inoculated first and chemically treated one day later, disease was more severe than in plants which were sprayed first and then inoculated. Agri-Strep appeared to give better control than copper-maneb.

The disease possibly originated on plants imported from Puerto Rico, since in one case it was reported that seemingly diseased tip cuttings were observed upon arrival in this country. Thus, roguing out the infected tips before planting should help control this disease. Chemical treatment was not wholly successful in providing adequate control in our experiment. Although disease incidence was reduced and development of the lesions was retarded, no effective chemical control can, as yet, be recommended.

In two attempts to repeat the experiment in late September and early October, our spray inoculations were unsuccessful. These failures could have been due to either lack of high enough temperatures or to the condition of the plants. It had previously been noted that as the leaves became more mature or "hardened," inoculations were increasingly unsuccessful.

THE DISTRIBUTION AND PATHOGENICITY OF ERWINIA CHRYSANTHEMI BURKHOLDER ET AL. TO SYNGONIUM PODOPHYLLUM SCHOTT

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ABSTRACT

The rapid decay of propagative stem cuttings has often been a limiting factor in the production of plants belonging to the genus *Syngonium* (Nephthytis). Isolations from rapidly rotting leaves of stock plants and from propagative stem cuttings have yielded primarily bacteria. Of these, only *Erwinia chrysanthemi* Burkholder *et al.* was found to be abundant and to incite consistently the rapid rot of *Syngonium* leaves. On one occasion, *Erwinia carotovora* was isolated and found to be capable of rotting wounded *Syngonium* leaves but its infrequency of isolation suggests a minor role in this disease. A survey of 5 foliage nurseries revealed *E. chrysanthemi* common to *Syngonium* at all locations. Culture indexing of nursery stock indicates that *E. chrysanthemi* may be present within *Syngonium* stem tissue at the time of propagation. Inoculations of *Syngonium* with isolates obtained from other foliage species indicate that more than one host may act as a reservoir for the pathogen and this should be considered in the overall planting design of a stock area.

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INTRODUCTION

In 1968, the foliage plant industry of Florida had a yearly wholesale value of approximately 15 million dollars (1, 9). This figure accounted for over one half of the total net value resulting from foliage plant production in the United States (1).

Although many plant species are grown for commercial foliage, only a small number of these account for the major portion of the total number of plants grown (9). One such group of plants are members of the genus *Syngonium*, commonly called "Nephthytis". Within this genus, the species *S. podophyllum* Schott predominates in sales importance. In 1967 (9), *Syngonium* sales accounted for approximately 2.4 percent of total foliage sales, thus placing it among the important foliage plant types.

Propagation of *Syngonium* is either by seed collected in the tropical Americas or by stem cuttings (eyes) taken from canes grown in ground beds under slat shed culture. Although reproduction by seed would in all probability

provide disease-free plants, propagation by stem cuttings predominates. This vegetative method of propagation, because of its very nature, has contributed greatly to the continued disease problems confronting *Syngonium* growers.

The major problem, a rapid rot and collapse of the propagative cuttings, usually occurs within the first week after cuttings are placed in the rooting bed and is particularly severe in Florida during hot, humid summer months. The purpose of this research was to identify and describe both the disease and the pathogen and to study their distribution within the foliage industry by surveying selected foliage nurseries.

Review of Literature

The rapid rot of *Syngonium* cuttings has long been noted by growers and research personnel. However, limited information is available as to the possible cause of this disease. McFadden (3) in 1960 noted in South Florida nurseries a leafspot of *Syngonium* caused by a species of *Erwinia*. In 1961 he (4) reported *Erwinia chrysanthemi* Burkh. *et al.* capable of causing a severe disease of *Syngonium* foliage and cuttings. His latest report in 1962 (5) directs attention to a species of *Xanthomonas* as the primary cause of *Syngonium* leafspot and *Erwinia chrysanthemi* and *E. aroideae* Townsend as secondary invaders, but no mention is made of the cane rot nor of its causal agent.

Materials and Methods

The sources of plant material surveyed for the presence of the pathogen were leaf and stem tissue taken directly from stock beds and from rotting propagative stems taken 2-3 days after sticking in rooting media.

Isolations from stock leaves or rotting cuttings were performed by selecting a portion of the active lesion's margin, crushing it in sterile distilled water, allowing it to set for 30 min and then streaking to a Lima Bean Agar (LBA)[1] plate. After 2-3 days in a 30°C incubator the plates were read for presence of the pathogen.

Isolations from stem material from stock beds were performed employing a modification of the culture—indexing method used for many vegetative propagated ornamental plants (7).

[1]Difco Laboratories; Detroit, Michigan; 23 g per 1000 ml distilled water.

All isolates considered to be the causal agent were further checked by inoculation with a bacterially charged needle to leaves of *Syngonium podophyllum* 'Green Gold'. Readings were taken for leaf rot after covering the inoculated plant with a plastic bag and placing it in a greenhouse for two days. Further confirmation of the identity of the causal agent was made on the basis of physiological and pathogenic characteristics of the isolates.

Isolations were made from foliage plant species other than *Syngonium* employing the same techniques previously mentioned for isolation from stock leaf and rotting cutting tissue. Pathogenicity of these isolates to *Syngonium podophyllum* 'Green Gold' was determined by atomization of bacterial suspensions to cutting tissue and wound inoculation to leaf tissue.

Results

A white bacterium was consistently isolated from *Syngonium* leaf and stem tissue and proved to be pathogenic by artificial inoculation to *Syngonium* leaf tissue.

The pathogen is a short rod, motile by means of peritrichous flagella. On LBA growth is moderate, grayish white and butyrous often exhibiting an iridescent character. Its physiological characteristics are identical to those of *Erwinia chrysanthemi* as described by Burkholder *et al.* (2) except for very minor differences. Gelatin and sodium polypectate agar are liquefied: nitrate is reduced; hydrogen sulfide is produced in tryptone broth; corn seed oil is not metabolized and starch is not hydrolysed. On Endo agar, the growth is pink and the color of the medium remains unchanged. This characteristic distinguishes it from *E. aroideae*, which turns the streak and the medium deep red, and from *E. carotovora* Jones, which produces a metallic luster on the dark red streak with the medium also turning a deep red.

The majority of the isolates produced acid from dextrose, levulose, sucrose, galactose, mannose, raffinose, arabinose, and mannitol, but not from lactose and maltose. Some isolates, however, did produce acid slightly from lactose or from maltose. Burkholder *et al.* (2) reported that growth on lactose and maltose is slow and acid production is weak. It is possible that all isolates would have been reported positive for this characteristic if the cultures had grown longer than the customary 4 to 5 days.

Succulent chrysanthemum cuttings were inoculated by removing their tops and placing a drop of bacterial suspension in water on the cut end of the stem. Three to 4 days later the tops turned dark brown to black and the infection had progressed 1 inch or more downward into the stems. The pith was decayed and the leaves were wilted but still green. Several days later, the affected part of the stem had become hollow and the brown, dry leaves still clung to the stem. These symptoms are typical of bacterial blight and coupled with the physiological characteristics, suggest that the isolates are identical with *Erwinia chrysanthemi* as described by Burkholder, *et al.* (2).

Of 46 isolates which were pathogenic to *S. podophyllum*, 44 proved to be *E. chrysanthemi* when submitted to the physiological tests. Of the remaining two, one proved to be *E. carotovora*, the other of undeterminable species. Included in the *E. chrysanthemi* group were isolates obtained from *Philodendron panduraeforme* Kunth, *P. wendlandii* Schott, *P. 'Burgundy'* and *P. selloum* C. Koch, all isolates produced the rapid rot and collapse of *Syngonium* stem tissue.

The pathogen was recovered from 108 of 211 separate isolations from foliar leafspots. Isolations from rotting *Syngonium* cuttings and from stock stem tissue yielded *E. chrysanthemi* 64 of 220 and 38 of 464 times, respectively. All isolates tentatively identified as *E. chrysanthemi* prior to physiological tests proved to incite leaf rot through artificial inoculation.

The Disease

The disease may be observed on any above ground, non-flowering part of the plant. The most obvious symptom, resulting from infection of wounded or unwounded leaf tissue, is an oblong leafspot that often is diffuse and irregular (Figure 1). The size of the leafspots varies from less than 1 mm to coalescing spots that often encompass the major portion of the leaf lamina. The characteristic leafspot, from which bacteria were isolated, is initially a blackish color, often with a chlorotic margin. On the leaf undersurface, lesions contained small viscous drops that range in color from light cream to tan to reddish-brown. These lesions, when macerated in a drop of sterile distilled water, contained numerous bacterial rods and the latex-like sap common to *Syngonium*. As the lesion ages and dries, it takes on a dark-brown color often with a reddish-brown border surrounded by a chlorotic margin. The bacteria-latex conglomerates turn deep black and give the lesion a peppered appearance. During hot and humid weather, when the foliage is wet for long periods of time, the disease develops rapidly. Infected leaves appear water-soaked, and may become mushy, collapse, and drop from the stem often falling on healthy stem or leaf tissue beneath.

Symptoms may occur on both intact stems, within the stock area, and stem cuttings used in propagation. In the former, symptoms appear mainly as dark brown cracks often accompanied by a dark green or gray streaking extending from the lesion borders along the stem. Browning of the pith and vascular tissues also occurs. Lesions often occur at the area of aerial root production, thus suggesting a correlation between aerial rootlets and stem infection. The young growing tip may be attacked and completely blighted, but this, however, is rare.

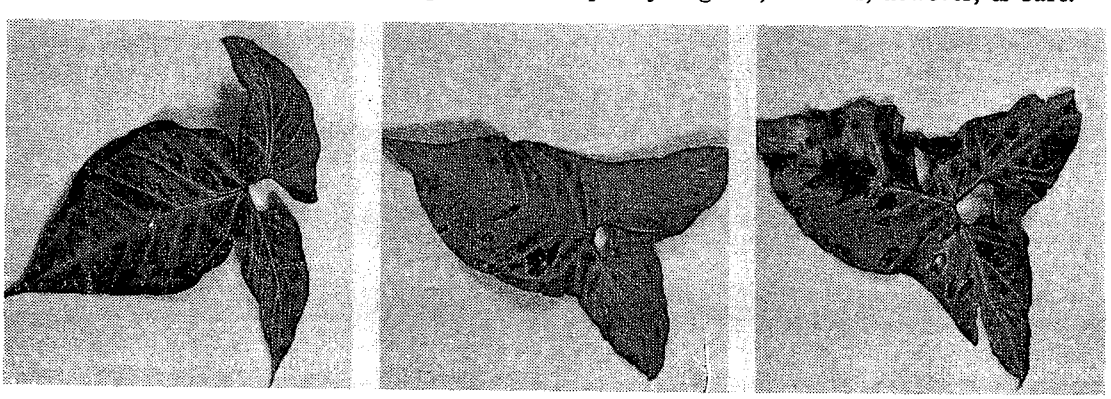

Figure 1.—Bacterial Blight of Syngonium - Leafspot phase. Left, healthy leaf. Center, leaf exhibiting recent infections. Right, leaf exhibiting old and recent infections.

In the propagation bed, infected stem cuttings take on a water-soaked, greasy-green color that eventually develops into a dark brown mushy rot. Under favorable conditions for disease development, complete collapse of a standard 3-5 cm stem cutting may occur within 3 to 7 days. Generally, the inner portion of the stem becomes completely decayed after several weeks, leaving only the outer cortical shell.

This disease is unnamed, but symptoms are typical of the disease syndrome often referred to as a blight (8). For these reasons, it is proposed that henceforth, this disease be designated as 'Bacterial Blight of *Syngonium*'.

Discussion

Erwinia chrysanthemi was found to be abundant in infected *Syngonium* tissue from all five nurseries surveyed. Isolation, identification and reinoculation into *S. podophyllum* along with its omnipresence indicate it to be a serious pathogen of this host plant. The fact that the pathogen is present within the plant tissue, as shown by culture-indexing of *Syngonium* stems, suggests that it moves internally within the host and spreads to non-infected tissue during vegetative propagation.

The pathogen evidently may be present in other foliage plant species as is evidenced by this research and that of Miller and McFadden (6). The fact that other species act as reservoirs for *E. chrysanthemi* and its pathogenicity to *Syngonium* should be considered in the overall planting design of new areas with *S. podophyllum*.

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CONTROL OF BOTRYTIS CINEREA DISEASES ON CHRYSANTHEMUM, CARNATION, ROSE, SNAPDRAGON, PETUNIA AND PHALAENOPSIS FLOWERS

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Abstract

Carnation plants were sprayed three times with various fungicides at four day intervals, then inoculated with *Botrytis cinerea* Fr. Eighteen hours after inoculation another spraying of the test fungicides was made. The three applications of Morsodren were the most effective in protecting against infection of petals, but the best control was the post-inoculation Tutane application, although Tutane was ineffective as a protective spray.

Carnations, roses, and petunia flowers were also protected most effectively by Morsodren applied before inoculation or by Tutane applied 5 to 18 hours after inoculation. Daconil 2787 and Botran sprays were less effective. Termil "thermal dust" was as effective as the Daconil spray.

Snapdragon and Phalaenopsis flowers sprayed after harvest, then inoculated with *B. cinerea*, were protected well by captan, Botran and Daconil 2787, but their appearance was spoiled by the spray residues. Tutane gave better control and Termil gave as good control as the fungicidal sprays, but with no visible residue.

Natural infections of 'Indianapolis White' chrysanthemum flowers were controlled more effectively by early morning spraying with Tutane three times weekly than by more frequent captan spray/zineb dust applications.

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