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FUNGAL DISEASES OF DENDROBIUM FLOWERS

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CONTENTS

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INTRODUCTION

Propagation and production of dendrobium as cut flowers and potted plants have increased markedly in the past 15 years. With increased production, floral diseases and their control have become major factors in determining total production and quality of blossoms. Serious dendrobium blossom blights are caused primarily by two fungi, *Botrytis* and *Colletotrichum*. Other fungi such as *Phytophthora* are also important but occur less frequently. Smaller spots and flecks are caused by several other fungi, such as *Alternaria* and *Bipolaris*.

BOTRYTIS BLOSSOM BLIGHT

This floral disease of dendrobium is characterized by a watery, soft rot of petals, sepals, and entire flowers, usually accompanied by flower drop (Ito and Aragaki, 1977). The disease begins as tiny tan to brown flecks, less than 1 mm (0.04 inch) in diameter. These water-soaked flecks expand rapidly under cool, wet field conditions. In the early stage of disease development, typical spots are elliptical, commonly 5 to 12 mm (0.2 to 0.5 inch) long, and continue to be water soaked. These spots enlarge into irregularly shaped soft rots affecting entire petals or sepals, and frequently result in the complete collapse of a flower (Figs. 1, 2).

The disease is favored by relatively cool temperatures of 20–24°C (68–75°F), and disease progress is reduced when the temperature rises above 27°C (81°F). The primary fungal species involved is *Botrytis cinerea*, although several other *Botrytis* species are also present. During extended cool, wet periods, a fluffy gray-mold growth representing the reproductive stage of *Botrytis* spp. develops on diseased flowers (Fig. 2). These growths contain millions of spores that are readily dispersed by very slight air movement. Spores that land on healthy blossoms germinate in water, produce germ tubes that penetrate flowers, and begin the disease cycle again.

COLLETOTRICHUM FLOWER SPOTS AND BLIGHTS

Blossom diseases caused by *Colletotrichum coccodes* are similar to those caused by *Botrytis* and are easily confused with them (Fig. 3). *Colletrotrichum* spots are oval to circular, tend to be more restricted than *Botrytis* lesions, and develop more slowly. In advanced stages, spots may have dark borders surrounding salmon-colored rings. These rings are gelatinous masses of spores produced by the fungus. *Colletotrichum* also causes spike rot, dark brown to black leaf spots and blights, and premature defoliation. Foliar symptoms may be a better clue to its presence than blossom blight symptoms.

Although disease development due to *Colletotrichum* is slower, the disease is widespread over a broader range of environmental conditions than those observed for *Botrytis*. *Colletotrichum* thrives under the cool temperatures that are optimal for *Botrytis*, but is also quite destructive during warmer periods (26–28°C), when *Botrytis* is generally not a problem. Unlike *Botrytis*, spores of *Colletotrichum* are not readily spread by air movement, and splashing water is needed for dispersal. An expanded discussion of diseases caused by *Colletotrichum* is available (Uchida and Aragaki, 1991*a*).

PHYTOPHTHORA BLOSSOM DISEASE

Occasionally, *Phytophthora palmivora* and *P. nicotianae* have been isolated from severely diseased dendrobium flowers as well as other orchids (Figs. 4, 5) (Uchida and Aragaki, 1991*b*). Spots and blights on dendrobium blossoms are generally soft and water soaked and may have irregular edges. Under moist conditions, disease progress is rapid and entire flowers are lost within a few days. Foliar blight and root rots accompany floral problems, and these rotted tissues are likely reservoirs of fungal spores that initiate disease. *Phytophthora* produces specialized spores, called sporangia (Fig. 6), which are usually dispersed by splashing water. In water, the sporangial contents divide into smaller motile spores. These swimming spores, or zoospores, greatly increase the distribution rate and range of these pathogens.

PHYLLOSTICTA BLOSSOM SPOT

This disease has probably plagued growers for many years, although its occurrence was only recently discovered. Flowers infected with *Phyllosticta capitalensis* may remain symptomless for as long as three weeks. Small, faint blemishes about 1 to 3 mm (0.04 to 0.12 inch) long are formed three to four weeks after inoculation. These blemishes are slightly pink to mauve to blue on purple cultivars. Although lesion expansion is minimal, these diseased flowers contribute to rapid inoculum formation after the flower dies. Entire petals are darkened by fungal growth (Fig. 7), and *Phyllosticta* spores (Fig. 8) are formed. Leaf lesions also develop very slowly (Uchida and Aragaki, 1980), and spores that initiate disease development on flowers are commonly found on old leaves at the base of the plant. *Phyllosticta* produces two spore types, one distributed by splashing water and the other by air movement.

BLOSSOM FLECKS

These are tiny brown or black spots, frequently much less than 1 mm (0.04 inch) in diameter (Figs. 9, 10). Flecks are caused by several fungi, including *B. cinerea* and *C. coccodes*. *Alternaria alternata* is by far the most common fleck-causing organism (Fig. 11) and thereby the most important of several organisms that cause this disease. The others are *Exserohilum rostratum*, *Stemphylium* sp., *C. gloeosporioides*, *Bipolaris setariae*, *B. sorokiniana*, and other *Bipolaris* species (Uchida and Aragaki, 1979).

Alternaria, *Bipolaris*, and *Exserohilum* produce airborne spores and are favored by warm temperatures in the 24–28°C (75–82°F) range. None of these organisms, except *Botrytis* and *C. coccodes*, causes blighting of dendrobium flowers. The flecks represent infection and death of a few host cells. Fungal spores land on flowers, germinate, and penetrate the flower tissue (Fig. 12). The fungi grow very poorly beyond the initial infection area, and disease progress is halted. Biologically, these infections are of little consequence to the flower, but as blemishes on an ornamental they greatly reduce floral quality and marketability, resulting in large economic losses, particularly on white dendrobium cultivars.

CONTROL MEASURES

Effective control of plant diseases requires close adherence to several procedures. Reliance on chemical control measures usually gives disappointing results. Adherence to all of the following methods is essential for economic control of fungal diseases on dendrobium flowers.

Regulating Moisture Levels

The most important factor in controlling the fungal diseases discussed above is the management of moisture levels. Water is required for spore germination and for penetration of the host flower by the fungus. Rapid disease development and abundant sporulation by organisms such as *Botrytis* and *Phytophthora* are favored by an ample supply of water. In general, fungi do not produce spores on plant surfaces in dry environments. Distribution of fungal spores is also dependent on splashing or moving water in many cases. Every reasonable effort should be made to protect flowers from rain and prolonged exposure to dew. Solid-covered greenhouses are expensive but offer cost-effective disease and cultural controls. Good ventilation and air movement also reduce extended periods of high moisture.

Reducing Inoculum Levels

Only a single fungal spore is needed to start a fleck, spot, or flower blight. The greater the number of spores, the higher the rate of disease development. The likelihood of high infection rates and thus high disease levels is increased by high spore levels. These spores are produced on old, infected, decaying leaves and flowers. Sanitation, which includes the collection and destruction of diseased plant parts, reduces spore levels and thereby decreases disease levels. Without removal of diseased tissue, spore concentrations become so high that localized epidemics occur. Diseased plant parts should be buried or removed from the nursery site. Dumping leaves at the end of the row or field results in high spore levels that can easily be blown back into the field. Fleck-causing organisms such as *Alternaria* and *Bipolaris* sporulate well on grasses and organic debris; areas surrounding greenhouses should be kept clean and weed free.

Chemical Treatments

Several fungicides are known to be effective against fungi attacking dendrobium flowers. Always check pesticide labels and comply with legal application procedures.

Metalaxyl (Subdue) and mancozeb (Dithane M45) are effective against *Phytophthora* species. Thiram (Spotrete) is highly effective in preventing *Phyllosticta* infections. This fungicide and mancozeb are also effective against *Botrytis*, *Bipolaris*, and all of the above fungi. Benomyl (Benlate 50) is a very popular fungicide and has been registered for use on orchids. It was shown to be highly effective against *Botrytis*, but continued use and indiscriminate applications over the past 15 years have resulted in the development of benomyl-resistant *Botrytis* strains, greatly reducing the effectiveness of this fungicide (Aragaki and Noborikawa, 1977). Vinclozolin (Ornalin) is also registered for use on dendrobium to control *Botrytis*. Triadimefon (Bayleton 25TO) is registered for use against *Colletotrichum*. *Colletotrichum coccodes* is not

Figure 1. Dendrobium flower blight caused by *Botrytis cinerea*.

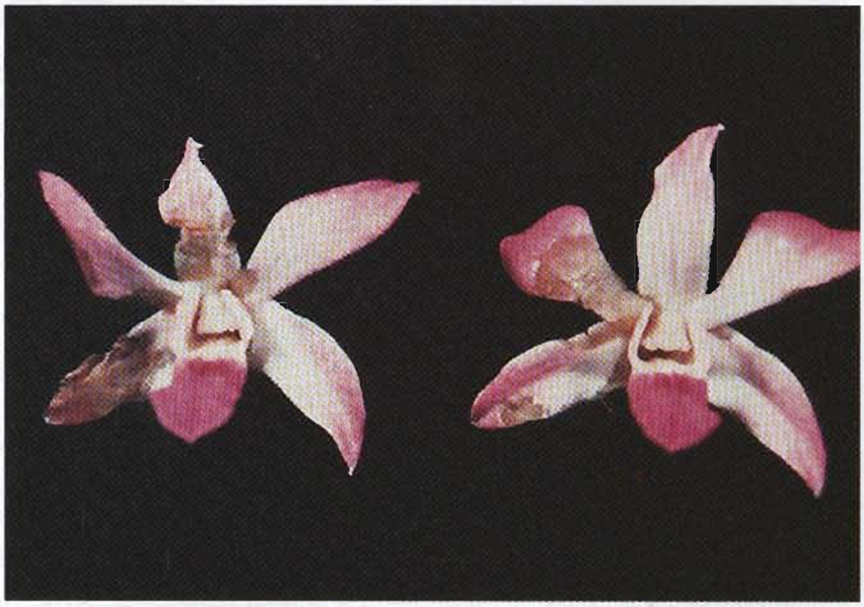

Figure 2. Spore masses of *Botrytis cinerea* on decaying flower.

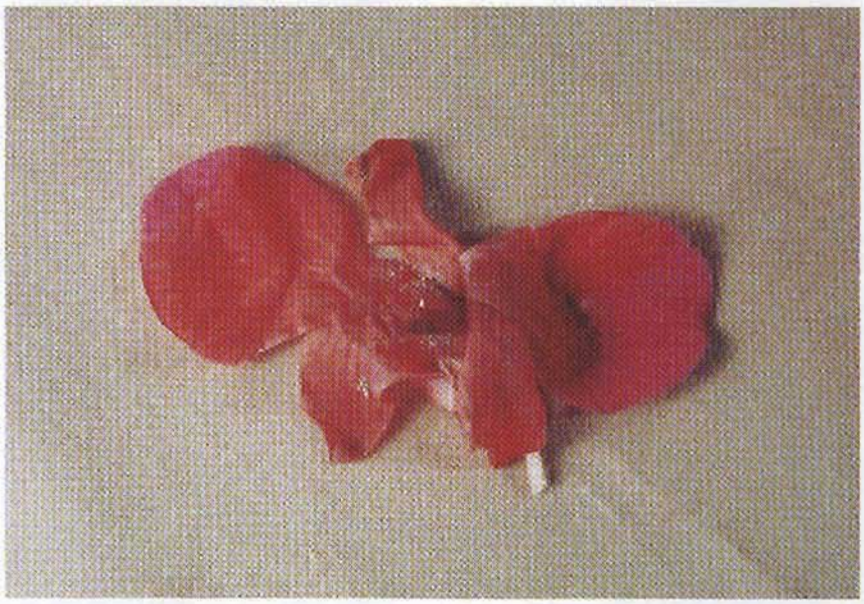

Figure 3. Dendrobium flower spot caused by *Colletotrichum coccodes*.

Figure 4. Irregular pink spots on UH232 caused by *Phytophthora palmivora*. Small, sunken whitish blemishes also caused by *P. palmivora*.

Figure 5. Blossom rot caused by *Phytophthora palmivora*.

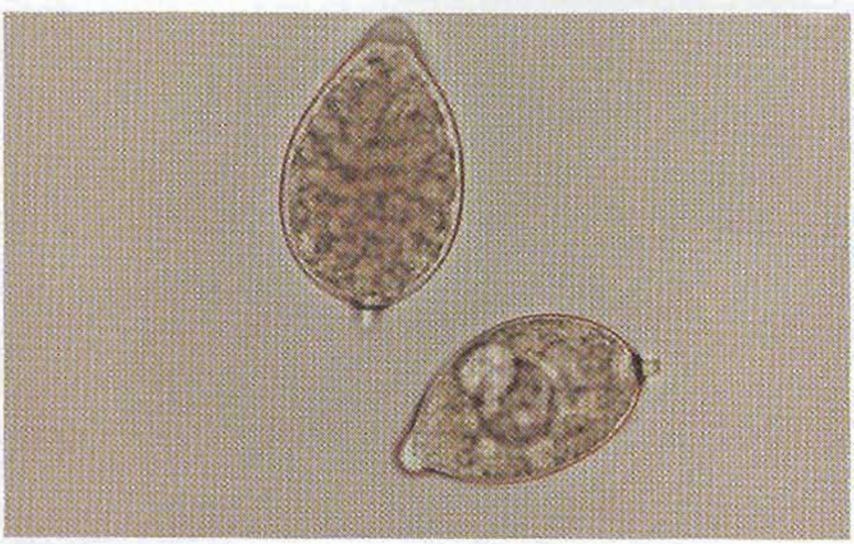

Figure 6. Photomicrograph of sporangia of *Phytophthora palmivora*.

Figure 7. Decaying flower with *Phyllosticta* growth.

Figure 8. Photomicrograph of spores of *Phyllosticta capitalensis* being discharged.

Figure 9. Blossom flecks caused by *Alternaria alternata*.

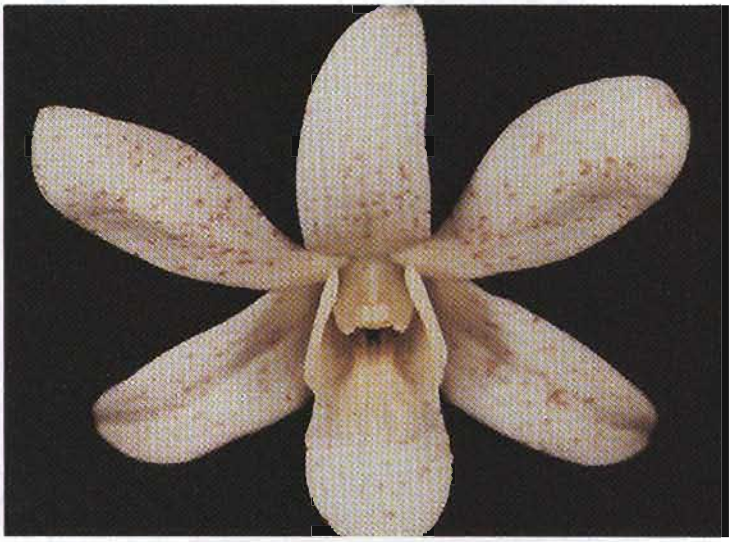

Figure 10. Blossom flecks caused by *Bipolaris sorokiniana.*

Figure 11. Photomicrograph of *Alternaria alternata* spores.

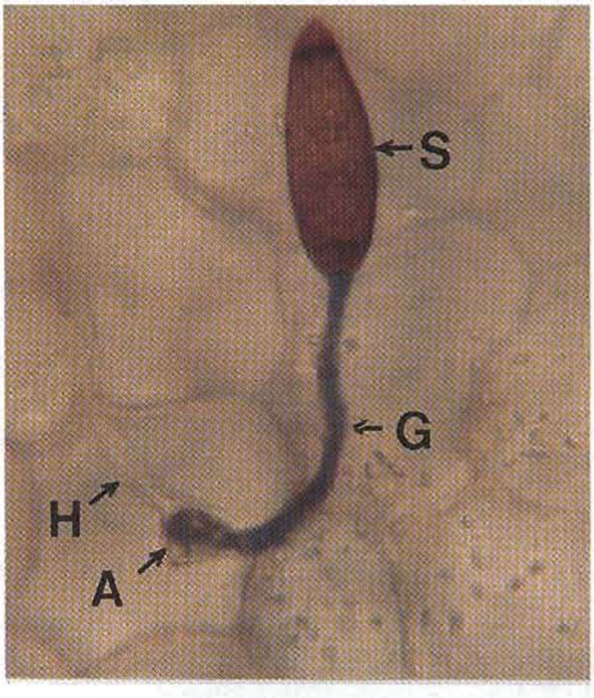

Figure 12. Photomicrograph of dendrobium flower surface and early stage of fleck formation. S = spore of *Exserohilum rostratum*; G = germ tube growing from the spore; A = appressorium (attachment structure) produced at the tip of the growing germ tube; H = fungal hypha, or thread, that has penetrated the flower and is feeding on host tissue. The resulting flecks (Figs. 9, 10) are small groups of host cells killed by fungal invasion.

inhibited by benomyl, a fungicide commonly used to control *C. gloeosporioides*.

Many fungicides control disease by preventing infection. Good coverage and retention of the fungicide are important for effectiveness. Effectiveness of compounds such as mancozeb can be greatly reduced by massive numbers of spores present on the crop. These contact fungicides kill or inhibit spores exposed to the fungicide, but a few spores generally escape and cause disease. High levels of spores, or inoculum, will result in a higher number of escaping spores.

Maximum benefits from pesticide applications can be obtained by integrating fungicide use with moisture regulation and diligent sanitation programs.

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