



Efficacy of Fungicides for Control of *Colletotrichum gloeosporioides* on Dendrobiums

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Dendrobium clone hybrid plants, one-year-old, were potted in hard coco on 10 Sept. 2009. Plants were fertilized weekly with 150 ppm Peters Professional 20–20–20 water soluble fertilizer (The Scotts Company, Marysville, OH). The experimental plants were inoculated with conidia spores of *Colletotrichum gloeosporioides*. Twelve plants per treatment were arranged in a completely randomized design. Fungicide treatment were sprayed until runoff using a compressed air hand pump sprayer on 10 Mar. to 10 May 2010. The foliage was allowed to dry and the conidia spore inoculum was applied using a spray bottle. *Colletotrichum gloeosporioides* lesions were counted on 17 May 2010. Plants were rated on a scale of 1 to 10, where 0 = no disease and 10 = plant defoliated. Treatments were: Control, Pageant 38% WG at 6.0 oz per 100 gal, Pageant 38% WG at 12.0 oz per 100 gal, Cleary's 3336 4F at 6.0 fl oz per 100 gal, Pentathlon LF at 32.0 fl oz per 100 gal, Heritage 50 WG at 4.0 oz per 100 gal, Insignia 20% WG at 4.0 oz per 100 gal, and Insignia 20% WG at 8.0 oz per 100 gal. All fungicide treatments gave some control of *C. gloeosporioides*. Pageant at 12.0 oz and Insignia at 8.0 oz provided excellent control followed by Heritage and Cleary's 3336.

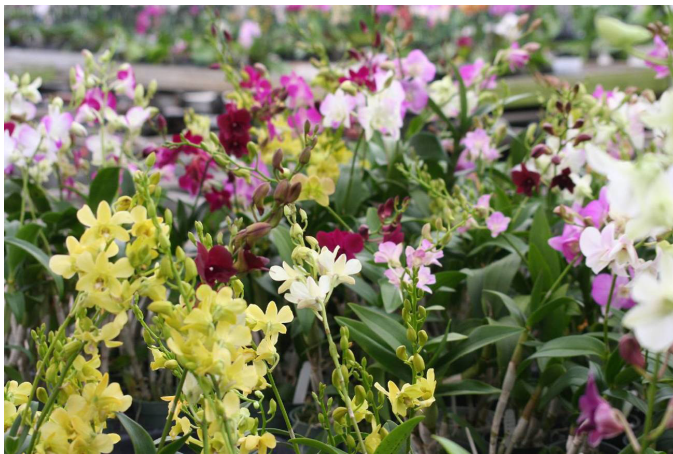


Fig. 1. Flowers of *Dendrobium* spp.

Introduction

Dendrobium spp. are epiphytic orchids grown for their attractive flowers (Fig. 1). *Dendrobium* is a large genus of tropical orchids that consists of about 1400 species. The genus occurs in diverse habitats throughout much of south, east and southeast Asia including the Philippines, Borneo, Australia, New Guinea, and New Zealand. The name is from the Greek *dendron* (meaning tree) and *bios* (meaning life) (Northen, 1990; Rosenberg, 2005; Watson, 2002).

The species are either epiphytic—growing on a tree—or occasionally, lithophytic—growing over a rock. They have adapted

to a wide variety of habitats from the high altitudes in the Himalayan mountains to lowland tropical forests and even to the dry climate of the Australian desert (Northen, 1990; Rosenberg et al., 2005; Watson, 2002). The orchids in this genus often develop pseudobulbs, which unite into a long reedlike stem with a typical length of more than 30 cm. Some appear densely covered with short white hairs. The short, ovate leaves grow alternately over the whole length of the stems. The axillary flower buds develop into short flower stalks with one or two terminal flowers. The orchids grow quickly throughout summer, but take a long rest during winter. In the spring, new shoots are formed from the base of the main plant and the dormant buds come back into action. The blooming flowers are found on pseudobulbs formed in the previous year.

Some species are in great demand by orchid lovers. This has resulted in numerous varieties and hybrids, such as the *Dendrobium nobile* varieties, which have greatly extended the range of colors of the original flower from the Himalayas (Northen, 1990).

The fungus attacks some 100 different types of plants, including both cultivated ones and weeds (Alfieri et al., 1991; American Orchid Society, 1986; Chupp et al., 1960; Pirone, 1970; Pirone et al., 1960; Preston, 1968).

Water-soaked leaf spots that increased rapidly in size and became light tan to brown necrotic areas were observed on Dendrobiums in a commercial nursery during periods of cloudy, rainy weather from July through Sept. 1991 and 1992. Severe infections resulted in defoliation and death of plants. A *Colletotrichum*-like fungus was isolated from infected leaves and stems on potato dextrose agar and was identified as *Colletotrichum gloeosporioides*.

The disease occurred as a severe blight affecting over 90% of 500 potted nursery stock during periods of cloudy, rainy weather from July through Sept. 1991 and 1992. Grade and standard reduction resulted from a severe foliage blight. This epiphytic occurred during an abnormal period of excessive rainfall and high temperatures.

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Anthraco-nose caused by *C. gloeosporioides* Penz. (sexual stage *Glomerella cingulata*) of *Dendrobium* spp. has been reported in Florida, Thailand and most of the tropical areas of the world where *Dendrobiums* are grown. It most commonly occurs in South Florida and has been significant in *Dendrobium* production losses. Anthracnose is occasionally found on other orchids in Florida, including *Aerides* sp., *Angraecum* sp., *Ansellia* sp., × *Ascocenda* sp., *Ascocentrum* sp., *Bifrenaria* sp., × *Brassolaeliocattleya* sp., *Brassavola* × *Laelia* × *Cattleya* sp., *Bulbophyllum* sp., *Calanthe* sp., *Catasetum* sp., *Cattleya* spp., × spp., *Cochleanthes* sp., *Cychnoches* sp., *Cymbidium* sp., *Cypripedium* sp., *Dendrobium* sp., × *Doritaenopsis* sp., *Doritis* sp., × *Epicattleya* sp., *Epidendrum* sp., *Eria* sp., *Gongora* sp., *Grammatophyllum* sp., *Ionopsis* sp., × *Laeliocattleya* sp., *Lockhartia* sp., *Lycaste* sp., × *Macrangraecum* sp., *Maxillaria* sp., *Miltonia* sp., *Neomoorea* sp., × *Odontocidium* sp., *Odontoglossum* sp., *Oncidium* sp., *Paphiopedilum* sp., *Peristeria* sp., *Pescatorea* sp., *Pescatorea* sp., × *Phaiocalanthe* sp., *Phaius* sp., *Phalaenopsis* sp., *Phragmipedium* sp., *Pleurothallis* sp., × *Renades* sp., *Rhynchostylis* sp., × *Schombodiacrium* sp., × *Schomboepidendrum* sp., *Schomburgkia* sp., × *Sophrocattleya* sp., × *Sophrolaeliocattleya* sp., *Spathoglottis* sp., *Stanhopea* sp., *Trichopilia* sp., *Vanda* sp., *Vandopsis* sp., *Vanilla* sp., × *Vuytstekeara* sp., × *Wilsonara* sp., and *Zygopetalum* sp. (Alfieri et al., 1991).

Currently only ammoniacal copper carbonate or Bordeaux mixture and Chlorothalonil are labeled for control of anthracnose on orchid in the United States (Dodge et al., 1943; Norton, 1990; Perone et al., 1960). Anthracnose efficacy studies conducted in 2006–2007 showed that the new BASF azoxystrobin compounds are significantly effective.

The purpose of this research was to reproduce the disease and to determine effective methods of control.

Materials and Methods

A culture of *C. gloeosporioides* originally isolated from natural infected *Dendrobium* hybrid was transferred periodically on potato-dextrose agar and maintained at 22 °C. This isolate was employed throughout this study. Leaf lesions on the *Dendrobium* were first noted on a *Dendrobium* clone that was potted in hard coco on 10 Sept. 2009. Plants were fertilized weekly with 150 ppm Peters Professional 20–20–20 water soluble fertilizer (The Scotts Company, Marysville, OH). The experimental plants were inoculated with conidia spores of *Colletotrichum gloeosporioides* as described for greenhouse studies 2 d after the first spray application. All inoculations were accomplished by inoculating 12-month-old plants of *Dendrobium* hybrids with a 3-d-old conidia spore suspension of *C. gloeosporioides* and observed for symptoms after 10 d. The field trial consisted of twelve, 12-month-old plants per treatment, and were sprayed five times with the candidate fungicides at 7-d intervals. The 12 plants per treatment were arranged in a completely randomized design. Fungicide treatments were sprayed until runoff using a compressed air hand pump sprayer on 10 Mar. to 10 May 2010. The eight fungicides and an untreated control were evaluated for disease control in a commercial nursery. The compounds and their concentrations per 100 gal of water were Cleary's 3336 (thiophanate methyl) 6.0 fl oz (177.4 mL), Dithane (mancozeb) 32.0 fl oz (946.4 mL), Heritage (azoxystrobin) 4 oz (113.4 g), Insignia (pyraclostrobin) 4 oz (113.4 g), Insignia (pyraclostrobin) 8 oz (226.8 g), Pageant (pyraclostrobin + boscalid) 6 oz (170.1 g), Pageant (pyraclostrobin + boscalid) 12 oz (340.2 g) (Table

Table 1. Effect of foliar spray of different fungicides on *Colletotrichum gloeosporioides* anthracnose of *Dendrobium* hybrids.

Treatment rate/100 gal (378.54 L)	Disease rating ^z	% Anthracnose ^z
Control (untreated)	4.28 a	95.09 a
Cleary's 3336 6.0 fl oz (177.4 ml)	1.88 b	13.75 c
Dithane LF 32.0 fl oz (946.4 ml)	2.03 b	50.83 b
Heritage 50 WG 4.0 oz (113.4 g)	1.40 c	12.71 cd
Insignia 20% WG 4.0 oz (113.4 g)	1.43 c	8.33 d
Insignia 20% 8.0 oz (226.8 g)	0.38 d	2.99 f
Pageant 38% WG 6.0 oz (170.1 g)	1.33 c	10.83 d
Pageant 38% WG 12.0 oz (340.2 g)	0.35 a	2.29 f

^zMean followed by the same letter within a column are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

1.). The control treatments were sprayed with water.

Plants were rated on a scale of 1 to 10, where 0 = no disease and 10 = plant defoliated.

Results and Discussion

The anthracnose caused by the *Colletotrichum gloeosporioides* which resulted from inoculation of *Dendrobium* hybrids in the greenhouse were identical in respect to those resulting from natural infection. Twelve-month-old plants of *C. gloeosporium* were inoculated with conidia spore suspensions of *C. gloeosporioides*. The symptoms on inoculated plants were identical in all respects to the anthracnose resulting from natural infection and after that described by Burnett (1974). Koch's postulates were fulfilled by reisolation of the pathogen.

The disease occurred as a severe blight affecting over 90% of 500 potted nursery stock during periods of cloudy, rainy weather from July through Sept. 1991 and 1992. Grade and standard reduction resulted from a severe foliage blight. This epiphytotic occurred during an abnormal period of excessive rainfall and high temperatures. *Colletotrichum gloeosporioides* was reisolated consistently from the diseased tissue. Disease symptoms were first noted on the leaves 10 d after inoculation and began as small circular spots that appeared water-soaked or scalded (Figs.



Fig. 2. First noticeable disease symptoms.

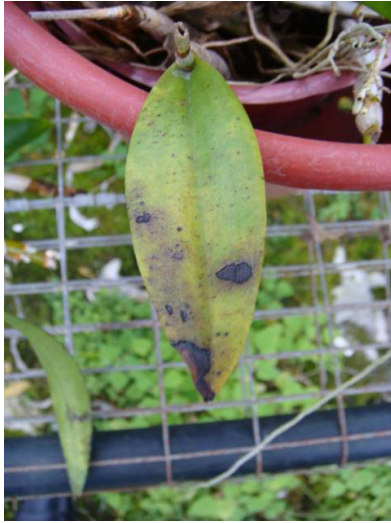


Fig. 3. Advanced stages of anthracnose.



Fig. 4. Anthracnose on mature lesion.

2 and 3). The spots enlarged to 25 mm or more, became tan with a darker border, were sometimes zonated (Figs. 3 and 4) and after that described by Burnett (1974). The undersurface of the leaf appeared as pale yellow sunken spots, 1–3 mm in diameter. With time, the spots continued to enlarge in a circular or irregular pattern and eventually covered the whole under side of the leaf. Later the spots became slightly sunken and purple-black with the developing margin remaining yellow. Following the appearance of the spots on the lower leaf surface a corresponding yellow-pale green area was seen on the upper leaf surface. Eventually these spots turned purplish black or black. Heavily infected leaves abscise. Prolonged periods of leaf wetness should be avoided.

A *Dendrobium* orchid's health depends on genetic resistance, good environment, and disease free through the use of effective fungicides (Northen, 1990).

All of the fungicides applied as a protective spray were significantly better than the control (Table 1.). Pageant at 12.0 oz. and Insignia at 8.0 oz. provided excellent control followed by Heritage and Cleary's 3336 which were significantly better for

Table 2. Current price of fungicide treatment per application and price of treatment for the duration of the trial (5 applications).

Treatment rate/100 gal (378.54 L)	Price U.S. per application ^a	Price U.S. per 5 applications ^a
Cleary's 3336 4F at 6.0 fl oz (177.4 mL)	\$6.09	\$30.45
Dithane LF at 32.0 fl oz (946.4 mL)	7.50	37.50
Heritage 50 WG at 4.0 oz (113.4 g)	7.73	38.65
Insignia 20% WG at 4.0 oz (113.4 g)	3.80	19.00
Insignia 20% WG at 8.0 oz (226.8 g)	7.60	38.00
Pageant 38% WG at 6.0 oz (170.1 g)	27.38	136.90
Pageant 38% WG at 12.0 oz (340.2 g)	54.76	54.15

^aBased on current prices of product per pound.

Table 3. Current price of fungicide treatment per application and price of treatment for the duration of the trial (5 applications) as compared to disease control.

Treatment rate/100 gal (378.54 L)	Applications (no.)		% Disease
	1 Ap	5 Ap	
Cleary's 3336 4F at 6.0 fl oz (177.4 mL)	\$6.09	\$30.45	13.75 c
Dithane LF at 32.0 fl oz (946.4 mL)	7.50	37.50	50.83 b
Heritage 50 WG at 4.0 oz (113.4 g)	7.73	38.65	12.71 cd
Insignia 20% WG at 4.0 oz (113.4 g)	3.80	19.00	8.33 e
Insignia 20% WG at 8.0 oz (226.8 g)	7.60	38.00	2.99 f
Pageant 38% WG at 6.0 oz (170.1 g)	27.38	136.90	10.83 d
Pageant 38% WG at 12.0 oz (340.2 g)	54.76	54.15	2.29

disease control than Pentathlon LF, which was significantly better than the inoculated control. Current price of fungicide treatment per application and price of treatment for the duration of the trial (5 applications) are compared with anthracnose control as shown (Table 2 and Table 3).

All of the fungicides reported must be applied as per the manufacturer's label.

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