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Disease Management fo

Many educators, students, and practitioners throughout the world are replacing the term "houseplant" with "interiorscape plant," reflecting the reemergence of the elaborate use of living plant material in indoor gardens. Complex economic and social analyses have been used to explain the reasons for the rebirth of this area of ornamental horticulture. This "new" industry is likely to stay, and with it come new concerns and responsibilities to those of us in the profession of plant health management.

Where does plant pathology fit into this new industry? Can plant pathologists be of service in research, teaching, and extension efforts? Do we merely extend our classic concepts or do we develop new concepts of disease management and control? Perhaps I can provide some answers to these questions.

Most indoor gardeners of either professional or hobbyist status are deeply concerned about "sick" plants. The commercial indoor plant-maintenance industry is highly competitive. The continued cosmetic perfection of plants in the interiorscape provides the competitive edge in many urban communities, especially when carried out at minimum expense and effort. I have found the members of that industry to be quite open, communicative, and cooperative as we attempt to assist them in their diagnostic efforts and in improving their plant health management skills.

Without question, most of the "sick" plants noted in indoor gardens result from the complexities of cultural management (6,11). Root decline (Fig. 1) is an especially common situation. In a survey conducted a few years ago, we were somewhat surprised to find that the fungal and/or nematode pathogens recognized as aggressive attackers of ornamental plant roots were not associated with the great majority of plants suffering from root death and dieback in commercial interiorscapes (1). Although the exact causes of the declines were not researched, the evidence suggested that various stresses and imbalances brought on by suboptimal interior environments were at fault.

Environmental Stresses

Plant health decline resulting from environmental stress is well known to plant pathologists. Indeed, in recent years, our profession has seen increased research, extension, and teaching activity in these sorts of health management scenarios (6,12). My experience has been that the concepts particularly important in dealing with stresses on plants in interior gardens differ only slightly from those delineated by plant health managers in general.

Indoor gardens are usually composed of large, container-grown plants that have been produced quickly by means of unlimited amounts of water and nutrients, high temperatures, and optimal lighting. When brought indoors, such plants are often difficult to maintain in a healthy state, even those that have been "conditioned" for a time by reducing the amount of light and the frequency of watering and fertilizing. Good interior

Fig. 1. Root decline from a variety of primarily noninfectious stresses is the most prevalent plant health problem in interior gardens.

Fig. 2. Plants in interior gardens can be stressed by excessive light and sunburn.

Fig. 3. Nonspecific leaf symptoms resulting from a variety of stresses can confuse diagnosis of problems on plants in interior gardens.

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lants in Interior Gardens

gardeners generally provide transitional environments and care programs for such plants (9). Proper acclimatization is still not widely practiced, however.

Reliable information about the environmental tolerance of the various kinds of plants used indoors is not readily available and is complicated by diverse conditioning or acclimatization concepts and practices. Interior gardeners throughout the world are maintaining various kinds of plants in good health in impossible situations—impossible, that is, if one were to rely only on published information concerning the needs of the plants in use (10).

The stereotype of an indoor environment includes low lighting and overwatering. In a recent survey of interiorscapes in New York City, however, I noted very few in which light was stressful because of low intensity. Indeed, the opposite was more likely (Fig. 2). Furthermore, the planting media in common use tend to be highly aerated and well drained. This can lead to health problems, especially when the plants are watered sparingly and infrequently—often by the day of the week rather than by how much water is used or needed. Many in the industry have encountered widespread drought stress and soluble salt toxicities (7). Such toxicities often result from heavy fertilization in the nursery and subsequent drought stress indoors.

Fig. 4. This type of systemic bacterial wilt is being seen less often on interior garden plants.

Fig. 5. Fungal leaf spots are common on some plants at the time of installation indoors but rarely continue to develop and do not require specific treatment.

Fig. 6. Branch of *Ficus* spp. on left has cankered area resulting from *Phomopsis* spp. infection; wounded branch on right is not infected. (Courtesy A. R. Chase, University of Florida Research Center, Apopka)

Fig. 7. (A) Plant of *Spathiphyllum* spp. on right is infected with *Cyclindrocladium spathiphylli*; other factors can also cause yellowing of lower leaves. (B) *Cylindrocladium* lesion on leaf petiole of the diseased plant. (Courtesy A. R. Chase, University of Florida Research Center, Apopka)

Fig. 8. Powdery mildew can destroy some indoor plants, as evidenced by this begonia plant.

Much of the research to explain a syndrome has successfully reproduced the symptoms by changing one environmental variable. This basically sound experimental approach has inadvertently confused many in the interiorscape industry. I believe this is because the symptoms commonly observed with noninfectious maladies are actually quite nonspecific, possibly resulting from many causes (Fig. 3) (5,8,11). Fluoride-induced tip burn in many monocotyledons is an example. Many environmental stresses can cause tip burn! Plant pathologists commonly encounter such situations, especially when working with noninfectious diseases or disorders.

The need to greatly lessen the water and nutritional content of soils in which interior plants are being maintained is generally recognized, but there is little agreement on what these levels should be. This is especially true when one tries to integrate these environmental elements with the others at any one site. Furthermore, many soil testing services prescribe (either as a matter of course or as part of their computerized output) care programs based on classic plant production research. Good research on water and nutrient needs of plants used indoors is being done, but it is only now becoming widely appreciated and adapted to the interiorscape industry.

Infectious Diseases

My experience has been that infectious diseases, for the most part, are being seen less often on indoor plants (Fig. 4). I would guess this is the result of improved production techniques as well as the good phytopathological research conducted in recent years on plants intended for use in indoor gardens. Soilless media, tissue culture techniques, new fungicides, plant spacing, irrigation, and handling procedures in the nursery and the demands of the industry for quality material have all played a part.

Some diseases and some probable reasons for their decline in incidence are listed in Table 1. Inclusion of water mold crown and root rots may seem surprising (3). After all, the classic scenario is that houseplants are generally planted in poorly drained potting mixes, sitting in saucers or decorative cachepots, being overwatered and overfertilized by well-intentioned plant enthusiasts. I agree this may be the case with many plant hobbyists, but I have generally found that commercial interior gardeners and "young urban professionals" tend to culture indoor plants in ways that curb development of root rots.

Many indoor gardeners express concern over the occasional fungal leaf spot or blight on plant material intended for indoor use (Fig. 5). As expected, leaf spots vary in type and severity. The most common are: *Fusarium moniliforme* on *Dracaena* spp., *Alternaria panax* on *Brassaia* spp., *Coniothyrium concentricum* on *Yucca* spp., *Colletotrichum gloeosporioides* on *Dieffenbachia* spp. and *Ficus elastica*, and *Rhizoctonia solani* on *Epipremnum aureum*.

The prescription for managing these types of diseases remains a part of classic plant pathology. This can be easily appreciated if the practicality of the situation is kept in mind. The conditions that favor such foliar diseases—overhead watering, high humidity, crowded blocks of similar plants, etc.—are not generally found in indoor gardens. Furthermore, application of fungicides often creates a cosmetically unsuitable residue. Finally, regular spraying of plants in many indoor gardens is difficult or even impossible. Such diseases are best managed by using only disease-free material or by trimmming out all infected parts of the plant before installation in the indoor garden.

A few infectious diseases require more intense management. For example, Phomopsis blight and cankering of *Ficus* spp. (Fig. 6) has recently been described as the most widespread disease of foliage plants used in interiorscapes (2). Several plant pathologists are now in agreement that the syndrome of gradual dieback and progressive branch cankering results from development of *Phomopsis* after a variety of stress-inducing management practices. Evidence suggests that *Phomopsis* can be latent (subclinical) in or on infection courts for some time, perhaps as a "normal" constituent of the microbial surface flora on the plant. Overwatering or underwatering, improper acclimatization before the plant is placed in a dimly lighted garden, soluble salt toxicities, and improper pruning have all been associated with the development of this disease.

Control of *Phomopsis* involves preventive sprays with benomyl in the production nurseries. In indoor gardens, use of disease-free, fully acclimatized

Table 1. Some foliage plant diseases that seem to have decreased in incidence in indoor gardens

Diseases	Pathogens	Probable reasons for decreased incidence
Bacterial leaf spots and blights	Several	Trickle-tube and subirrigation methods More enclosed (under roofs and within walls) production
Bacterial wilts	*Erwinia* spp.	Tissue culturing of plants used for stock Trickle-tube and subirrigation methods
Crown and root rots	*Pythium* spp. *Phytophthora* spp.	Use of well-aerated, well-draining bark media Improved soil fungicides More bench-grown plants
Mosaic and ring spotting	Dasheen mosaic virus	Tissue culturing of plants used for stock Increased diagnostic awareness
Stunting, root knot, leaf blight	Nematodes in general	Increased use of soilless media Increased diagnostic awareness and nursery inspection

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trees is of primary importance. Proper maintenance to lessen environmental stresses is necessary to keep plants disease-free. Once Phomopsis blight begins in a fig tree in an indoor garden, health and form of the plant generally cannot be regained without extreme cultural modification and pruning.

Root and crown rot of *Spathiphyllum* spp. caused by *Cylindrocladium spathiphylli* is another troublesome decline disease commonly seen (Fig. 7) (4,13). The disease generally begins as a root rot and progresses to a crown rot. Diagnosis in indoor gardens is usually not made until the disease is advanced, when yellow older foliage is the most notable symptom. Continuous use of benomyl during production is somewhat effective in reducing disease severity, but sanitation is the most important management tool (4). Indoor gardeners must learn to inspect plants closely for symptoms of the disease before installing them.

Powdery mildews are found on only a few indoor plants, including grape ivy (*Cissus rhombifolia*), various *Begonia* spp. (Fig. 8), and several flowering plants used indoors temporarily. Infection commonly begins on older leaves or on shoots well within the foliage canopy and may continue to spread. Fungicidal sprays such as triadimefon and benomyl are registered on most of the hosts when grown outdoors but not when grown indoors except in greenhouses. Many indoor gardeners prevent powdery mildews by keeping plants away from cold air drafts, never watering late in the day, and avoiding drought stress.

Conclusions

Do the concepts of classic plant pathology serve us well when conducting research or teaching in the indoor gardening industry? I think they do, if we keep the value of integrated practices and the peculiarities of the industry in mind. Plant producers are responsible for growing high-quality plants as disease-free as possible, and indoor gardeners are responsible for maintaining plants under favorable conditions after purchase. Both are responsible for properly carrying out the environmental transition from the growing site to the indoor display site. Continued cooperation and communication among teachers, researchers, and practitioners in this exciting horticultural industry are vitally needed to ensure future growth and success.

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