

IMPORTANT DISEASES OF ORCHIDS AND THEIR MANAGEMENT



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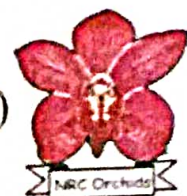
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Technical bulletin

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Pakyong- 737 106, East Sikkim, Sikkim, India

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Cover Photographs

First row: left to right: *Coelogyne flaccida* showing anthracnose symptoms, *Cymbidium* hybrid showing black rot symptoms, brown coloured sclerotia on orchid wilt affected *Cymbidium* hybrid, root necrosis of *Cymbidium* hybrid due to *Helicotylenchus microcephalus*.

Second row: black rot affected *Cymbidium* shoots, ringspot symptoms on *Cymbidium aloifolium* due to ORSV infection,

Third row: *Aranda* hybrids showing black spot on leaves and stem, *Calanthe* sp. showing blight symptoms due to *Colletotrichum gloeosporioides*, Sun burn symptoms on orchid leaves, *Phalaenopsis* flower showing dark spots due to *Botrytis cinerea*

Back cover photograph

Phalaenopsis flower showing petal blight due to *Botrytis cinerea*

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FOREWORD

Orchids exhibit an incredible range of diversity in size, shape and colour of their flower. They are widely grown for production of commercial cut flowers and potted plants. They have extremely beautiful flowers and long vase life which fetch very high price in national and international market. The orchid cultivation is affected by large number of fungal, bacterial, nematode and viral diseases. These diseases cause great losses to the orchid growers in terms of quality and quantity. In our country, no attention has been given to study the disease and pests of orchids in the past but as the orchids is emerging in the world floral market in the recent years, attention is being given to study diseases and pests of orchids and adopt sanitary and phytosanitary measures as per WTO requirements for import and export. After the inception of National Research Centre for Orchids in 1996 at Pakyong, Sikkim, a systematic study on important diseases of orchids, their epidemiology and management practices are worked out.

This technical bulletin covers all the important diseases of orchids emerging in Sikkim and Darjeeling hills. The major diseases like anthracnose, black rot, petal blight, wilt, root necrosis nematode, bacterial diseases their distribution, identification, epidemiology and management strategies have been discussed. The important viral diseases of orchids namely Cymbidium mosaic and Odontoglossum ringspot viruses have

also been discussed with their symptoms, mode of transmission, detection and management practices. The authors have made this technical bulletin self explanatory and handy so that it can be easily accessible to the common orchid growers. The photographs showing symptoms are of very good quality and pathogens have been correctly identified.

It gives me immense pleasure to bring out this technical bulletin on "*Important Diseases of Orchids and Their Management*" which is the outcome of the research work done in NRC for Orchids for the last one decade. I am sure this bulletin will be useful for the orchid growers, extension workers, students and research workers to identify the diseases correctly and manage them efficiently so that disease free production of orchids can be accomplished.

February 2013
NRC for orchids, Pakyong, Sikkim



R. P. Medhi
Director

Preface

Like any other crops orchids are also affected by large number of diseases caused by fungi, bacteria, nematode and viruses. Generally, orchids are less affected by pest and diseases in natural conditions but when they are cultivated under protected conditions they are attacked by large number of pathogens causing anthracnose, black rot, petal blight, wilt, leaf blight or leaf spots etc. The commercial cultivation of orchids in Sikkim is increasing gradually and at present about 25-30 hectares area is under cultivation and producing about 2.5 million spikes. During the last one decade extensive surveys was undertaken in the state and documented large number of pathogens associated with orchids. The identification, epidemiology, host range and management strategies of major pathogens of orchids were carried out. A new nematode disease, causing root necrosis disease in *Cymbidium* hybrids, has also been reported on some imported *Cymbidium* hybrids.

I sincerely thank Dr. R. P. Medhi, Director, NRC for Orchids for his encouragement, support and valuable advice for writing this bulletin. I profusely thank Dr. T. K. Bag, who initially started systematic work on orchid diseases in Sikkim and Darjeeling hills and has been a source of inspiration for me to continue the work on orchid diseases. Many of the diseases described in this bulletin like *Sclerotinia* rot, orchid wilt, rust, blight of *Bulleyia yunnanensis*, web blight of *Pleione humilis* has been identified by him. I also thank Mr. Mrinas Das, Ms. Boichitra and Ms.

Smita Gupta, who worked with me as RA and SRF and involved in isolation, identification and management of orchid pathogens. I take this opportunity to thank members of QRT, RAC and IRC for their valuable suggestions.

I hope this bulletin will be helpful for the orchid growers of Sikkim in identification and proper management of various diseases occurring on orchids so that they can increase their production qualitatively and quantitatively.



R. P. Pant

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1. Introduction

Orchids belong to the family Orchidaceae, which is the largest and highly advanced family of the flowering plants comprising more than 30,000 species under 800 genera. It is estimated that about 1300 species are found in India with Himalayas as their main home beside Eastern and Western Ghats. Sikkim Himalayas comprising hills of Sikkim and Darjeeling contain about 525 species of orchids belonging to 137 genera. Orchids exhibit an incredible range of diversity in size, shape and colour of their flower. They are found in different climatic conditions and are capable of growing in soil, tree trunks, rock surfaces and dead organic matter. More than 60% orchids are epiphytes which depend on other trees for support but do not take nutrition from them. They have extremely beautiful flowers and long vase life which fetch very high price in national and international market. The commercial cultivation of orchids both for potted plant as well as cut flower production has been developed in many countries. Development and deployment of new technologies is very important for improvement of flower quality and rapid and mass propagation to meet the demand of orchids in the future as well as conservation of biodiversity. Number of orchid species and more than 100 commercial hybrids are cultivated in this region by nurserymen and hobby growers under protected conditions. Sikkim is pioneer in orchid cultivation in the country and it is 100 year old business. The famous Pradhan families of Sikkim and Kalimpong (W.B.) are associated in orchid

cultivation and their conservation.

Like any other crops, orchids are also affected by number of diseases and pests. There are about 130 plant diseases affecting one or more orchid genera caused by fungi, bacteria, nematode and viruses. In India, no attention has been given to study the diseases and pests of orchids in the past but as the orchids is emerging in the world floral market in the recent years, attention is being given to study diseases and pests of orchids and adopt sanitary and phytosanitary measures as per WTO requirements for import and export. Generally, orchids are less affected by diseases and pests in their natural habitat but can succumb to number of diseases and pests when they are cultivated under protected conditions. Several diseases and pests have attained significant status and can lead to severe losses. Plants infected by diseases and pests lose their vigor, production capacity and affect their market value considerably. Among fungal diseases, black rot (*Phytophthora palmivora*, *P. parasitica*, *Pythium ultimum* and *P. splendens*), anthracnose (*Colletotrichum gloeosporioides*), orchid wilt (*Sclerotium rolfsii*), petal blight (*Botrytis cinerea*), rust (*Uredo* sp.), leaf blight (*Fusarium oxysporium*), *Sclerotinia* white rot (*Sclerotinia sclerotium*), and leaf spots (caused by species of *Fusarium*, *Cercospora*, *Alternaria*, *Pestalotia* and *Haplosporella*) are most common. The bacterial soft rot, caused by *Erwinia* sp. has been reported on many *Cymbidium* hybrids and orchid species. An ecto-parasite nematode, *Helicotylenchus microcephalus*, causing root necrosis has also been reported on many *Cymbidium* hybrids.

The orchids have more virus diseases than any other crops. There are more than 50 viruses known to infect orchids all over the world but in India, nine viruses namely Cymbidium mosaic *potexvirus* (CymMV), Odontoglossum ringspot *tobamovirus* (ORSV), Calanthe mild mosaic *potyvirus* (CalMMV), Cymbidium ringspot *tombusvirus* (CyRSV), Cucumber mosaic *bromovirus* (CMV), bean yellow mosaic *potyvirus* (BYMV), Orchid fleck *rhabdovirus* (OFV), vanilla mosaic *potyvirus* (VanMV) and vanilla necrosis *potyvirus* (VNV) have been reported. Among them, CymMV and ORSV are the most important and prevalent viruses. These viruses are widely distributed on all commercial hybrids and species in Sikkim and Darjeeling hills.

2. Diseases of orchids and their seasonal incidence in Sikkim and Darjeeling hills

Sl. No.	Name of disease	Causal Pathogen	Plant part affected	Period of occurrence
1.	Anthracnose	<i>Colletotrichum gloeosporioides</i>	Leaf, stem and flower	April-September
2.	Black rot	<i>Phytophthora palmivora</i> , <i>P. parasitica</i> , <i>Pythium ultimum</i> and <i>P. splendens</i>	Leaf, pseudobulb and new shoot	April-September
3.	Orchid wilt	<i>Sclerotium rolfsii</i>	Pseudobulb, crown region, stem and root	June - August
4.	Petal blight	<i>Botrytis cinerea</i>	Flower petal, flower spike, leaf and pseudobulb	January - June
5.	Rust	<i>Uredo</i> sp.	Leaf, inflorescence, aerial portion of pseudobulb and stem	Throughout the year

6.	Leaf blight of <i>Thunia bensoni</i>	<i>Rhizoctonia solani</i>	Leaf and stem	June - July
7.	Blight of <i>Bulleyia yunnanensis</i>	<i>Fusarium oxysporum</i>	New shoot and inflorescence	April - September
8.	Web blight of <i>Pleione humilis</i>	<i>Rhizoctonia solani</i>	Leaf and stem	June-July
9.	Leaf spot of <i>Zygopetalum intermedium</i>	<i>Alternaria alternata</i>	Leaf	April September
10.	Black leaf spot of <i>Aranda</i> , <i>Mokara</i> and <i>Renanthera</i> hybrids	<i>Pestalotia</i> sp.	Leaf and stem	Throughout the year
11.	Bacterial soft rot	<i>Erwinia corotovora</i> pv <i>corotovora</i>	Stem	April September
12.	Bacterial brown rot	<i>Pseudomonas cattleya</i>	Leaf	April September
13.	Root necrosis nematode	<i>Helicotylenchus microcephalus</i>	Root	Throughout the year

3. Important Fungal Diseases

3.1 Orchid Anthracnose

Causal pathogen: *Colletotrichum gloeosporioides* (Penz) Sacc.

The anthracnose disease is an important disease of orchids found in all orchid growing areas of the country. The disease has become a serious constrains in orchid cut flower production in Sikkim and Darjeeling hills over the last few years. It is most destructive disease and known to cause great losses to the orchid growers in terms of quality and quantity. The causal organism of the disease was described by various workers as *Colletotrichum orchidacearum*, *C. gloeosporioides*, *C. dendrobii* and *Glomerella cingulata*. But on the basis of molecular

characterization, it has now established that the anthracnose disease of orchids is caused by *Colletotrichum gloeosporioides*.

Distribution

The disease has been reported from Arunachal Pradesh, Assam, Kerala, Meghalaya, Maharashtra, Sikkim, Uttarakhand and West Bengal.

Symptoms

The pathogen attacks all the above ground parts of the plants but leaves are more frequently attacked. Initially small oblong to circular, oval, sunken and reddish brown to dark brown and grey coloured spots appear at the tip or middle of the leaf lamina which gradually enlarges and covers large area of the leaf surface. It generally attacks leaves, petioles and blooms during periods of prolonged leaf moisture and high humidity. It also produces dieback symptoms which start from the tip and proceed downward. It produces conidia within black acervuli. It also affects leaf sheaths, stems and floral spikes. It is found in nature mostly in conidial stage and can over winter as mycelium or conidia.



Anthracnose on *Cymbidium*
hybrid



Vanda cristata



Cym. devonianum



Calanthe triplicata



Coelogyne flaccida



Thunia marshalliana

Host range

The disease has been reported from a number of orchid species like *Arachnis rubra*, *Agrostophyllum brevipes*, *A. callosum*, *Bulbophyllum guttulatum*, *B. scabratum*, *Coelogyne corymbosa*, *C. barbata*, *C. fuscescens*, *C. elata*, *C. flaccida*, *C. flavida*, *C. nitida*, *C. ovalis*, many *Cymbidium* sp. and hybrids, *Dendrobium hookerianum*, *D. nobile*, *D. densiflorum*, *D. chrysotoxum*, *D. chrysanthum*, *D. moschatum*, *D. kingianum*, *D. fimbriatum*, *D. thysiflorum*, *Eria amica*, *E. bamboosifolia*, *E. graminifolia*, *E. pamila*, *E. pubescens*, *E. radiata*, *E. spicata*, *E. vitata*, *Epigonium rotundatum*, *Flickengeria fugax*, *Liparis viridifolia*, *L. botanensis*, *L. longipes*, *L. plantaginea*, *Pholidota articulate*, *P. rubra*, *Otochilus* sp., *Thalasis longifolia* and several *Cymbidium* hybrids. Few *Cymbidium* hybrids infected by the fungus are: Bertha 'Petershort', Yankalila, Madrid 'Forest King', Show Girl 'Cooksbridge' X Cold Stream, Coral Sea, Evening Star 'Pastel Princess', Susan Hughes 'R.D. Hughes and Sayonara Blazing Gold.

Epidemiology

The pathogen perpetuates when phytosanitary measures are not adequate. The fungus survives on quiescent infection of small lesions on leaves and pseudo stem. During summer season these lesions become necrotic. It also spread through infested compost, media or leaf mould and through old contaminated pots. The disease usually occurs throughout the year. However, during June-September when the temperature reaches over 30°C and relative humidity is above 80%, the incidence is very high.

Management

Immediate removal of the diseased plants from the polyhouse and manually cutting of infected leaf portions with sterilized scissors. Repotting of the plant with proper sterilized potting mixture and fungicidal treatment is recommended. Contaminated pots, potting mixture and wooden benches should be sterilized with 2% formalin. Keep the surrounding free from other host plants. Plant should not be exposed to direct sunlight as direct exposure to sun light acts as precursor of the disease. Spraying of Blitox @2-5 - 3.0 g/litre at 10 days interval or spraying of Carbendazim + mancozeb @1g/litre of water at 7 days interval has shown good control of the disease.

3.2 Black Rot or Crown Rot Disease

Causal pathogens: *Phytophthora palmivora* and *parasitica*

Black rot of orchids is caused by the pathogens, *Phytophthora*

palmivora and *Phytophthora parasitica*. *Phytophthora* belongs to Oomycetes class and responsible for black rot disease on several species of orchids. In India, *P. parasitica* and *P. palmivora* have been reported on many orchid species and hybrids. In addition to *Phytophthora*, other fungi like *Pythium ultimum* and *Pythium splendens* have also been isolated from black rot infected orchid plants. Although *Phytophthora* and *Pythium* are different genera but their life cycles, morphology, epidemiology and control measures are similar. The identification of *Phytophthora* species is conventionally done by using selective media and microscopic examination. These procedures are cumbersome and labour intensive. To overcome these problems a highly sensitive technique, nested PCR has been developed in order to simplify and speed up disease diagnosis.

Distribution

The disease is very common in Sikkim and Darjeeling hills and has been recorded in Pakyong, Rumtek, Ranipool, Namli Garden, Namcheybong and Namchi, Raigaon, Kartok, Assam Lingzey in Sikkim and Lava, Kalimpong, Kurseong, Sukia Pokhari, Mirik, Darjeeling, Takdah orchid sanctuary and Nagari Tea estate in West Bengal.

Symptoms

It is a serious disease of orchids in which affected plant die immediately. Initially the disease appears as water soaked lesions on the aerial parts of plants which subsequently become black. The necrotic lesions develop on pseudobulbs and roots which later spread upward resulting in complete defoliation of the plant. The disease spreads very fast in the populations due to water splash and other cultural practices. New shoots also show the black rot symptoms, which starts from the portion attached with the mother plants/pseudobulbs. Several *Cymbidium* hybrids are also susceptible to the disease and shows water soaked lesions on the leaf, which later get transformed into blight symptoms covering larger leaf area. Black rot symptoms on leaves might be initiated by secondary air borne inoculum. These pathogens are also responsible for damping-off of seedlings in orchids.



Black rot infected
Cattleya pseudobulb



Black rot infected shoots of
different age (*Cymbidium*
hybrid: Red Star)



Black rot on potted and soil grown *Cymbidium*



Black rot symptom
on leaf of *Cymbidium* hybrid



Black rot on shoots
of *Cymbidium* hybrid

Host range

The disease has been reported on number of orchid species and hybrids of *Aerides*, *Ascocenda*, *Cattleya*, *Coelogyne*, *Cymbidium*, *Dendrobium*, *Epidendrum*, *Oncidium*, *Paphiopedilum*, *Phalaenopsis*, *Vanda* etc. The important *Cymbidium* hybrids which are found susceptible to the disease are: Cym. Takarjuki, Cym. Red Star, Cym. Rievaulx 'Cooksbridge', Cym. Soul hunt, Cym. Tahiti, Cym. Showgirl Marion Miller, Cym. Arabian Nights 'Glacier', Cym. Princess Elizabeth 'Linda', Cym. Whitish miniature, Cym. Velvet Green, Cym. Khyber Pass 'Rowe's Red X Red Star, Cym. Mayfair 'stonehurst', Cym. Golden Girl, Cym. Oklahama tetraploid.



Black rot on potted and soil grown *Cymbidium*



Black rot symptom on leaf of *Cymbidium* hybrid



Black rot on shoots of *Cymbidium* hybrid

Host range

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Cym. Sarah Jean, Cym. San Francisco 'Del Rio', Cym. Ann Green, Cym. High lander 'Cooksbridge', Cym. Luana "imperial", Cym. Brass Bottom, Cym. Pesibi Rose Queen, Cym. Bertha "Petershort", Cym. Agnes Norton "Shoe Off".

Epidemiology

The disease appears with the initiation of rainy season in the month of May and continues up to September. During this period the climatic conditions are very congenial for the development of the disease. The disease mainly spreads through contaminated potting media or water splash from adjacent infected plants or even through irrigation water. Plants grown in soil are more infected than raised beds. Rotting occurs mostly on the *Cymbidium* plants grown in clay soil beds, which are practically observed lower in elevation and easily get moistened with excessive water by rain or overhead irrigation. Besides where rainwater was continuously drops on the plants, make the plant surface wet for longer period. Temperature in the range of 24-30°C and relative humidity of 80-95% and continuous rainfall coupled with misty foggy weather favour the disease.

Management

Use of unsterilized potting media and pots should be avoided. Remove the infected plants and also destroy infected parts to check further spread of the disease. A good aeration in the nursery is essential. Reduce watering when disease is expected to occur (June-September). It is advisable to keep the orchid plants on

benches, 90-120 cm above the ground level to avoid contamination through water splash. In terrestrial orchids proper drainage should be provided. For effective control, matco MZ or metalaxyl @ 1g/l or mancozeb @ 2g/l can be used as spray or soil drenching. Application of contact fungicide e.g. captan, thiram or mancozeb alternately with a systemic base fungicide metalaxyl is recommended.

3.3 Blossom Blight/Petal Blight/Leaf Blight

Casual pathogen: *Botrytis cinerea*

The petal blight of orchids is a serious disease causing considerable damage to flower petals and makes flower spikes unmarketable thereby causing serious losses to the growers. The pathogen also causes leaf blight on *Phaius tankervilleae* and few other orchids.

Symptoms

The most prominent symptoms are water soaked lesions and dense grey mold growing on infected tissues. It is the most common disease of orchid flowers. The disease first appears as numerous small dark spots on petals, especially on older flowers. Sometimes shot hole effect is found in infected flower petals. In case of petal blight on *Calanthe triplicata*, the fungus causes drying of flowers with visible gray coloured fungal growth over the infected flowers. The fungus also causes top leaf blight when new young leaves start to emerge. Sometimes the fungus also attacks pseudobulbs and leaf sheaths. The incidence of the disease on *Phaius tankervilleae* was reported up to 36%.



Phalaenopsis flowers showing severe infection of blight

Host range

The fungus is known to infect many orchid species like *Aerides odoratum*, *Cattleya maxima*, *Cymbidium pendulum*, *C. lowianum*, *C. aloifolium*, *Eria javanica*, *Phaius tankarvillae*, and *Phalaenopsis lobii* and their hybrids.

Epidemiology

The fungal spores are disseminated by wind and rain splashes. *Botrytis cinerea* is active in a wide range of temperature. However, optimum temperature range is 21-25⁰ C. The fungus is particularly very troublesome under conditions of moderate temperature and high relative humidity (92-93%). Free moisture is an essential component for germination of spores and growth within plant tissues and spread of the disease is faster in young, tender and succulent plant parts. However, dry weather restricts growth of the fungus. In Sikkim and Darjeeling hill conditions, the disease usually occurs on most of the orchids during Feb.-May due to favourable temperature and relative humidity.

Management

Botrytis multiplies very fast producing several cycles of asexual spores that are migrated by air currents. As spores may originate in decaying vegetative tissues and old flowers, removal or destruction of spore regenerating source is an important part. Orchid growers should give great attention to avoid condensation or deposition of water on plant parts and avoid overhead watering during blooming. Wider plant spacing, ensure ventilation to minimize disease incidence. Many chemicals are effective against gray mould. Spraying with Bavistin @ 1g/l or Indofil M 45 @ 2g/l or Topsin M @ 2g/l or Benlate @ 1g/l at 7-10 day interval are effective against petal blight of orchids.

3.4 Orchid Wilt

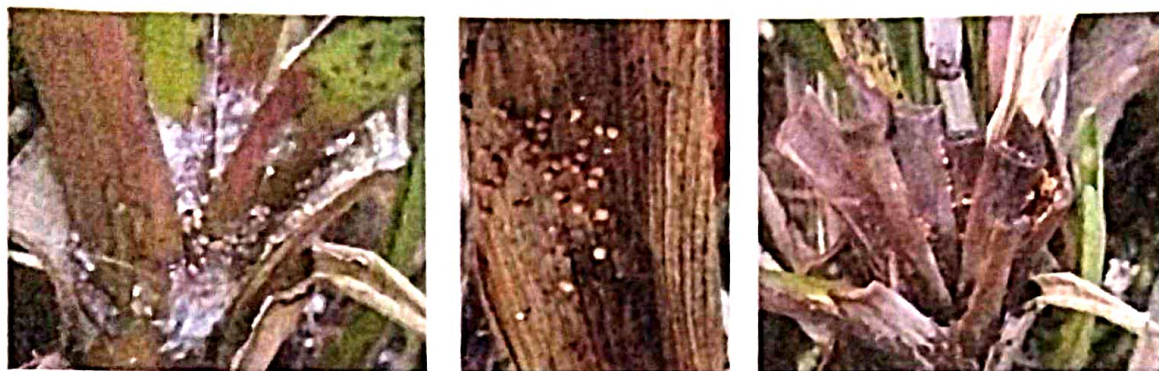
This fungus has a very wide host range outside orchid family. The disease has been reported from tropical as well as temperate regions. In India, the disease has been reported on two important orchids: *Phaius flavus* and *Paphiopedilum venustum* which are very common in Sikkim and Darjeeling hills.

Causal pathogen: *Sclerotium rolfsii*

Symptoms

The disease appears rapid collapse and rotting of roots and stems/pseudobulbs. The affected plants turn yellow and rot and eventually become brown and dry. Leaf base turns yellow and defoliated. Presence of mycelial webs with fan shaped growth on the infected surface is the sign of disease. The formation of small,

brown colored sclerotia on the affected tissue is a diagnostic characteristic of the disease. These sclerotia are very hard structure made up of fungal threads in which food material is stored which is used under dormant conditions. These sclerotia may survive in the soil or in potting media for long period



Sclerotium wilt on *Cymbidium* hybrids

Host range

The disease has been reported from number of orchids namely *Acampe*, *Eria*, *Paphiopedilum*, *Phaius*, *Dendrobium*, *Tainia*, *Pleione*, *Bulbophyllum*, *Lycaste*, *Calanthe*, *Robiquetia*, *Vanda*, *Luisia* and many *Cymbidium* species and hybrids. Some of the *Cymbidium* hybrids which are severely infected with the fungus are: Bertha 'Petershort', Yankalila, Madrid 'Forest King', Show Girl, 'Cooksbridge' X Cold Stream, Coral Sea, Evening Star 'Pastel Princess', Susan Huges 'R.D. Huges' and Sayonara Blazing Gold.

Epidemiology

The disease mainly spreads through infested compost or leaf mould. Old contaminated plant parts and pots also play important

role to spread the disease. The disease usually occurs during June-August when the temperature goes above 30°C and relative humidity above 70-80%.

Management

The disease can be managed successfully by removal of diseased plants and repotting of the plant using sterilized potting mixture after fungicidal treatment. Contaminated pots, potting mixture and the wooden branches should be sterilized properly with 2% formalin.

4. Other Minor Fungal Diseases

4.1 Rust

Casual pathogen: *Uredo* sp.

Symptoms

The young leaves show yellow flecks, usually on the lower surface of leaves and later on upper leaf surface. The older spots became dark with large target broad effect of numerous ruptured small pustules. Several pustules coalesced and produce larger pustules on leaves. Only uredial stage of the fungus was recorded on the orchids but no telial stage was known and the fungus has been identified as *Uredo* sp.



Phaius wallichii and *Calanthe* sp. leaves showing the rust infection

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Management

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Phaius wallichii and *Calanthe* sp. leaves showing the rust infection

Orchid hosts

Phaius tankervilleae, *P. flavus*, *P. wallichii*, *Calanthe trulliformis*, *C. plantaginea*, *C. discolor* and *C. biloba*.

Epidemiology

The disease mainly spread by air borne spores. The fungus prefers shady place with mild to moderate temperature of 13-24.7°C and relative humidity of 30-73%. The disease occurs during February to April.

Management

Removal and destruction of infected leaves or if whole plant in heavily infected, spraying with Zineb @ 2g/litre.

4.2 Inflorescence Blight and Shoot Rot of *Bulleyia yunnanensis*

The fungus attacks at collar region and cause rotting and blighting symptoms. Inflorescence starts rotting from base and progress upward covering whole inflorescence. Flowers are effected badly and do not open. Whole inflorescence is covered with powdery mass of fungus.

Causal pathogen: *Fusarium* sp.

Management

Proper sterilization of media and proper sanitation gives good control of the pathogen.

4.3 Leaf Spot

Causal pathogen: *Haplosporella cymbideii*

Symptoms

The symptoms appear as buff colored areas with dark mousy grey margins. The spots are initially separate but later merged to form elongated to irregular areas with smooth margins.

Management

Removal of infected leaves, making proper ventilation and aeration etc are the some preventive measures to control the disease.

4.4 Cercospora Leaf Spot

Causal pathogen: *Cercospora* sp.

Symptoms

Symptom appears as small yellow spots on the under surface of leaf. The infected tissues become necrotic, dark brown or black and sunken.

Management

To manage the disease effectively, good sanitation practices are required. Manual cutting of infected leaves with sterilized scissors limits the disease incidence. Spraying with bavistin @ 0.1% at periodical interval is advisable.

4.5 Sclerotinia Rot of Jewel orchids

Causal pathogen: *Sclerotinia sclerotiorum*

Sclerotinia white rot reported from Darjeeling (West Bengal) on *Goodyera schlechtendaliana* and *Anoectochilus lanceolatus*. These orchids are terrestrial leafy herbaceous commonly found in

Khasi hills in Meghalaya, Manipur, Arunanchal Pradesh, Sikkim and Darjeeling hills. The disease is caused by *Sclerotinia sclerotiorum* causing 2-5% death of the plants in the beds.

Symptoms

Plants show severe chlorotic spots followed by wilting. Such plants collapse immediately. There is soft watery rot at the basal portion, which gradually rot the whole plant. Sometimes, several plants are infected at a time and all the plants fall down showing damping off symptoms. White mycelium gradually covers the collapsed plants. Black small sclerotia are formed on the rotted stem tissues. The rot caused death of 5% and 2% of *Goodyera schlechtendaliana* and *Anoectochillus lanceolatus* plants respectively in the bed.



Sclerotinia rot of *Goodyera* sp.

Host range

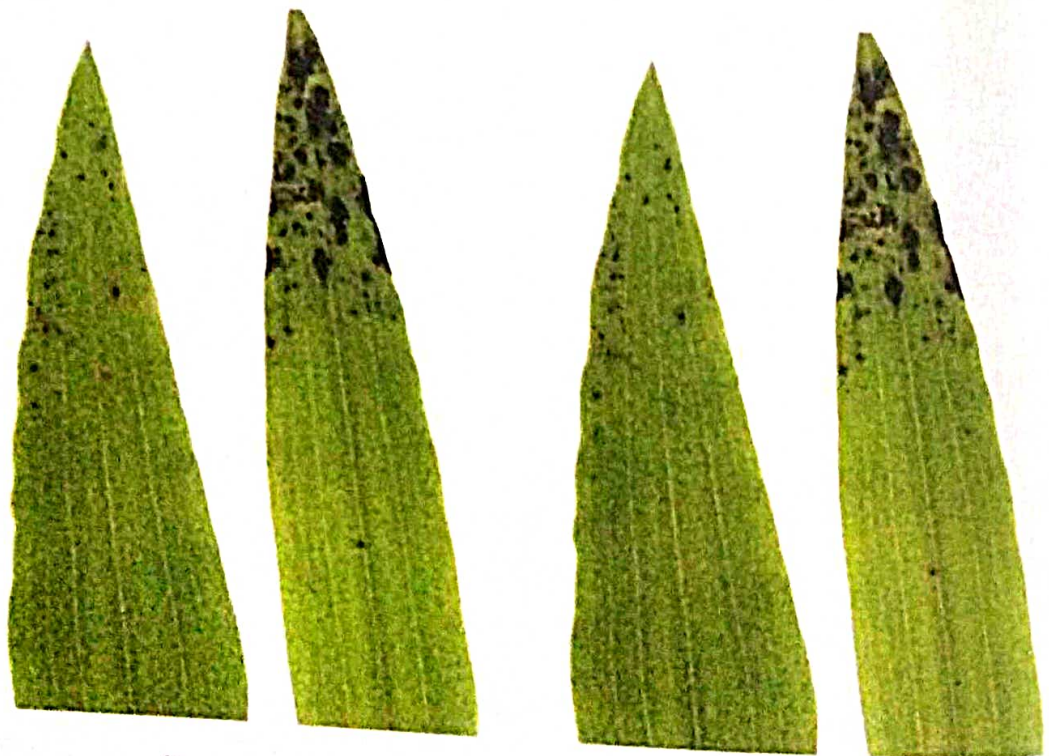
The disease has been reported only from *Goodyera schlechtendaliana* and *Anoectochillus lanceolatus* from India.

Management

Proper sanitation and use of sterilized medium provides good control of the pathogen. Fungicides like Benomyl and thiophenate-M (Ridomil) are effective against the pathogen.

4.6 Leaf Spot of *Zygopetalum intermedium*

The disease has been recorded on *Zygopetalum intermedium* causing severe necrotic spots and dark patches on adaxial surface of the leaves. The causal organism of the disease has been identified as *Alternaria alternata*.



Zygopetalum leaves showing black necrotic spots

4.7 Black Spot of *Aranda*, *Mokara* and *Renanthera* Hybrids

Hybrids of *Aranda*, *Mokara* and *Renanthera* imported from Thailand showed severe incidence of black spot disease on leaves and stem. The disease initially appears as small yellow or brown or black spots on the leaves. Under optimum environmental conditions, the spots may enlarge and coalesce to form leaf blight. The disease also produces dieback symptoms in several hybrids. The incidence of the disease is ranging from 33 to 100%. The causal organism is identified as *Pestalotia* sp.



Aranda hybrids showing black necrotic spots and leaf blight

Host Range

Aranda, *Mokora*, *Renanthera*, *Cattleya*, *Oncidium* and their hybrids.

Management

Proper sanitation and use of sterilized medium gives good control of the pathogen. Application of 0.1% mencozeb is very effective for the control of the pathogen.

5. Bacterial Diseases of Orchids

5.1 Bacterial Soft Rot

Causal pathogen: *Erwinia corotovora* pv. *corotovora*

The disease is very common in warm climate. It has very wide host range including family Orchidaceae.

Distribution

The bacteria are found worldwide on different orchid hosts. The disease has been reported from Sikkim and Darjeeling hills during rainy season.

Symptoms

The disease appears when temperature and atmospheric humidity is very high. The pathogen is very common on the leaf surface and aggressive invaders of wounded tissue. Bacteria spread generally by rain or irrigation water. The infected plants initially showed water soaking lesions and grayish-green lesions that rapidly enlarged. The affected areas are soft, decayed and brown in colour. With increasing severity the internal tissues disintegration produces foul smell and subsequently the bulb gets completely rotten and the entire plant collapsed.

Host range

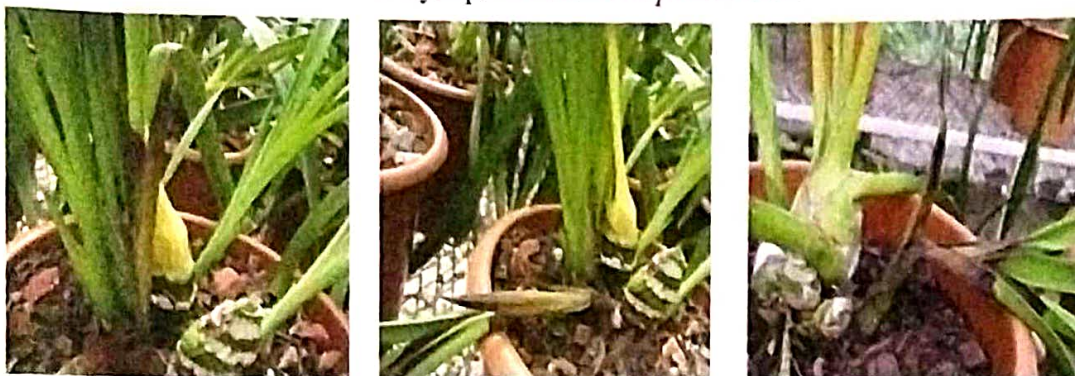
The pathogen attacks *Cymbidium aloifolium*, *Eria pubescence* and number of *Cymbidium* hybrids in protected conditions.

Epidemiology

High temperature and high humidity favour the disease. The bacterium spreads very fast by rain splash and overhead irrigation water.



Soft rot symptoms in *Eria pubescens*



Different stages of soft rot infection in Cymbidium hybrids "Winter Beach Sea green"

Management

Proper sanitation and sterilization of cutting tools with alcohol is recommended. Only disease free planting material should be used. Watering frequency needs to be less to minimize leaf wetness. Application of copper based fungicides is effective against the bacterium.

5.2 Bacterial Brown Rot

Causal pathogen: *Pseudomonas cattleya*

Symptoms

Small, soft, water soaked sunken spots are found on leaves that later become black / brown. The disease advances rapidly resulting in immediate death of plants.

Host range

Cattleya, *Phalaenopsis*, *Paphiopedilum*, *Cymbidium* and *Dendrobium*

Epidemiology

High temperature and high humidity favour the disease. The bacterium spreads very fast by rain splash and overhead irrigation water.



Bacterial brown rot on *Cattleya* sp.

Management

Acquire disease free plants and isolate new stocks for at least four weeks before integration with existing stock. It is advised to reduce prolonged wetness by increasing air circulation and the water retention capability of the growing medium. The infected leaves may be cut off to check further spread of the disease. Overhead irrigation should be avoided. Copper based fungicides are effective against bacteria. The infected plants should be drenched or sprayed with 8- hydroxyquinoline at a dilution of 1: 2000 in water.

6. Nematode Disease of Orchids

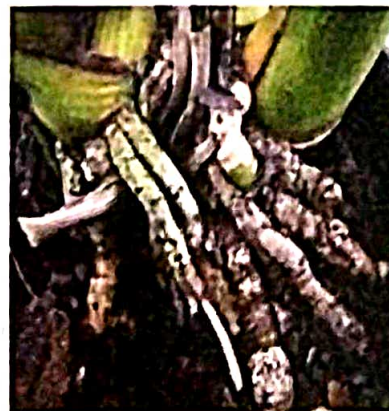
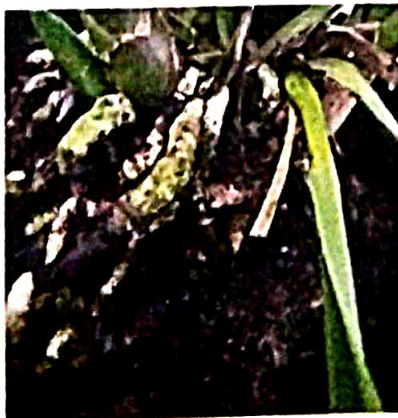
6.1 Root necrosis of *Cymbidium*

Causal pathogen: *Helicotylenchus microcephalus*

An ecto-parasite nematode has been reported on some imported *Cymbidium* hybrids in Sikkim. Although the incidence of the disease was very low but can be potential threat if proper steps were not taken for its management.

Symptoms

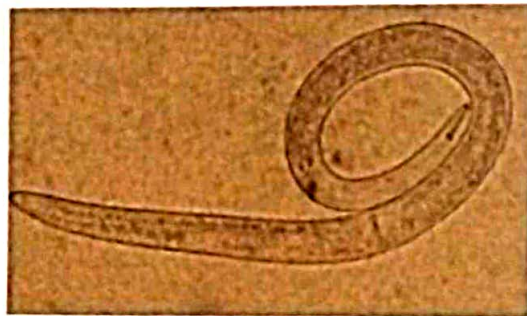
The roots of affected *Cymbidium* hybrids develop severe necrosis, swelling and fluffy root system. The leaves of affected plants also exhibited typical bending, twisting and abnormal growth. The associated nematode, *Helicotylenchus microcephalus*, is spiral, most frequent plant parasitic nematode found world wide in temperate and tropical countries. The species is considered to be migratory ecto-parasitic feeders and feed from outside the roots by inserting their stylet into epidermis of young succulent roots. Eggs are laid in the soil close to the roots or on the root surface and hatch in two or three days under favorable temperature conditions.



Underground Symptoms



Above ground Symptoms



Helicotylenchus microcephalus

Distribution

The disease has been reported at different localities in Sikkim like Raigaon, Rumtek, Namchi, Dickling, Berring, Rabanglaw and Assam Lingzey on *Cymbidium* hybrids.

Management

Control of plant parasitic nematode is achieved with nematode free planting material. Tissue cultured plants are best option. Proper cultural practices limit the spread of nematode. Hot water treatment of propagative material has limited the survival of plant parasitic nematode. Mustard oil cake, neem oil cake can be incorporated with the planting media. For heavy infestation Carbofuran 3G can be used.

7. Viral Diseases of Orchids

There are more than 50 viruses reported to infect orchids throughout the world but in India nine viruses have been reported so far on different orchid species and cultivated hybrids. But *Cymbidium mosaic Potexvirus* (CymMV) and *Odontoglossum ringspot Tobamovirus* (ORSV) are the most common and widely distributed orchid viruses. The high incidence of these two viruses in cultivated orchids can be largely attributed to their stability and ease of their transmission by horticultural tools used to cut spikes and divide plants.

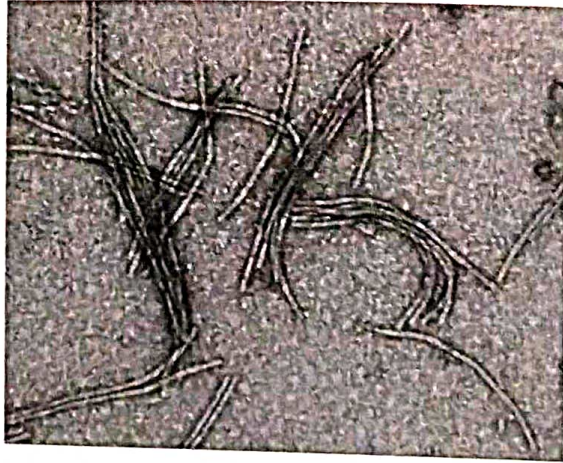
7.1 *Cymbidium* mosaic virus (CymMV)

The virus belongs to the family Flexiviridae and Genus potexvirus. The virus was first reported on *Cymbidium* sp. It is very destructive viruses of orchids which reduce the growth of the plant badly and also affects flower quality.

Symptoms

The virus produces symptoms like mosaic, necrosis, chlorotic flecks, water soaked lesions and flower necrosis on different orchid hosts. It infects almost all species and hybrids. In *Cymbidium*, mild chlorotic mosaic or blotches occur on newly emerged leaves about 18-25 days after infection, which later turn black and necrotic. Leaves having severe necrotic areas drop prematurely on *Phalaenopsis*. CymMV infection makes plant stunting. On some other species symptoms appear as sunken brown or black spots on the ventral surface of the leaves. The spots sometime appear in concentric rings with few spots breaking through to the dorsal leaf surface. *Cymbidium*

aloifolium shows sunken pits on leaves on severe infection. On *Epidendrum*, the infection leads to stunting and formation of brown or black oval spots on ventral surface. The virus is having flexuous particles measuring 480 nm in length and 13 nm in width.



Electron micrograph of Cymbidium mosaic virus (CymMV) showing flexuous filamentous particles

Transmission

The virus is transmitted by only mechanical means and no insect vector or seed transmission is reported so far.

Host range

The virus affects almost all the species of orchids and its hybrids.



Mosaic and chlorotic flecking due to CymMV infection



Severe necrosis on *Cymbidium* hybrid and *Rhynchostylis* sp.
due to CymMV infection

7.2 *Odontoglossum* ringspot virus

The virus belongs to the family *Virgaviridae* and Genus *tobamovirus*. The virus was first reported on *Odontoglossum grande* from USA.

Symptoms

The virus produces ringspot on *O. grande* and diamond mottle on *Cymbidium* spp. It produces colour breaking, chlorotic streaking, mosaic and necrosis. Some orchid cultivars are also symptom less. The virus particles are rod shaped, not enveloped, straight having model length of 300 nm and 18 nm width.



Ringspot symptoms due to ORSV on *Dendrobium* sp.,
Cymbidium hybrid and *Cymbidium aloifolium*

Electron microscopy of negatively stained preparations of dried bacilliform particles measuring 32-40 nm in diameter and 100-150 nm in length.



Chlorotic and necrotic flecks and ring spot. Symptoms of Orchid leaf blight virus on different orchid species.

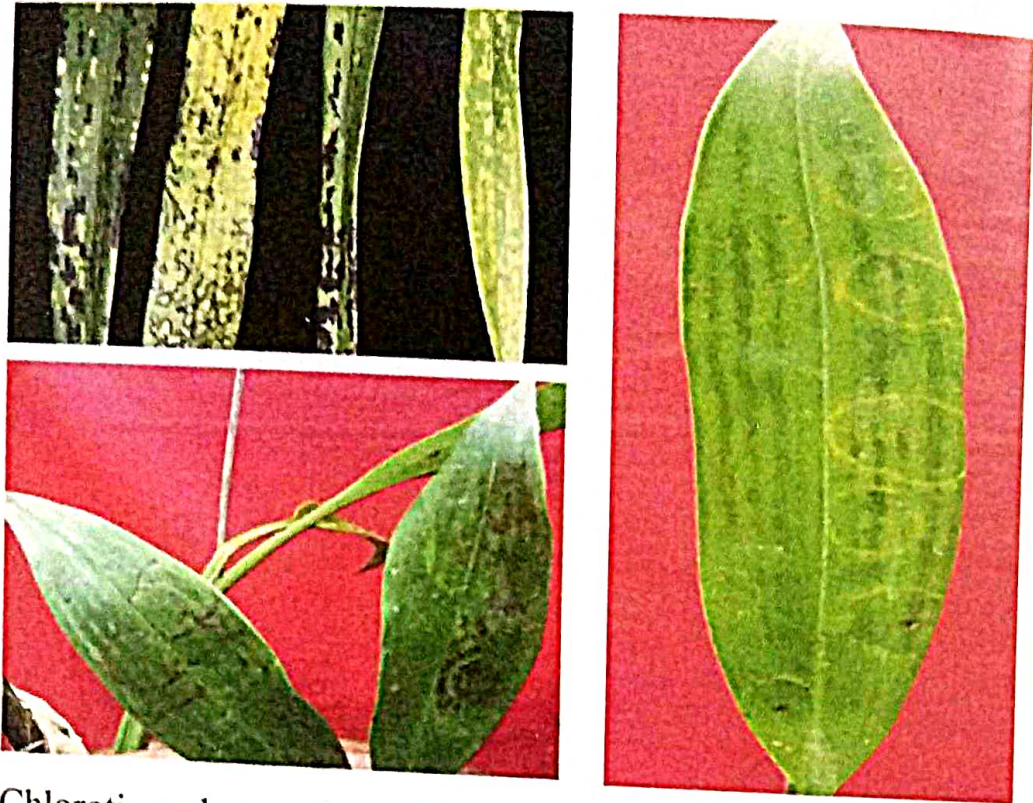
8. Detection of orchid viruses

There are number of diagnostic techniques available for the detection of orchid viruses which are accurate, reliable and less time consuming and can detect a very low concentration of virus. Generally, following four methods are used to detect the viruses from infected plants.

8.1 Bioassay

Biological assay is basically performed to confirm the virus infection using different herbaceous hosts outside family Orchidaceae. In this method symptomatic leaves from virus infected plants are taken and standard extract is prepared in

Electron microscopy of negatively stained preparations showed bacilliform particles measuring 32-40 nm in diameter and 100-150 nm in length.



Chlorotic and necrotic flecks and ring spot Symptoms of Orchid fleck *Rhabdovirus* on different orchid species

8. Detection of orchid viruses

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8.1 Biodiagnosis

Biological assay is basically performed to confirm the virus infection using different herbaceous hosts outside family Orchidaceae. In this method symptomatic leaves from virus infected plants are taken and standard extract is prepared in

certain buffer and inoculated to different indicator plants. The inoculated plants develop local lesions or systemic symptoms after a certain period. The common indicators plants used in this study for orchid viruses are: *Cassia occidentalis*, *Chenopodium amaranticolor*, *C. quinoa*, *Datura stramonium*, *Nicotiana glutinosa*, *N. benthamiana*, *N. rustica*, *Gomphrena globosa*, *Tetragonium expansa*, *Physalis floridana*, *Phaseolus vulgaris* etc.

8.2 Serological methods

Serological techniques have been extensively used for detection of low concentrations of virus in orchids. These techniques are especially useful for large scale testing of many samples at a time. In this method, enzyme linked immunosorbent assay (ELISA) is the most widely used technique for the detection of Orchid viruses. It consists of immobilization of antigen to a microtitre plate and its binding with antibody conjugated to an enzyme. The enzyme then hydrolysis with the substrate resulting yellow color which is measured by colorimeter or ELISA reader.

8.3 Electron microscopy

It is an optical instrument in which a beam of electron is used to form a greatly enlarge image of an extremely small object through a series of electromagnetic lenses. It is a vital instrument used to study the viruses, their structure and morphology. One can detect the virus from the infected plant quickly within 5-10 minutes with the help of EM.

8.4 Nucleic acid based detection

8.4.1 Polymerase chain reaction (PCR)

In this method the most widely used technique is polymerase chain reaction (PCR) which is commonly used for the detection of viral and other viruses. This technique is used to amplify the desired region of genomes could be synthesized and used as RT-PCR (Reverse Transcription Polymerase Chain Reaction). This technique is highly sensitive, accurate and reliable.

8. Management of orchid viruses

- For management of viruses, cultural practices play a very significant role particularly in orchid viruses generally spread by insect vector propagation. Hence strict sanitation practices are essential for the control of orchid viruses. Clean cultivation by avoiding the sources of infection is best option requiring minimum inputs but unfortunately this is not practiced by orchid growers.
- Meristem culture has been used to develop virus free planting material. Meristem tip culture to obtain virus free clonal material of *Cymbidium* based on the concept that majority of plant viruses do not infect the meristematic dome despite various systematic infection of the plants and therefore, this region can be excised and regenerated to plants.
- Chemotherapy using natural compounds like ribavirin (rebravon), diflunisal is being used in some culture media to get the virus free plants. It has been reported that ribavirin is very effective in eliminating virus free clonal tips and culture from parent plants infected by *Cymodictyon* and *CHV1* from *Cymbidium* cultures of *Cymbidium*.

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9. Management of orchid viruses

- For management of viruses, cultural practices play a very significant role particularly as orchid viruses generally spread by inadvertent propagation. Hence strict sanitation practices are essential for the control of orchid viruses. Clean cultivation by avoiding the sources of inoculum is best option requiring minimum inputs but unfortunately this is not practiced by orchid growers.
- Meristem culture has been used to develop virus free planting material. Meristem tip culture to obtain virus free clonal material of *Cymbidium* based on the concept that majority of plant viruses do not infect the meristematic dome despite severe systematic infection of the plants and, therefore, this region can be excised and regenerated to plantlet.
- Chemotherapy using antiviral compounds like ribavirin (virazole), dithiouracil is being used in tissue culture media to get the virus free plants. It has been reported that virazole is very effective in obtaining virus free shoot tips and callus from parent plants infected by CymMV and ORSV from *in vitro* cultures of *Cymbidium*.

- Genetic engineering coupled with tissue culture techniques offers a useful way to introduce specific genes into plants. The coat protein (CP) mediated resistance against CymMV and ORSV has been demonstrated by various workers. Similarly replicase gene has also been used for the production of virus resistant plants of various orchid genera.

9. PREVENTIVE MEASURES FOR ORCHID VIRUSES

9.1 Procurement of planting materials from reputed nurseries

Procure virus free plants from certified nurseries. Tissue cultured plants may be procured with a phytosanitary certificate issued by an authentic laboratory ensuring that the planting materials are free from orchid viruses.

9.2 Use of sterilized garden tools

Growers/polyhouse workers are advised to sterilize their tools carefully to avoid virus transmission from one plant to another plant. The garden tools can be sterilized in two ways.

9.2a Heat/flame sterilization

Generally heat treatment is commonly used for sterilization of tools. Reusable razor blades or knives should be heated in an oven at 149 °C for an hour. The most stable orchid virus ORSV can be inactivated by heating the blade of the cutting tools at 96-

100 °C for few minutes. Propane burner can be used for flame sterilization of cutting knives at least 200 °C for few minutes to inactivate the virus. Just running the flame along the edge is not sufficient and whole surface needs to heat up to 200 °C till it begins to glow.

9.2b Chemical sterilization

The tools can also be sterilized by using different chemicals by dipping them in alcohol before they are flamed. Number of liquid virus inactivating solutions is available in the market which can be used to disinfect tools. 2 % Clorox can be used to inactivate CymMV in cutting tools but not ORSV. A mixture of 2 % sodium hydroxide and 2 % formaldehyde has been recommended for treating cutting tools. 2 % solution of Sodium hydroxide can effectively reduce ORSV infectivity by 86-96 %. Use of 5% Trisodium phosphate (TSP) is another good virus inactivator because it produces a high pH in water solution. A dip in 10% solution of any of these chemicals helps in destroying viruses sticking to garden tools.

9.3 Wear disposable latex gloves while, trimming leaves or cleaning plants.

While repotting, trimming leaves, or cleaning plants up for exhibition, wear disposable latex gloves for each plant, and discard them when you clean that plant. The gloves keep hands clean and protected from abrasion by the potting mix, and any virus particles are left on the glove so it cannot contaminate next plant. Alternately, one can wash hands thoroughly with soap and

water after cleaning each plant.

9.4 Use of sterilized metal stakes

The metal stakes used to tie up spikes has to be sterilized after each use. If these stakes are not sterilized properly, orchid viruses can be transmitted easily. It is advised that bamboo stakes should not be reused. Their relative porosity can readily absorb loose virus particles, and can be a source of virus infection.

9.5 Avoidance of crowding of plant

As most of the orchid viruses like CymMV and ORSV are highly contagious, crowding of plants encourage easy transmission of virus. The movement of insects from one plant to another and shaking of leaves by wind and touching or rubbing against each other may transmit the virus from one plant to another. With the crowding of orchids in our collections, there is a risk of transmission of viruses. Strict pest control, careful watering and vigilance will help to keep the incidence of viral infection to a minimum.

9.6 Disinfection of benches

Benches can be sterilized by using 0.5% (W/V) of sodium hypochlorite solution at least 1 minute for complete disinfection. Spraying of 10 % solution of Clorox or Trisodium phosphate or Sodium hydroxide or potassium hydroxide is also used for disinfection of bench surfaces. ORSV is stable virus and persists in plant debris for years hence removal of all debris and

roots from bench surface is essential prior to chemical treatment.

9.7 Sterilization and reuse of old pots and tags

Used pots are potential source of virus infection. Therefore old pots may be used only after proper sterilization. *Cattleya* seedlings planted in sphagnum moss from pots previously growing virus infected plants can be a potential source of infection. Potting substrate should not be reused.

10. Some abiotic or physiological disorders

10.1 Edema

Some abiotic diseases have also been reported on orchids which are equally responsible for the poor growth of the crop. One such problem is known as Edema. Edema is a phenomenon in which excess water is absorbed by the roots quicker than it is lost by the leaves, causing swelling of plant cells and producing a blister-like lesion on leaf tissues. The blister-like symptoms can appear on upper or lower leaf surfaces, stems, petals or sepals. It occurs when plants watered during warm days and the nights turn cool or during periods of cool weather when water quantity is not reduced.



Blister like symptoms due to Edema

10.2 Cold injury

Cold injury leads to surface lesions, pitting, large sunken areas and discoloration. The leaves show water soaking in tissues followed by wilting and browning. This accelerates the rate of natural death.



Surface lesions and discoloration due to cold injury

10.3 Sun burn

The sun burn leads to black spots on the leaves due to overheat by exposing to direct sunlight resulting leaf scars black spots or patches on the leaves.



Sun burn symptoms on orchids

10.4 Salt toxicity

Salts present in the water and added in fertilizer accumulate over the time. Salt build up looks like whitish or brownish crust on the medium. Excess of salts is very harmful for orchid growth. Excess of salt leads to poor root growth. The root tips become brown and subsequently die. The leaf tip become brown and

show burn symptoms. To overcome such situation, dilute the fertilizer to 1/4 or 1/8 strength and flushing the pot with water monthly to drain out excess of salts



salt toxicity leads to burn symptoms on leaf tips of some orchids

10.5 Mesophyll cell collapse

During spring season particularly in *Phalaenopsis* plants express virus like symptoms due to the mesophyll cell collapse. Generally the mesophyll cells are collapsed due to the exposure of the low temperature. The symptoms are appeared after about six weeks. The affected plants show yellowing and streaking symptoms on leaves. This kind of symptoms is generally confused with viral symptoms. Such symptoms are noticed only on young leaves.



Phalaenopsis leaves showing symptoms of mesophyll leaf collapse

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