 'Bennett', *S.* 'Queen Amazonica' and *S. wallisii* 'Regal', which were obtained from local tissue culture laboratories. The remaining species were propagated by division of plants maintained at this research center.

Three different experiments were conducted in the course of this study. Expt. 1 tested 2 *Spathiphyllum* species and 3 cultivars for possible resistance to *C. spathiphylli*. Expt. 2 tested 4 species and 5 cultivars for resistance and was repeated 3 times, while Expt. 3 compared 20 hybrid seedlings from a cross of *S. lechlerianum* Schott with *S. floribundum*.

In Expt. 1, all plants inoculated with *C. spathiphylli* (except *S. floribundum*) developed symptoms within 7 weeks and generally worsened by 13 weeks (Table 1). *Spathiphyllum* 'Tasson', 'Mauna Loa', 'Bennett', and *S. lechlerianum* eventually died, while *S. floribundum* showed no disease symptoms. Similar results occurred in Expt. 2 except that 3 separate sources of resistance were found, including *S. floribundum*, *S. floribundum* 'Mini' (a dwarf variegated form of *S. floribundum*), and *S. cannifolium* (Dryand.) Schott (Table 2). The 5 commercial cultivars and *S. lechlerianum* included in this experiment developed severe symptoms within 8 weeks after inoculation, with many dead prior to the 8-week rating. In Expt. 3, 20 hybrids from a cross of *S. lechlerianum* (susceptible) and *S. floribundum* (resistant) appeared resistant to *C. spathiphylli* (Table 3). None of the 20 seedlings developed disease symptoms 8 weeks after inoculation, compared to *S.* 'Mauna Loa' — all of which had died within the same period. The resistant hybrids were still alive and showed no disease symptoms more than one year after the experiment was terminated.

Results from this study show that potential sources of resistance to *C. spathiphylli* include *S. floribundum*, *S. floribundum* 'Mini', and *S. cannifolium*. All commercial cultivars

Table 1. Response of 2 *Spathiphyllum* species and 3 cultivars to artificial infection with *Cylindrocladium spathiphylli*.

Species and/or cultivar	Mean disease severity rating[z] 7 weeks	13 weeks
S. floribundum	1.0 a[y]	1.0 a
S. Tasson	2.0 bc	2.6 b
S. Mauna Loa	1.6 ab	3.0 bc
S. Bennett	2.5 bc	3.9 cd
S. lechlerianum	2.8 c	4.7 d

[z]Values given are the mean for 5 plants rated at 7 and 13 weeks after inoculation according to the following scale: 1 = no symptoms; 2 = 1–25% diseased; 3 = 26–50% diseased; 4 = 51–75% diseased; and 5 = 76–100%, usually dead.
[y]Means in a colum separated by Duncan's new multiple range test, $P = 0.05$.

Table 2. Response of *Spathiphyllum* species or cultivars to artificial infection with *Cylindrocladium spathiphylli*.

Species and/or cultivar	Mean disease severity rating[z] Test 1	Test 2	Test 3
S. floribundum	1.0 a[y]	1.0 a	1.0 a
S. floribundum Mini	1.5 a	1.3 a	1.0 a
S. cannifolium	1.3 a	1.1 a	1.6 a
S. lechlerianum	2.6 b	5.0 c	2.5 b
S. wallisii	4.3 c	4.9 c	4.4 c
S. Tasson	2.6 b	4.1 b	3.0 b
S. Bennett	3.6 bc	4.4 b	4.7 c
S. Mauna Loa	3.2 bc	5.0 c	4.9 c
S. Queen Amazonica	4.4 c	4.3 b	2.9 b

[z]Values given are the mean for 10 plants rated 8 weeks after inoculation according to the following scale: 1 = no symptoms; 2 = 1–25% diseased; 3 = 26–50% diseased; 4 = 51–75% diseased; and 5 = 76–100%, usually dead.
[y]Means in a column separated by Duncan's new multiple range test, $P = 0.05$.

Table 3. Response of *Spathiphyllum* 'Mauna Loa' and hybrids of *S. lechlerianum* × *S. floribundum* to artificial infections with *Cylindrocladium spathiphylli*.

Plant tested	Mean disease severity rating[z] 4 weeks Shoots	4 weeks Roots	8 weeks Shoots	8 weeks Roots
S. lechlerianum × *S. floribundum*	1.0 a[y]	1.0 a	1.0 a	1.0 a
S. Mauna Loa	2.6 b	2.4 b	5.0 b	5.0 b

[z]Values given are the means of 20 plants rated 4 and 8 weeks after inoculation according to the following scale: 1 = no symptoms; 2 = 1–25% diseased; 3 = 26–50% diseased; 4 = 51–75% diseased; and 5 = 76–100%, usually dead.
[y]Means in a column separated by Duncan's new multiple range test, $P = 0.05$.

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tested were highly susceptible, as was *S. lechlerianum*, which corresponds with previous studies on commercial cultivars (4). Hybrids between *S. lechlerianum* and *S. floribundum* were resistant, indicating a heritable genetic basis of resistance since *S. floribundum* was the male parent. Resistance is likely dominant, although further tests would be required for confirmation. Unfortunately, *S. floribundum, S. lechlerianum*, and their hybrids possess few commercially acceptable qualities, as does *S. cannifolium*. Development of new commercial cultivars resistant to *C. spathiphylli* will most likely require hybrids of *S. floribundum* or *S. cannifolium* with commercial cultivars. However, to date, all such cross attempts have failed (unpublished data) and an intensified effort to obtain such hybrids (i.e., embryo culture) may be required. Results from this study indicate there is potential for developing new *Spathiphyllum* hybrids with resistance to *C. spathiphylli*.

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Thidiazuron Stimulation of Apple Shoot Proliferation in Vitro

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Abstract. **Thidiazuron stimulated shoot proliferation on shoot tip explants of 'Gala' apple (*Malus domestica* Borkh.) when incorporated in Linsmaier–Skoog medium at concentrations of 10, 1, and 0.1 μM. Shoot numbers with thidiazuron were equivalent to, or greater than, the number produced when using 4.4 μM BA in the medium, but the shoots were shorter than with BA. At 10 and 1 μM thidiazuron, shoot leaves were narrow, had pointed laminae, and were somewhat distorted. Shoot proliferation continued when explants from the 2 highest thidiazuron concentrations were transferred to cytokinin-free medium. Shoots from cultures grown at all 3 concentrations of thidiazuron rooted after 1 to 2 subcultures on cytokinin-free medium. Chemical names used: *N*-(phenylmethyl)-1*H*-purin-6-amine (BA) and *N*-phenyl-*N'*-1,2,3-thiadiazol-5-ylurea (thidiazuron).**

Thidiazuron had a high degree of cytokinin activity in callus cultures of *Phaseolus lunatus* L. (1, 4) and tobacco (4) and stimulated growth of dormant buds of apple (G.L. Steffens, personal communication). We decided to test whether thidiazuron would also stimulate in-vitro proliferation of axillary shoots of apple cultivar cultures.

Shoots from existing in-vitro cultures of 'Gala' apple were cultured on Linsmaier–Skoog (3) medium containing 10, 1, 0.1, 0.01, or 0.001 μM thidiazuron (NOR-AM Agricultural Products, Naperville, Ill.) or 4.4 μM BA plus 0.5 μM indolebutyric acid (IBA), 1.4 μM gibberellic acid, 87.6 mM sucrose, and 7 g·liter^{-1} Difco Bacto-agar. After adjusting the pH of the medium to 5.2, 40 ml were dispensed per 120-ml jar and the medium was autoclaved for 15 min at 121°C and 1.1 kg·cm^{-2}. Cultures were grown at 25° ± 2° with 16-hr photoperiods provided by warm white fluorescent lights at a photosynthetic photon flux density of 40–60 μmol·s^{-1}·m^{-2}.

Table 1. Number of new shoots and mean shoot length after 6 weeks on proliferation medium.[z]

Cytokinin	Concentration (μM)	Number of new shoots	Mean shoot length (cm)
Thidiazuron	10	10.6 ± 3.2[y]	2.3 ± 0.4
	1	10.0 ± 2.4	2.4 ± 0.3
	0.1	8.5 ± 2.3	2.8 ± 0.6
	0.01	0.1 ± 0.0	2.1 ± 0.7
	0.001	0.0 ± 0.0	1.5 ± 0.5
Benzyladenine	4.4	8.0 ± 2.4	5.1 ± 0.7

[z]Based on 5 shoot tip explants per jar, 4 jars per treatment.
[y]Mean ± SE

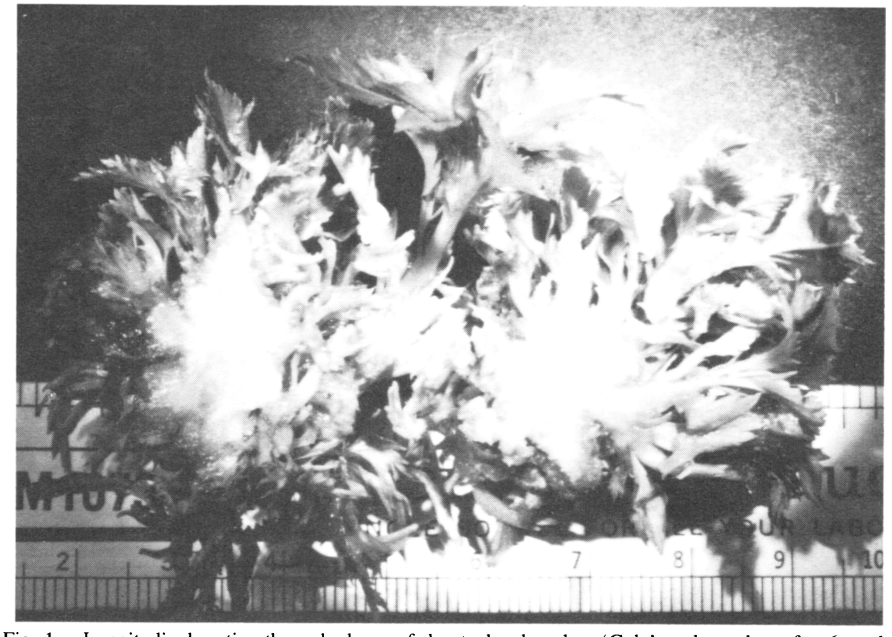

Fig. 1. Longitudinal section through clump of shoots developed on 'Gala' apple explant after 6 weeks on medium containing 1 μM thidiazuron and 4 weeks on cytokinin-free medium.

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