Disease Resistance in Twenty *Dieffenbachia* Cultivars

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Abstract. Twenty commonly grown *Dieffenbachia* cultivars were tested for their resistance to diseases affecting production caused by the following bacterial and fungal pathogens: *Xanthomonas campestris* pv. *dieffenbachiae* (McCulloch and Pirone) Dye, *Erwinia chrysanthemi* Burk, *Fusarium solani* Sacc., and *Myrothecium roridum* Tode ex Fr. Two isolates of each pathogen were used to compare heterogenic pathogen populations to the relatively homogenetic asexually produced cultivars. Cultivars having horizontal resistance toward tested pathogens could then easily be identified. The cultivars Camille, Compacta, and Parachute showed the broadest horizontal resistance, with resistance toward three of the four pathogen groups tested. Disease resistance identified in this research permits the selection of plants to be used in breeding, and also creates a baseline to compare resistance of newly developed cultivars.

Dieffenbachia is one of the most popular ornamental foliage plants in the United States, continually ranking in the top 10 genera for annual wholesale value (Sheehan, 1994). Production of *Dieffenbachia* often requires frequent pesticide applications; however, environmental concerns about extensive chemical use and its associated liabilities, as well as costs, make their recurrent use undesirable. Once purchased by consumers, healthy looking plants are often subjected to environmental stress and left to survive with minimal care, allowing any remaining or introduced disease inoculum to multiply and incite subsequent plant injury or death. One solution to reduce pesticide use is the development of disease-resistant plants. A prerequisite to such a breeding program is the identification of germplasm that contains genetic sources of resistance to major pathogens.

Two major fungal pathogens of *Dieffenbachia* are *Fusarium solani* and *Myrothecium roridum*; these cause a petiole rot (Chase and Gholl, 1982) and leaf spot (Chase and Poole, 1984), respectively. The two common bacterial pathogens affecting *Dieffenbachia* pro-

duction are *Xanthomonas campestris* pv. *dieffenbachiae* and *Erwinia chrysanthemi*, which cause leaf blight and a soft rot of leaves and stems, respectively. Indexed tissue-cultured propagules have reduced pathogen incidence in *Dieffenbachia* production (Chase et al., 1981). Nevertheless, fungal and bacterial pathogens can eventually be introduced to production facilities by wind, water, contaminated soil, tools, and workers. We, therefore, screened 20 popular *Dieffenbachia* cultivars for resistance to four of the most common pathogens affecting production.

Materials and Methods

Twenty *Dieffenbachia* cultivars were selected for this study (Table 1). Pathogen-free tissue-cultured *Dieffenbachia* plants were obtained from Agri-Starts (Apopka, Fla.) and Twyford Plant Laboratories (Santa Paula, Calif.) in 72-plug cell packs and were potted into 10-cm pots (450 cm³) containing Vergo Container Mix A (Verlite, Tampa, Fla.) amended with Sierra Plus Minors 17N–6P–12K (Grace-Sierra, Milpitas, Calif.) at 1.5 g/pot. Plants were allowed to grow for 2 months before they were inoculated. Two bacterial strains of *X. c.* pv. *dieffenbachiae* and *E. chrysanthemi* and two fungal isolates, *F. solani* and *M. roridum*, were selected. Criteria for selecting pathogens were as follows: They had 1) to have been isolated from *Dieffenbachia* plants, 2) to have been isolated from several

locations in Florida to maximize their genetic variability, and 3) to have exhibited aggressive pathogenicity toward *Dieffenbachia* plants. Experiments were conducted in a randomized complete-block design, having six blocks each containing one plant of each cultivar per block. A seventh block containing noninoculated control plants was isolated to limit possible cross-contamination from inoculated plants. Each test of the 20 cultivars was conducted twice during warm weather from June to August and twice again during cooler weather from October to December, for a total of four separate tests (two for each pathogen isolate) for each pathogen species.

For production of bacterial inoculum, cultures of *X. c.* pv. *dieffenbachiae* and *E. chrysanthemi* were grown for 48 h at 28 ± 1 °C on Difco Nutrient Agar (NA; Difco Laboratories, Detroit) amended with 5% sucrose. Bacteria were harvested from NA plates, suspended in saline (NaCl 8.5 g·L⁻¹), and adjusted spectrophotometrically at A₆₀₀ to 1 × 10⁸ colony-forming units/mL. Leaves and stems were sprayed with a bacterial suspension and enclosed in a clear polyethylene bag for 24 h. Inoculated *Dieffenbachia* plants were kept in a fiberglass house maintained between 16 to 32 °C and with light at 266 μmol·m⁻²·s⁻¹. In each experiment, noninoculated plants (sprayed with saline) of the cultivars were used as controls. To aid in bacterial infection, plants were misted for 15 s every 30 min during daylight hours. Percentage of foliage exhibiting bacterial disease symptoms was visually estimated after 4 weeks and values were ranked using a pretransformed rating scale (Little and Hills, 1978) as follows: 0 = no symptoms; 1 = ≥1% ≤ 10%; 2 = ≥10% ≤ 35%; 3 = ≥35% ≤ 65%; 4 = ≥65% ≤ 90%; 5 = ≥90% ≤ 100%.

Fungal inoculum isolates were grown on Difco potato dextrose agar (PDA) at 25 ± 1 °C under cool-white fluorescent lights on a 12-h day/night cycle (9.4 μmol·m⁻²·s⁻¹). Fungal cultures were incubated for 2 to 3 weeks to generate sufficient spore counts. Fungal spores were harvested from PDA plates by flooding the plates with sterile distilled water (SDW) and scraping with rubber spatulas. Before inoculations, spore concentrations were adjusted in SDW with the aid of a hemacytometer to 1 × 10⁶ conidia/mL. For *M. roridum* inoculations, the three uppermost expanded leaves of each plant were wounded using a cork with three insect pins imbedded in it, making a total of nine wounds per plant. No wounding was done with *F. solani* inoculations. Spore suspensions were applied to plant surfaces until run-off using hand sprayers. To maintain high humidity and aid in the infection, plants were placed inside clear polyethylene plastic bags for 24 h. *Dieffenbachia* plants inoculated with *M. roridum* were rated by counting the total number of wounds that exhibited typical symptoms of *M. roridum* infection. To rate *F. solani* infections, the total number of infected shoots per plant was counted and percentage of infected shoots was calculated. Reisolations from representative symptomatic plants were made to verify presence of a causal disease agent in

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each experiment. Results from the four experiments with each pathogen were combined and data were compared using Tukey's LSD procedures.

Results and Discussion

None of the *D. maculata* cultivars screened were immune to any of the bacterial or fungal pathogens, although several showed minimal infection levels. Variations in disease severity were observed between some isolates of pathogen species on various cultivars (data not shown). The cultivars Camille, Compacta, Hilo, and Parachute exhibited the broadest horizontal resistance, each having the highest resistance level for three of the four pathogens tested (Table 1). No cultivars displayed the highest resistance level to all four pathogens tested. Of the remaining cultivars, 'Bacara', 'Paco', 'Sparkles', 'Star Bright', 'Star White', 'Triumph', and 'Tropic Marianne' exhibited good resistance to two pathogen groups while 'Bali Hai', 'Mary', 'Octopus', 'Rebecca', 'Sarah', and 'Tiki' were resistant to at least one pathogen. Three cultivars, 'Golden Sunset', 'Paradise', and 'Princess', showed poor resistance to all four pathogens. The noninoculated control plants were free of disease symptoms.

This study will help in planning a breeding program whose goal is to produce disease-resistant hybrids. For example, three cultivars, 'Camille', 'Compacta', and 'Hilo', showed high resistance for both bacterial pathogens, whereas 'Star Bright' and 'Parachute' were the only cultivars to have a low incidence for both fungal pathogens. A breeding program involving these four cultivars could lead to production of hybrids possessing resistance to all four pathogens.

Although no information exists regarding the inheritance of disease resistance in *Dieffenbachia*, the range of responses among unrelated genotypes and the similar responses by closely related cultivars in this study indicate a probable genetic basis for resistance. Foliar variegation patterns in *Dieffenbachia* are controlled by a single gene (Henny, 1986); it is highly probable that sports are nearly genetically identical to the original source plant. For example, 'Camille' and 'Compacta' both received similar disease resistance rat-

Table 1. Resistance of 20 cultivars of *Dieffenbachia* to the four major pathogen groups affecting production.

Cultivar (Patent #)	Disease occurrence			
	Bacteria ²		Fungi ³	
	<i>X. c. pv. dieffenbachiae</i> ^x	<i>Erwinia chrysanthemi</i>	<i>Fusarium solani</i>	<i>Myrothecium roridum</i>
	Rating		Incidence (%)	
Bacara	0.9 de	0.8 a-d	2.6 ab	12.9 b-e
Bali Hai (6872)	1.2 fg	1.48 h	3.6 a-c	14.3 c-g
Camille	0.5 a-c	0.4 a	1.9 ab	27.7 hi
Compacta	0.4 ab	0.7 a-d	2.4 ab	29.6 h-j
Golden Sunset (7317)	1.5 gh	0.9 b-f	9.3 e	13.4 b-f
Hilo (6858)	0.7 b-d	0.6 a-c	4.8 a-d	24.5 g-i
Mary	1.0 ef	1.4 d-h	0.8 a	20.3 d-h
Octopus	1.3 gh	1.6 f-h	13.5 f	1.4 a
Paco	0.2 a	1.0 c-g	2.7 ab	14.8 c-g
Parachute	0.7 b-e	0.6 a-c	4.3 a-c	11.1 a-d
Paradise (6854)	1.4 gh	0.8 b-f	5.7 b-e	23.1 e-i
Princess	0.8 de	1.4 f-h	15.9 f	12.0 b-d
Rebecca (6292)	0.2 a	1.0 b-f	7.0 c-e	38.8 j
Sarah	0.8 c-e	0.7 a-d	5.4 b-e	37.0 j
Sparkles (9051)	1.0 d-f	0.5 ab	3.7 a-c	16.2 c-g
Star Bright (9050)	1.6 i	1.5 h	2.8 ab	7.7 a-c
Star White	0.2 a	1.3 e-h	15.9 g	3.2 ab
Tiki (7298)	0.5 a-c	1.3 gh	8.4 de	20.8 f-i
Triumph	0.7 b-d	0.8 a-e	3.3 a-c	21.3 d-i
Tropic Marianne	1.0 d-f	0.4 a	2.5 ab	31.4 ij

²Percentage of foliage exhibiting symptoms was visually estimated and percentages were ranked using a pretransformed rating scale (Little and Hills, 1978) as follows: 0 = no symptoms; 1 = $\geq 1\% \leq 10\%$; 2 = $\geq 10\% \leq 35\%$; 3 = $\geq 35\% \leq 65\%$; 4 = $\geq 65\% \leq 90\%$; 5 = $\geq 90\% \leq 100\%$. Cultivars were compared using Tukey's LSD procedures at ($P \leq 0.5$).

³Total number of infected shoots or fungal spots were counted for *F. solani* and *M. roridum*, respectively, and percentages of infection calculated and compared using Tukey's LSD procedures at ($P \leq 0.5$).

^x*X. c.* = *Xanthomonas campestris*.

ings in this study and are variegated sports of each other. In fact, they may be genetically similar, with only a developmental difference. Likewise, one of the two least resistant cultivars, 'Princess', is a sport of 'Golden Sunset', another of the least resistant cultivars. Moreover, precedence for simple inheritance to fungal disease resistance exists among aroids, with resistance to *Cylindrocladium* root and petiole rot in *Spathiphyllum* reported to be a single dominant gene (Henny and Chase, 1986). Integrating improved disease resistant cultivars with quick cropping time and continued use of clean starter plants from tissue culture facilities could lead to a further significant reduction in pesticide use.

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