

Review Article

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Diseases of *Dieffenbachia* spp. Caused Fungi, Bacteria, Viruses and Nematodes: A Review

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ABSTRACT

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Important ornamental houseplant genera, *Dieffenbachia* are attacked by different biotic and meso-biotic agents as recorded from different parts of the world including India. They are attacked by 5 fungal, 3 bacterial, 6 viral and 2 important nematode diseases. Relevant comprehensive compilations based on several research and literature findings of those diseases are made to present the significant importance of each and every disease in respect of various viewpoints such as geographical distribution of the disease, symptoms and its causal pathogen, epidemiology and management.

Introduction

Several species of *Dieffenbachia* are economically important basically for their ornamental values, as most of them are cultivated as potted or house plants for their attractive shiny foliar variegation, unique leaf shaped and floral structures. Besides the ornamental values, other important characteristic of this plant is its significance as agri-horticultural economic enterprises due to demand in International and Domestic markets. The genus *Dieffenbachia* (commonly known as dumb cane), native to tropical regions of Central and South America, consists of about 30 monocot species contained in the family Araceae. It has the ability to remove the volatile organic compounds from air to improve indoor air

quality (Liu, 2007). They are affected by large number of diseases caused by fungi, bacteria, viruses and nematodes.

All these diseases were reported from the different parts of World including India. Researches on various aspects of those diseases are also being conducted worldwide and considerable volume of research findings has been accumulated. Information on those aspects have been collected, compiled and presented below.

Diseases of *Dieffenbachia*

Most important diseases of *Dieffenbachia* reported so far from different growing regions

of the World including India are described below:

Fungal diseases

***Phyllosticta* leaf spot**

Symptom

The pathogen basically produced leaf spot symptoms which were irregular, pale yellow with dark yellowish brown margin, measuring 25 - 60 mm in width (Chowdhury *et al.*, 1982).

Causal organism

There was an earlier record of this disease, caused by a fungus, *Phyllosticta dieffenbachiae* sp nov. Pycnidia produced by the pathogen were amphigenous, single or in groups (3 or 4 together), scattered, somewhat depressed, globose, 90 - 240 μ in diameter, flat with a single circular ostiole of 10 - 20 μ in diameter (Chowdhury *et al.*, 1982). Pycnidial wall was 15 - 20 μ thick (1 - 4 cells), composed of partly thick and partly thin walled brownish cells, darker and thicker around the pore, thin and hyaline towards the conidiogenous region.

Conidiogenous cells were cylindrical, measuring 8 - 12 x 2 - 2.5 μ . Pycnidiospores were one-celled, ovoidal or globose with a truncate base when young, broadly rounded apically, 8 - 14 x 5 - 8 μ , surrounded by a thick slime layer, containing short to long appendage (Chowdhury *et al.*, 1982).

Root and stem rot

Distribution

Phytophthora nicotianae var. *parasitica* found on *Dieffenbachia* was reported by Nema and Sharma (2000) as new record from

India. *Phytophthora nicotianae* and *Phytophthora palmivora* causing stem and root rot of *Dieffenbachia picta* was reported for the first time by Palmucci *et al.*, (2011) from Argentina and by Knauss (1974) from America. The disease was observed since 2007 on crops cultivated in warm provinces and in the outskirts of Buenos Aires city, Argentina, wherein large number of plants were lost in commercial greenhouses. The same pathogen was reported to cause root rot in commercial nursery of *Dieffenbachia maculata* in the UK where the crop was grown intensively on sand beds (O'Neil and Pye, 2000).

Symptom

Symptoms as soaked lesions in the basal leaves began in four- to six-months old plants causing plants to wilt due to basal stem and root rot. Stem rot on *Dieffenbachia picta*, caused by *Phytophthora palmivora* Butler appeared as small, irregular, water-soaked lesions on the main stem at the soil level (Knauss, 1974)

Causal organism

The pathogen was identified initially as *Phytophthora nicotianae* based on cultural characteristics, morphology of vegetative and reproductive structures and on the analysis of sequence of the nuclear ribosomal internal transcribed spacer (ITS) region by Palmucci *et al.*, from Argentina (2011). Pathogenicity tests were carried out and Koch's postulates were established by them.

Epidemiology

Root and stem rot on *Dieffenbachia picta*, caused by *Phytophthora palmivora* Butler, favoured by relatively high temperature (25-28°C), high humidity and poor soil drainage (Knauss, 1974).

Management

For the control of disease, water stagnation should be avoided by regulating watering. Drenching the soil with Bordeaux mixture (1%) and spraying the plants with Bordeaux mixture or Difolatan (0.3%) were advised (*c.f.* Sohi, 1990). Formaldehyde and Glutaraldehyde-based products mixed with sand were particularly effective for controlling the disease (O'Neil and Pye, 2000). A good control of *P. palmivora* on greenhouse-grown *Dieffenbachia picta* was obtained with Pyroxychlor, applied as a soil drench to rooted or unrooted cuttings, or as a foliar spray to rooted cuttings, at 7.5-20 and 50-75 g/100 l, respectively (Knauss, 1974). In California, control of these fungi had been obtained by dipping 2 ft long sections of hardened canes in hot water at 125°F for 30 minutes. The canes were then cooled and placed in steamed sphagnum moss until roots and buds start. Soft canes or soft leafy shoots would not withstand the hot-water treatment (*c.f.* Pascal, 1978).

Several *Dieffenbachia* varieties e.g. Alex, Compact, Camilla and Marianne were found susceptible to the infection caused by *P. nicotianae* whereas Tropic snow (*D. amoena*) was resistant (Palmucci *et al.*, 2011).

Anthracnose

Distribution

Anthracnose of *Dieffenbachia* was reported from different parts of the world. Anthracnose of *Dieffenbachia amoena* caused by *Colletotrichum gloeosporioides*, was reported for the first time in Italy (Lorenzini, 1983). Mirabolfathy (1989) identified the cause of leaf spots on *Dieffenbachia amoena* as *Glomerella cingulata* from the greenhouses Tehran. Gally (1994) reported *Glomerella cingulata* as the causal agent of anthracnose

from *D. picta* [*D. maculata*] in Argentina. It was suggested that the appearance of *G. cingulata* on *D. maculata* was related to the introduction of cuttings from Poland (Kotova and Gazel, 1994). The causal agent of leaf spot and stem rot symptoms of *Dieffenbachia seguine* was isolated and identified as *Colletotrichum gloeosporioides*. (Penz.) sacc. for the first time in Saudi Arabia (Shahwan, 1992). Sohi (1990) mentioned the incidence of anthracnose of *Dieffenbachia* caused by *C. gloeosporioides* from India.

Symptom

Light to medium brown, circular to irregular spots appeared with yellowish haloes and narrow dark brown margins. In many cases adjacent spots coalesced forming large irregular patches. The affected portions became thin and papery. At Allahabad, the pathogen caused irregular marginal (sometimes also central) leaf spots, smoke-grey with a rim of olive-ochre on *Dieffenbachia amoena* Hort. ex Gentil., the infected areas dropping out in 10-15 days.

Causal organism

The anthracnose disease of *Dieffenbachia*, *Dieffenbachia picta*, was caused *Colletotrichum capsici* whereas *Dieffenbachia seguine* Schott var. *variegata* Linn. was attacked by *Colletotrichum gloeosporioides* Penzig. Acervuli were numerous, black, dot-like, epiphyllous, erumpent, setose. Conidia were 1-celled, hyaline, 12 - 15µ x 3.3 - 5µ (*c.f.* Sohi, 1990). Potato dextrose agar (PDA) was the best medium for fungal growth (Shahwan, 1992). In culture and on leaves inoculated with conidia, perithecia of *Glomerella cingulata* developed in 15 - 20 days and inoculation with ascospores produced both perithecia and conidia, this being a new host record for both perfect and imperfect states of the fungus (Lal and Tandon, 1965).

Management

Mancozeb was the best fungicide to inhibit fungal growth *in vitro* (Shahwan, 1992). Of the varieties tested (Mariana, Exotica, Nelly and Alex), Mariana and Exotica were susceptible to this disease (Gally *et al.*, 1994).

Myrothecium leaf spot

Distribution

The disease was recorded earlier from USA (Chase, 1990), Poland (Orlikowski and Wolski, 1998) and Japan (Horinouchi *et al.*, 1999). During the winter of 2012, *Dieffenbachia picta* (Lodd.) Schott 'Camilla' was found to attack by *Myrothecium* leaf spot disease in Wandan Township, Pingtung County, Taiwan (Hong *et al.*, 2013).

Symptom

The disease was characterized by dark brown concentric spots with bright yellow borders on leaves. On diseased leaves, fungal fruiting bodies were sometimes observed in the concentric lesions.

Causal organism

The disease was caused by *Myrothecium roridum*. Based on physiological, morphological and molecular characteristics, the fungal isolate was identified as *M. roridum* on *D. picta* 'Camilla' in Taiwan.

In the mycelial growth test, the diameter of fungal colony reached 58.2 mm on PDA at 25°C after 14 days. The colonies were floccose, white to buff and sporulate in concentric zones with olivaceous black to black sporodochia bearing viscid masses of conidia. Conidia were narrowly ellipsoid with rounded ends. The average size of 100 conidia was $6.25 \times 1.63 \mu$ (Hong *et al.*, 2013).

Host range

Inoculation tests showed that the causal fungus was pathogenic to kalanchoe, tomato, *Spathiphyllum* sp. and *Vinca* sp. (Horinouchi *et al.*, 1999).

Epidemiology

The effect of temperature on *Myrothecium* leaf spot was studied by Chase and Poole (1985). It was observed that temperature changes as little as 2°F, such as commonly occurring from one end of a greenhouse to other were sufficient to alter disease development. At 90° F and below 65° F disease development was inhibited.

Management

Bitertanol and Kresoxim-methyl were two important chemicals used for reducing the disease incidence (Horinouchi *et al.*, 1999). In the control of *Myrothecium roridum* on *Dieffenbachia*, Chitosan at a concentration 0.06 - 0.25 per cent was used 24 hours before or after inoculation of leaves (Wojdyla *et al.*, 1996). Preventive spraying of *Dieffenbachia* with Chitosan in lower concentrations was more effective in *Myrothecium* leaf spot control than application of the compound after inoculation. It suggested that chitosan might induce resistance reaction in the invaded plants (Wojdyla *et al.*, 1996). The herb extract from *Echinacea purpurea* at concentrations of 0.05 and 0.1% significantly decreased the development of *Myrothecium* leaf spot on *Dieffenbachia cv. compacta* (Orlikowski and Wolski, 1998).

Cephalosporium leaf spot

Symptom

On *Dieffenbachia picta*, infection appeared first on the young, rolled leaves as tiny,

reddish-brown circular to elongate lesions. These increased in size as the leaf unfolds and expands, later becoming almost circular in outline sharply delimited by dark brown border. The central portion of the lesions became greyish. Lesions were also formed on other parts of the plant. Infection commonly occurred through wounds caused by mealybugs, which feed under the leaf sheaths.

Causal organism

The disease was caused by *Cephalosporium dieffenbachiae*.

Management

Promiscuous syringing should be avoided. Optimum spacing should be given for proper maintaining the temperature and humidity. Controlling mealybugs by timely spraying with malathion (*c.f.* Pascal, 1978). The spraying of bavistin (0.1%) or copper oxychloride (0.3%) was also recommended (*c.f.* Sohi, 1990).

Bacterial diseases

***Pseudomonas* leaf spot and blight**

Distribution

The bacterial leaf spot disease caused by *Bacterium dieffenbachiae* was recorded earlier from United States, on commercially important *Dieffenbachia picta* cultivar (McCulloch and Pirone, 1939). Later on, leaf spot and blight of *D. amoena*, caused by *Pseudomonas marginalis pv. marginalis* were described for the first time, in Italy (Scortichini, 1994).

Symptom

Infection first appeared in the form of circular to elongated spots, up to 1 cm. in diameter,

with dull watery-green centre, orange-brown borders and irregular outer margins delimited by the veins. When the spots were numerous and conditions were favourable for the disease, the spots coalesced into large, yellow, wilted and dry areas. At this stage the dead leaves were dull, tan or light brown, thin and tough. The spots were covered on the lower - and later to some extent also on the upper-surfaces by a waxy, silvery-white, thin layer of exudates (McCulloch and Pirone, 1939).

Causal organism

The pathogen, Bacterium (or *Phytomonas*) *dieffenbachiae* n. sp. (McCulloch and Pirone, 1939) (Now known as *Pseudomonas marginalis pv. marginalis*) was a bacterium consisting of single or paired rods, the former measuring 0.9 to 2.8 (mostly 1 to 1.5) by 0.3 to 0.4 μ . It was motile by a single polar flagellum, capsulate on media containing starch or dextrose, aerobic, Gram-negative, non-acid-fast, liquefying gelatine and blood serum, producing a moderate amount of hydrogen sulfide and ammonia, but no indol. The colonies on beef-peptone agar at 23° to 25° C were circular, entire, flat, smooth, thin and translucent, massicot or Naples yellow, attaining a diameter of 2 to 4 mm. in six or seven days (McCulloch and Pirone, 1939). The bacteria made their optimum growth at 30° to 31°C, the minimum and maximum temperatures being 5°C and 37° to 38°C, respectively, and the thermal death point 48°C.

***Erwinia* stem rot**

Distribution

The occurrence of soft rot disease of *Deffenbachia* spp was reported from different parts of the world. Soft rot of *D. maculata* was reported first time in Syria by Balestra and Impiglia (1996). Severe outbreaks of

bacterial stem rot disease occurred on *D. amoena* in the eastern mediterranean region of Turkey (Yildiz *et al.*, 2004). Besides Syria and Turkey, a devastating stem rot disease of *D. picta* was observed in the greenhouse of the Faculty of Agriculture, Minia University, Egypt (Ouf *et al.*, 1997).

Symptom

Characteristic symptoms of the disease were darkening and water soaking lesions of the lower leaves and on stem at or below the soil level and browning in the conducting water vessel and pith of the diseased plants which became finally wilted (Yildiz *et al.*, 2004). Eventually, the stem and leaves completely rotted, and the plants collapsed. Naturally infected plants of *D. picta* showed symptoms of soft rot on the stems (Ouf *et al.*, 1997).

Causal organism

The disease was caused by a motile, rod shaped, Gram-negative bacteria *Erwinia chrysanthemi* pv. *dieffenbachiae*. Pectolytic and cellulolytic activity of enzymes secreted by the bacteria, caused stem soft rot on *Dieffenbachia* plants. Diagnostic tests and electron microscopic examination suggested that the pathogen was a new species, for which the name *Erwinia dieffenbachii* was proposed.

Host range

Host range studies revealed that the pathogen was able to produce soft rot on fruits or stems of aubergines, tomatoes, pepper, squashes, potatoes, carrots, turnips and table beet roots (Ouf *et al.*, 1997).

Management

Infected canes to be used for propagation should be dipped in Agrimycin or in hot water (*c.f.* Pascal, 1978).

***Xanthomonas* leaf blight**

Distribution

A distribution map for *Xanthomonas campestris* pv. *dieffenbachiae* (McCulloch and Pirone) Dye. Has been prepared on different araceae host species including *Dieffenbachia* (Anonymous, 1996). Information is given on the geographical distribution pathogen in Asia, Philippines, Australasia, Oceania, Australia, Hawaii, Tahiti, North America, Canada, USA, Central America, West Indies, Guadalupe, Jamaica, Martinique, Puerto Rico, South America, Brazil and Venezuela (Anonymous, 1996).

Symptom

At the initial stage of leaf blight, the spots were at first minute, yellow, or yellowish-orange with translucent centers. Under humid weather large amount of bacterial ooze appeared on the lower surfaces of the spots. Later the ooze might appear on the upper surfaces. The spots enlarged up to ½ inch in diameter and ran together. Under dry weather conditions the spots did not enlarge but turned reddish-brown, giving the leaves a speckled appearance. They were somewhat limited in size by the larger veins. If they were excessive spotting, the result was a general yellowing, wilting and death of the infected parts of the leaves, which turned brown and became thick and tough (*c.f.* Pascal, 1978).

Causal organism

The disease was caused by *Xanthomonas campestris* pv. *dieffenbachiae*. Characterization of *Xanthomonas campestris* strains from aroids using physiological, pathological and fatty acid analyses was done by Chase *et al.*, (1992). A total of 149 strains of *X. c.* pv. *syngonii* and *X. c.* pv. *dieffenbachiae* from ornamental and agronomic aroid plants were characterized by

pathogenic and physiological reactions. Genetic analyses of *Xanthomonas axonopodis* pv. *dieffenbachiae* strains revealed distinct phylogenetic groups. A comprehensive analysis of 175 *Xanthomonas axonopodis* pv. *dieffenbachiae* strains isolated from 10 Araceae hosts was done to identify pathogen variation (Donahoo, 2013).

Management

Proper spacing should be given for lowering temperature. Spraying with Paushamycin (50ppm) or Streptomycin and roguing out infected plants were recommended for this disease (c.f. Sohi, 1990). Norman *et al.*, (1997) worked on twenty commonly grown *Dieffenbachia* cultivars, tested for their resistance to diseases affecting production caused by the following fungal and bacterial pathogens including *Xanthomonas campestris* pv. *dieffenbachiae* [*X. axonopodis* pv. *dieffenbachiae*]. Cultivars with horizontal resistance toward tested pathogens could then be easily identified. The cultivars Camille, Compacta and Parachute showed the broadest horizontal resistance, with resistance to 3 of the 4 pathogen groups tested. It was concluded that the disease resistance identified in this research permitted the selection of plants for use in breeding programmes.

Viral diseases

A flexuous rod-shaped virus, 754 nm long, was isolated from diseased plants in commercial plantings of taro and the ornamentals *Dieffenbachia* spp., *Caladium* spp., and *Zantedeschia* spp. in South Africa (Francine and Vander, 1985). The virus was identified as dasheen mosaic virus. Its host range was limited to Araceae. It was transmitted non-persistently by *Myzus persicae*, and no seed transmission was detected. Virus particle morphology and

inclusions were typical of the potato virus Y group (Francine and Vander, 1985).

A separate virus named Arabis mosaic virus (ArMV) was detected as pathogenic to *Dieffenbachia* along with seven representing ornamental plant families (Samuitiene *et al.*, 2008). In naturally infected host plants, the virus was found in mixed infections with other viruses. Virus identity in five ornamental species was confirmed by RT-PCR (Samuitiene *et al.*, 2008).

However, Rivas *et al.*, (2000) observed chlorotic spots and rings on *Dieffenbachia picta* [*D. maculata*] in Sao Paulo State, Brazil. The causal agent was identified as Tobamoviruses.

In addition to above three viruses infecting dieffenbachia, tomato spotted wilt tospovirus was reported in crops of tomato, *Capsicum*, *Gerbera*, *Chrysanthemum*, *Dieffenbachia* and 20 other plant spp. in 9 of the 16 farms inspected (Kaminska *et al.*, 1994). The percentage of infected plants varied (1 - 100), depending on the crop and farm. Mass appearance of the virus in Poland was correlated with the recent arrival of an important thrips vector, *Frankliniella occidentalis*, and extensive movement of plant material. The isolated virus was identified by symptomatology, host range, stability in sap and ELISA.

Another important Konjac mosaic virus naturally infecting three aroid plant species was also recorded from Andhra Pradesh, India (Padmavathi *et al.*, 2011). The genomes of three potyvirus isolates from, respectively, naturally infected *Dieffenbachia* spp. *Colocasia esculenta* and *Caladium* spp. in Andhra Pradesh, India, were amplified by RT-PCR using degenerate potyvirus primers. Sequence analysis of RT-PCR amplicons (1599 nucleotides) showed maximum identity

of 97% with the KoMV-Zan isolate from Taiwan (A/C AF332872) (Padmavathi *et al.*, 2011). The CP gene of the three isolates had 93.1-100% (nucleotide) and 98.2-100% (amino acid) identity (Padmavathi *et al.*, 2011). The three potyvirus isolates associated with mosaic, chlorotic feathery mottling, chlorotic spots, leaf deformation and chlorotic ring spots on three aroids were identified as isolates of KoMV for the first time from Andhra Pradesh, India (Padmavathi *et al.*, 2011).

Serological and molecular detection of Impatiens necrotic spot virus (INSV) was done in *Dieffenbachia amoena* (Mazandaran) from Iran (Ghotbi, 2013).

Nematodes

The plant-parasitic nematodes are responsible for serious injuries in roots and shoots of ornamental plants, reducing its beauty and consequently its economic value. A study was conducted in Nigeria to screen 16 ornamental plants including *Dieffenbachia* for root-knot nematode, *Meloidogyne incognita* resistance (Salawu and Darabidan, 2010). It was found that *Dieffenbachia picta* was moderately to highly susceptible to nematode infection. Galled roots of infected plants contained developmental stages of *Meloidogyne incognita* (Salawu and Darabidan, 2010). Besides root knot, *Rotylenchulus reniformis*, the reniform nematode was also recorded in several species of *Dieffenbachia* (Starr, 1991).

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