Disease and Pest Management in Flower Crops under Polyhouse






भाकृअनुप
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FOREWORD

Flowers, which symbolize love, affection, tranquility and peace, are the most beautiful creations on this earth. Among these, rose, gerbera, carnation and orchids have its admirers and enthusiasts all over the world for its use both as a commercial flower crop and as a popular exhibition flower. Their importance is well known not only from the literature but also from the statistics at both national and international markets.

Commercial floriculture has become increasingly popular not only as an essential part of good living but also as a commercial enterprise with vast potential for export. After achieving self-sufficiency in the production of food grains following the green revolution in agriculture, of higher number of quality flowers from unit area for domestic and export markets there should be strong technological base to solve the day-to-day problems.

Commercial floriculture has its own problems to achieve its full potential. One of such problems is recurrent occurrence of diseases and pests on these commercial flower crops. Due to congenial environment available inside the polyhouse for quick and easy multiplication and spread of these diseases and pests, it makes a potential problem in achieving marketable yield. Standardization of production technology particularly pest management under protected condition plays a key role in success of commercial floriculture. I am happy to know that under All India Coordinated Research Project on Floriculture, systematic efforts were made in this direction, which yielded location specific improved technologies.

I congratulate the authors for making a valuable publication **Disease and Pest Management in Flower Crops under Polyhouse** which will be of immense use to the researchers, teachers, the students and florists.

(K. P. Singh)

Pune
April, 2015

Contents

Sl.	Particulars	Page No.
1	Introduction	1
2	Causes and diagnosis of diseases and pests under polyhouse	1
3	Good agricultural practices under polyhouse	7
4	Diseases and pests of Rose	12
5	Diseases and pests of Gerbera	21
6	Diseases and pests of Carnation	29
7	Diseases and pests of Orchids	35
8	Diseases and pests of Chrysanthemum	42
9	Diseases and pests of Anthurium	47
10	Diseases and pests of Lily	50
11	Nematode management under polyhouse	54
12	Nutritional disorders in ornamental crops	56

Introduction

Commercial floriculture has assumed immense significance in the diversification of agriculture and national economy. With the global boom in floriculture trade, production of quality flowers of international standards has become a major challenge in commercial floriculture. The purpose of growing crops under ploy house is to provide optimum conditions for quality production, extending the cropping seasonand to protect from adverse conditions. Among the various factors affecting production of quality of flowers, diseases and pests are of prime importance and require constant monitoring and implementing appropriate control measures in time. Implementation of integrated pest management programme will determine the success of the greenhouse business. Disease and pests management strategies aim to prevent the establishment of diseases and pests in greenhouse, as well as to minimize the development and spread of the same.

Success of integrated pest management programme is highly depends on sound knowledge of polyhouse managers on correct identification of the key diagnostic symptoms and timely selection of appropriate control measures.

Causes and Diagnosis of Diseases in Plants

Any malfunctioning of host cells and tissues that result from continuous irritation by pathogenic agents (fungi, bacteria, viruses, viroid, protozoa and nematodes) or environmental factors (extreme temperature, excess or deficiencies of nutrients or water, low light, pesticides or fertilizer misapplication and mechanical injury) is known as a disease.

Diagnosis is the process of determining the cause or causes of diseases through examination and analysis. An accurate diagnosis is often needed before effective remedial or preventive measures can be taken. It is not unusual to encounter more than one disease on a given plant, so care should be taken to examine all of the signs and symptoms at hand. Attack by pests, diseases and environmental stresses can also predispose plant to attack by other infectious or non-infectious agents. Diagnosis is both art and science and diagnostic skills can be improved through experience, education and practice.

Symptoms and Signs

The changes or alternations that take place in the structure and function of a plant as a result of a disease or a disorder are known as “symptoms”. The totality of symptoms produced by a causal agent is known as symptom-picture or syndrome.The pathogen propagules may often be seen on the host plant, in which case they are known as “signs”. The study of signs and symptoms helps us to a great deal to recognize the disease. Microscopic examination or other tests may also be required to further confirm the cause. Given below are symptoms of some common diseases of garden plants:

Spot

Well-defined, self-limiting lesions on aerial plant parts are called spots. They are often named after the plant part on which they are present, for instance those on the leaves are called

leaf spots These may be of various shapes such as round, circular, angular, etc. and are often light to dark brown or black in colour. It is worthy to note that in angular leaf spots, veins and veinlets normally restrict the spread of infection.

Blotch

Large areas of discoloration on leaves, fruits etc. are called blotches. Their spread on the leaves is not restricted by veins.

Blight

Sudden and severe killing of aerial plant parts, which normally leaves a burning and scorching effect, is referred to as blight. Leaf/stem/shoot/sheath/blossom/pod blight etc. are some common types of blights infecting plants. The damage caused by them is normally extensive and large crop areas are engulfed in a short time.

Anthracnose

Black or charcoal-like, slightly sunken lesions on leaves, stems or fruits result in a disease condition known as anthracnose.

Canker

A necrotic, often sunken lesion, on a stem, branch or twig of a plant is called a canker.

Scab

A rough, crust-like lesion on a plant part, showing surface layer thickening; or the disease condition in which such areas form is termed scab.

Rot

Softening, discoloration and decay of succulent plant tissue as a result of infection is called rotting. Root rot, foot rot, crown rot, collar rot, bulb rot, corm rot, soft rot, brown rot, rhizome rot, sett rot, stem rot, charcoal rot etc. are some common types of rots.

Damping off

Death and collapse of seedlings at or near the soil line is normally referred to as damping-off. However, in the strict sense of the term, decay of seeds in the soil or of seedlings before or after their emergence from the soil is called damping-off. It is very common in the nursery and they often result in heavy seedling mortality. If the seedlings are very mildly infected they may withstand attack but carry infection to the field and at a later stage succumb if weather turns favourable.

Gummosis

External or internal production of an exudates or gum by the plant tissue is referred to as gummosis.

Dieback

Death, decay or drying of twigs or branches from tip downwards is called dieback. Discolouration or darkening of the bark is a very common feature in such diseases.

Wilt

A disease condition that results in drooping of plant parts generally caused by insufficient transport of water in the plant is called wilting. It may occur due to a pathological or a physiological cause.

Shot hole

A disease symptom, in which leaf lesions become cicatrized and fall away or drop off and leave small holes in their place, is called shot hole.

Mould

A disease in which the mycelium or spores of the fungus are seen as a blackish, brownish, bluish or grayish growth on the host surface. The term also refers to fungal growth, which may be present on the non-living substrate, too. Sooty mould is a common disease affecting plants and is caused by saprophytic fungi. It appears as a sooty or black coating on plant parts and is commonly associated with honeydew secreted by insects such as aphids, mealy bugs, scales and white flies.

Mildews

A disease in which mycelium and spores of the fungus are seen as a whitish or grayish growth on the host surface is called mildew. The leaves are most commonly infected, whereas the other aerial plant parts are not an exception. If the growth develops mainly on the upper surface of leaves, they are called powdery mildews. On the contrary, if the growth develops mainly on the lower surface of the leaves they are named downy mildews.

Rust

A disease giving a "rusty" look to a plant is called rust. It is caused by fungi belonging to the order Uredinales.

Smut

A disease characterized by masses of dark, powdery and sometimes odorous spores and caused by one of the members of fungi belonging to the order Ustilaginales.

Gall

A swelling or overgrowth produced on a plant due to infection by certain pathogens is called a gall. The galls are commonly noticed on leaves and roots

Tumor

An uncontrolled overgrowth of tissue due to infection by a pathogen is called a tumor.

Mosaic

Presence of dark- and light-green or yellow areas on leaves of virus-affected plants, is known by the name mosaic. Associated with them may be thickening, puckering or distortion as well as ring, line and streak patterns may also be encountered in mosaic-type diseases. *Vein clearing* or *vein-banding* is also a common symptom of infection with mosaic diseases.

Colour-break

Narrow elongated streaks or stripes of indefinite or restricted length on flower petals often result in variegation in flower colour and the symptoms are known as colour-break.

Witches' Broom

Broom-like growth or massed proliferation is caused by dense clustering of branches of woody plants. In such diseases the internodes get shortened and the number of stems is greatly increased.

Chlorosis

Yellowing of normal green tissue due to destruction or failure of chlorophyll to form is called chlorosis. It is called general chlorosis when uniformly present while interveinal when present between the veins.

Necrosis

Death and discoloration of tissue is called necrosis.

Scorching

It is burning of leaf margins or nearly whole leaves as a result of infection or unfavourable environmental conditions.

Stunting or dwarfing

It is reduction in the size of plant. It generally results from fungal, bacterial viral or nematode infections.

Diagnostic characters of insect and mite pests

Correct identification of the pest is first step for successful pest management program. It is necessary to have first-hand information on major pests of polyhouse, how they appear, where to look for them, how to identify them, their life cycle and their interaction with other pests under polyhouse. The major insect and non-insect pests observed under polyhouse are greenhouse whitefly, *Trialeurodes vaporariorum*; cotton whitefly, *Bemisia tabaci*; green peach aphid, *Myzus persicae*; cotton aphid, *Aphis gossypii*; American serpentine leafminer, *Liriomyza trifolii*; chilli thrips, *Scirtothrips dorsalis*; onion thrips, *Thrips tabaci*; greenhouse thrips, *Heliothrips haemorrhoidalis*; melon thrips, *Thrips palmi*; tobacco caterpillar, *Spodoptera litura*; tomato fruit borer, *Helicoverpa armigera*; spider mite, *Tetranychus* sp. and *cyclamen mite*, *Tarsonemus pallidus.*

Whiteflies

Whiteflies are oval shaped, tiny flies with mealy white wax covering their wing and yellow body. Eggs are laid on the undersurface of the leaves, in circular or semicircular fashion depending on the species. The early stages of nymphs resemble scale insects and there are four nymphal instars. Most whiteflies are confined to undersurface of the leaf and continuously suck the sap from leaves. High population causes yellowing and shriveling of leaves, affects plant health and flower quality. Whiteflies are most common and perhaps most difficult pests to control under polyhouse. Common species found under polyhouse are greenhouse whitefly, *Trialeurodes vaporariorum* and cotton whitefly, *Bemisia tabaci*.

Distinguishing characters of whitefly

Character	Greenhouse whitefly	Cotton whitefly
Wing position at rest	Held flat, almost parallel to the body	Usually tilted or held roof like at about 45° angle
Egg	More powdery mass around the eggs	Little or no wax around the eggs
Pupa	Has long sub marginal wax filament and short marginal wax fringes Pupa is elevated in profile, with edges perpendicular to the surface	No obvious waxy fringes around margin Pupa is convex or rounded in profile

Aphids

Aphids are small, 1.5 – 3.2 mm long, soft bodied insects. They range in color from green to brown, red, black or purple. Aphids excrete sugary liquid called honeydew. This honeydew drop onto plant foliage and provides suitable place for development of back mold.

Leafminer

Adults of leaf miner are small, black and yellow colored flies. They lays eggs on uppersurface of leaves by making a small puncture. Eggs can be seen as small white specks on the leaves. After hatching, larva mine into the leaf and form characteristic serpentine tunnel in the leaf.

Thrips

Thrips are tiny insects which feed mainly on new growing buds of the plant. Both nymphs and adults suck cell sap resulting in curled or bronzed leaves, deformed buds with burnt margins and some species can also from galls on plant parts. Some specific species may transmit plant viruses as vectors.

Tobacco caterpillar, *Spodoptera litura*

The adult moth is brown with complex pattern of cream streaks crisscrossing the fore wing and hindwings are silvery white. Female lays around 100 eggs in groups and covers with tuft of hairs. The early instars are gregarious and feed on the leaves by skeletonizing the leaf. The later instars spread to different parts of the field. The larvae hide in the cracks and crevices in the field during day time and become active during night hours and feed voraciously on different plant parts. The larvae are brown with three thin yellow lines down the black, one in the middle and one each on either side. A bright yellow stripe along the length of the dorsal surface is a characteristic marking on fully grown larva.

Tomato fruit borer, *Helicoverpa armigera*

Adults are medium sized stoutly built moths. Forewings are light yellow in males and brown in female. Female moth lays eggs singly on leaves, buds and flowers. The younger larvae feed on leaves and the older larvae bore into flower buds.

Mites

Spider mite, *Tetranychus* spp.

Adult female is about 0.5 mm long while male about 0.3 mm long. Females are yellowish-green, with two pronounced dark spots on the body. These spots are less conspicuous in males. During winter, males die and females stop feeding, change their color to orange-red, migrate to shelters for overwintering. When temperature starts rising, females move from the shelters, begin to feed and their color changes to yellowish-green. Females lay upto six eggs a day and

each female lays >70 eggs. The eggs hatch in 3 – 10 days depending on the temperature. The young mites mature in 4 – 12 days. During summer months, total life cycle may be completed in two weeks and overlapping generations may be seen.

Cyclamen mite, *Phytonemus pallidus*

These mites are very tiny, elliptical in shape and cannot be seen without the help of microscope. These mites tend to hide deep within tender buds or deep in the flowers.

Good Agricultural Practices for Commercial Polyhouse

Greenhouse producers must strive to provide environmental conditions that are more favorable to plant growth and development than to disease development with the help of IPM practices. Careful attention to such details helps to prevent the onset and spread of diseases and may reduce the need for an expensive eradicative program.

General pest management strategies

Insect pests cause enormous yield and quality losses in agricultural crops. With the burgeoning population there is an urgent need to reduce losses caused by them. There are several methods of pest control which are discussed below:

Physical control

The abiotic factors such as temperature, moisture, relative humidity and light will have a direct influence on the development of pests. Slight variations in these abiotic factors will disrupt the growth and development of diseases and pests.

Mechanical control

It is based on the knowledge of pest behavior. Hand picking, installation of bird perches, mulching and installation of traps are a few examples.

Cultural control

It includes crop production practices that make crop environment less susceptible to pests. Crop rotation, adjusting of row and plant spacing, staggering of planting dates and destruction of old crop debris are a few examples. Cultural controls are based on pest biology and development

Biological control

It includes augmentation and conservation of natural enemies of pests, such as insect predators and parasitoids. In IPM programmes, native natural enemy population is conserved and *non-native* agents are released with utmost caution.

Resistant varieties

Breeding for pest resistance is a continuous process. Resistant varieties are bred and selected when available in order to protect against key pests. Genetically modified (GM) plants have been used on a large scale in some of the countries in the recent past and have drastically curtailed pesticide use.

Chemical control

Pesticides are used to keep the pest population below economic threshold when the pests cannot be controlled by other means. These are applied when the pest's damaging capacity is nearing the threshold.

Integrated pest management (IPM)

It is a method to control pests by integrating a variety of strategies, such as physical, mechanical, biological, cultural and chemical methods of pest management. The main aim of IPM is to reduce dependence on chemicals, *i.e.* using them only as a last resort, while at the same time managing pest populations at an acceptable level. It helps to reduce resistance build-up in the pest populations. In the recent years IPM has emerged as one of the modern ways of reducing insect pest damage.

An IPM regime can be simple or complex. Historically, the main focus of IPM programmes was on agricultural insect pests. Although originally developed for agricultural pest management, IPM programmes are now developed to encompass diseases, weeds and other pests that interfere with the management objectives of sites such as residential and commercial structures, lawn and turf area and home and community gardens.

IPM holds that wiping out an entire pest population is often impossible and may be uneconomical. Hence the main emphasis is on control, not eradication. IPM programmes first work to establish acceptable pest levels, called action thresholds, and apply controls if those thresholds are crossed. The thresholds are pest and site specific, meaning that it may be acceptable at one site, but at another site may not be acceptable. The success of any IPM depends on good understanding of the crop, the pest, the climate and the control measures.

Monitoring helps keep track of the pests and their potential damage. It also provides knowledge about the current pests and crop situation and is helpful in selecting the best possible combinations of the pest management methods. Early detection of pest infestation is important to decide on the appropriate measures to be taken up for effective management of the pest.

General disease management methods for greenhouse crops

- Successful disease control relies on proper disease prevention practices and plant disease

diagnosis. Once the major diseases and pest problems have been identified, an integrated pest management (IPM) program can be followed.

- Several important cultural practices to control diseases/insect pests should be integrated into all greenhouse IPM/IDM programs to control diseases and pests. These serve to both prevent and minimize/eradicate diseases and pests.
- Analogous cultural control methods may be applied to specific diseases/pests that are common to several crops.

General pest management strategies under polyhouse

Since the microclimate inside the polyhouse is most congenial for the rapid development of insect pests, successful control of the insect pests depends on several biotic and abiotic factors. Avoidance of pests, early detection of infestation, if any, and timely imposition of correct curative measures are three key factors influencing the success of pest management.

Avoidance of pest entry into polyhouse:

- Use of insect proof nets to avoid lateral entry of insect-pest into the polyhouse.
- Provision of double-door system to avoid accidental entry of insect pests into the polyhouse.
- Maintaining sanitation in and around the polyhouse.
- Inspection of planting materials upon arrival for infestation of any pests.
- Use of ultra-violet radiation absorbing sheets as cladding material for avoiding the entry of insect pest into the polyhouse.
- Judicious use of fertilizers and irrigation water to maintain plant health.

Standard mesh sizes to exclude insect pests from polyhouse

Target insect pest	Hole size (microns)	Mesh size (No. of threads per linear inch)
Leafminer, *Liriomyza trifolii*	610	34
Cotton whitefly, *Bemisia tabaci*	462	42
Green aphid, *Myzus persicae*	340	52
Greenhouse whitefly, *Trialeurodes vaporariorum*	290	58
Melon thrips, *Thrips palmi*	192	76

Early detection of insect pest infestation:

Detection of insect pest infestation includes scouting and monitoring of insect pests population and maintaining a field data sheet for recording the insect identified, location on the plant, severity of pest and effectiveness of any control measure applied.

Initial infestation of insect pests in the polyhouse begins as isolated spots along the border and entry doors. Proper scouting of the plant must be done to detect infestations, if any. Entire plant has to be inspected properly starting form bottom of the plant including soil surface, then the older leaves, younger tender leaves and new flush growth. It is important to check on the undersurface of the leaves, as most of the insect pests prefer the undersurface of the leaves.

Yellow and blue sticky traps and pheromone traps can be used for monitoring the activity of different insect-pests inside the polyhouse.

Scouting and monitoring techniques under polyhouse

	Aphids	Leaf miners	Spider mites	Thrips	White-fly	Cater-pillars
Scouting						
Insect undersurface of leaves	X		X	X	X	X
Insect upper surface of leaves for stippling/small white spots			X	X		
Insect leaves for mines		X				
Insect new flush or terminal region for feeding	X		X	X		
Tap flowers over white surface and look for movement	X		X	X		
Observe for						
Honeydew or sooty mold	X				X	
Holes on leaves						X
Yellow spots on upper surface of leaf	X		X	X		
Curling of leaves	X					
Distortion of new growth	X		X		X	
Improper opening of flower buds				X		
Webbing on leaves and flowers			X			
Monitoring						
Sticky card on top of plant canopy	X	X		X	X	
Pheromone traps						X

Sticky cards have to be held 10 – 15 cms above the plant canopy. One to two cards per 100 square meter area are required for monitoring and more than 20 cards per 100 square meter area for mass trapping of the insect-pest. The sticky cards have to be tested twice a week and total number of each insect observed in the card has to be written in field data sheet. Yellow sticky cards attracts whitefly, leaf miner and aphids the most, while blue sticky cards attracts thrips.

ROSE (*Rosa* sp.)

Diseases

1. Black leaf spot, *Diplocarpon rosae* (Imperfect state: *Marssonina rosae*)

It is a very common disease of roses grown outdoors. Infection is deep-seated and difficult to rid of. Old leavesin polyhouse are the main source of initial inoculum. Pathogen spreads through splashing water. Poor polyhouse management and unhygienic conditions favor disease development.

Symptoms: Symptoms appear in the form of circular black spots ranging from 1/16 inch to 1/2 inch in diameter on the surface of leaves. The spots are frequently surrounded by a yellow halo. Infected leaves characteristically turn yellow and fall prematurely. This leaf spot can be distinguished from other leaf spots by characteristic fringed margin. The disease can cause almost complete defoliation of bushes. Cane may also get infected and develop reddish-purple raised irregular spots. The infected bush become weak and prone attack by cane die-back, stem canker and winter injury.

Management

i. Observe good hygiene in the field.

ii. Collect diseased plant debris with a garden rake and destroyed it.

iii. Give pruning cuts at least one inch deep into the healthy wood.

iv. Spray the bushes with fungicides, such as carbendazim (0.1%), chlorothalonil (0.2%),mancozeb (0.2%), kresoxim-methyl (0.1%) or tebuconazole (0.1%), Applications should begin as soon as the new leaves appear or at first appearance of black spots. Sprays may be repeated at an interval of 10 days or more oftener depending upon the severity of infection.

2. Powdery Mildew, *Podosphaera pannosa* (=*Sphaerotheca pannosa*)

This disease occurs everywhere in the world where roses are grown. It is widespread and endemically present in most parts of India, but in northern India it appears sporadically. Temperatures between 21-27°C and high relative humidity during night time are predisposing factors for disease development.

Symptoms: Leaves, buds and stems get covered with a white powdery coating. The infection can cause young leaves to curl and turn purple. Young canes may be distorted and dwarfed. If seriously infected, they can die. Severely infected buds fail to open.

Management

i. Spray plants with dinocap (Karathene (0.05%), penconazole (0.05%), propiconazole (0.05 %) or fenarimol (0.1%) at fortnightly intervals.

ii. Use disease resistant varieties.

3. Stem canker/ Dieback, *Diplodia rosarum*, *Botryodiplodia theobrome*, *Colletotrichum gloeosporoides*, *Coniothyrium fucklelii*

This disease is among most serious diseases of rose and is of complex etiology. Poor polyhouse management practices and old infected plant parts in the polyhouse are the main source of pathogen survival. Wet weather and high relative humidity above 80 per cent are predisposing factor for spread of pathogen.

Symptoms: As the name implies, the disease causes death of plants from tip downwards. Infection normally stems from the pruned end of the twigs and extends only a few centimeters below the cut end. During severe infection, however, the disease may spread right down to the base of the canes and subsequently the whole plant resulting in its death.

Management

i. Observe sanitation in and around the polyhouse.

ii. Prune and destroy dead and diseased plant parts periodically.

iii. Disinfect secateurs with 70 per cent alcohol before giving pruning cut to each cane. Mercuric chloride has to be avoided for disinfection, as the roses are particularly sensitive to this compound.

iv. Apply Bordeaux paste (copper sulphate 1 kg, unslaked lime 1.5 kg, water 10-15 litres) or Chaubattia paint (copper carbonate 4 parts, red lead 4 parts, raw linseed oil 5 parts) to cut ends at time of pruning of bushes.

v. The crop may be sprayed with copperoxychloride (0.3%) or mancozeb (0.25%) also at time of pruning if there is a time constraint.

4. Blossom blight, *Botrytis cinerea*

This is most serious disease of rose in the international trade. Cool weather and high relative humidity are predisposing factors for spread of the pathogen.

Symptoms: Infected buds usually fail to open and become covered with grey to grayish-brown growth of the fungus. Infection of open flowers also occurs. Small, more or less circular, lesions form on petals that may develop into blotches and rot the flowers. The disease causes flower buds to droop and remain closed. Buds turn brown and decay. Sometimes partially opened buds are attacked and an entire flower may be covered by gray fungus.

Management

i. Practice crop sanitation.

ii. Destroy dead and diseased plant parts.

iii. Avoid moisture condensationin the polyhouse.

iv. Adjust temperature to 21°C and relative humidity below 85 % in the greenhouse area

v. Sprays plants with mancozeb (0.2%) or chlorothlanil (0.2%) at suitable intervals. Sprays of the fungicides vinclozolin (0.2%) or iprodione (0.2%) are also very effective.

5. Downy mildew, *Peronospora sparsa*

Presence of thin layer of water on leaves is essential for spore germination and penetration. Poor polyhouse management practices and old infected plant parts in the polyhouse are main source of pathogen

Symptoms: Disease symptoms appear in the form of purplish-red to dark brown irregular lesions, delimited by veins, on the under surface of leaves. Stems, petioles and flower stalks may also develop purple marks.

Management

i. Hygiene in and around the polyhouse.

ii. Periodic removal of diseased leaves/infected parts.

iii. Alternate sprays with mancozeb (0.25%), metalaxyl-mancozeb (0.25%), fosetyl-aluminium (0.3%) or ziram (0.3%) at 10-14 day intervals.

6. Crown gall, *Agrobacterium temefaciens*

Agrobacterium is a gram negative bacterium. It enters the plant via wounds.

Symptoms: The disease is characterized by large lumps at the base of the plant stem or on roots. Galls may appear higher on stems as the disease progresses. Galls are soft compared to surrounding plant tissues.If the disease affects the plant while it is young the plant may be affected to the degree where it will not produce blooms. All affected plants wilt readily and grow poorly.

Management

i. Avoid injury to the plants.

ii. Purchase disease-free stock plants from a reputable supplier.

iii. Rogue out diseased plants early.

iv. Cultural control through prevention of introduction/elimination is the best method

v. Chemical control of the disease is not available.

vi. Biological control of the disease with *A. radiobacter* strain K84 or K1026 reported successful.

7. **Mosaic**, rose mosaic virus, rose ring pattern virus.

   Many virus diseases have been reported from rose and most of them are graft transmissible.

Symptoms: This disease is characterized by prominent chlorotic area on the leaves. The patterns vary considerably, ranging between all-over fine blotches to patterns of lines in waves. These symptoms may not appear on all the leaves.

Management

i. Remove and destroy diseased plants.

ii. Propagate cuttings from healthy plants only.

iii. Disinfect cutting tools between stock plants from which cuttings are being taken.

iv. Use bud wood from plants having received heat treatment (33°C, 4 wks).

v. Meristem culture can also help to eliminate virus.

Insect and Non-Insect Pests

1. **California red scale**, *Aonidiella aurantii* (Hemiptera: Diaspididae)

   These scales are flat, circular and reddish in colour and measure about 2 mm in diameter. They appear in severe form before and after the monsoon season. Both adults and youngones suck the sap from mature shoots and deplete vigor of the plant. The infested plants bear few small flowers. No rose plant is immune to scales attack.

Management

i. Selection of scale free planting material and cutting and burning of infested parts are the key operations to reduce the populations.

ii. Spray chlorpyriphos 20 EC @ 2.5 ml/l or dimethoate 30 EC @ 2.0 ml/l or ethion 50 EC @ 1.0 ml/l.

iii. Apply pongamia oil 10% to shoots after pruning to avoid scales infestation.

iv. Apply carbofuran 3 G @ 1.0 Kg. a.i./ha (33 kg/ha) after pruning, if the incidence is severe.

2. **Thrips**, *Scirtothrips dorsalis* Hood and *Rhipiphorothrips cruentatus* Hood (Thysanoptera: Thripidae)

   The nymphs of *Rhipiphorothrips cruentatusare* reddish in colour whereas the adults are dark brown or black in colour. The pest breeds throughout the year except in winter when it pupates in the soil. The adult appears in March and lays eggs on the undersurface of leaves in plant tissues. Both nymphs and adults suck cell sap from tender leaves, buds and flowers. Curled leaves with brown marks and deformed buds with burnt margins are the main symptoms of damage.

Scirtothrips dorsalis attack new flush after pruning. Both nymphs and adults suck cell sap from tender leaves, buds and flowers. Curled leaves with brown marks and deformed buds with burnt margins are the main symptom of damage. Under protected conditions thrips is a serious problem on roses almost round the year except during November – December and July – August.

Both nymphs and adults feed by rasping the tissues and sucking the sap which oozes out from the wounds. Affected leaves are deformed with brown or silvery patches or burnt margins. The affected leaves get distorted, wither and drop down. In case of severe infestation, flower buds shed prematurely and show brown patches on the petals. The females lay 60 – 100 eggs. The nymphs hatch in 2 – 7 days and starts feeding on the plant parts, fully grown nymphs pupate in soil and emerge as adults in 2 – 5 days depending on temperature.

Management

i. Spray acephate 75 SP @ 1.5 g/l or dimethoate 30 EC @ 2.0 ml/l followed with 1% pongamia oil, 2 – 3 times at fortnightly interval with onset of new flush.

ii. Drench the soil with chlorpyriphos 20 EC @ 5.0 ml/l at fortnightly interval to kill pupae in soil.

iii. Under polyhouse cultivation, spray with fipronil 5 SC @ 1.5 ml/l or imidacloprid 200 SL @ 0.4 ml/l or acephate 75 SP @ 1.5 g/l.

3. Aphid, *Macrosiphum rosae* Linnaeus (Hemiptera: Aphididae)

Pear-shaped, soft bodied, light green to dark blackish green aphids attack the tender shoots of the plant. Occurs on roses from November to April.

Both adults and nymphs found in clusters on the tender portions of shoots, buds, flowers and leaves. They feed by sucking the cell sap. As a result, tender shoots wither, buds fall prematurely and the flowers show malformation and fading. Severe damage to the top of the plant may reduce the number of flowers produced. Aphids also excrete honeydew on which sooty mold grows. Aphids feeding on flowers make them unmarketable and their presence is a nuisance on the plants because they leave cast skins stuck to the plant when they molt, which affect the value of the plant/flower.

Management

i. Spray 1% neem or pongamia oil or dimethoate 30 EC @ 2.0 ml/l.

ii. If the incidence is severe, spray imidacloprid 200 SL @ 0.4 ml/l or cartap hydrochloride 50 SP @ 1.0 g/l.

iii. Spray of *Verticillium lecanii* at 3.0 g/l during evening hours is also effective against aphids.

4. Bud borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae)

Incidence of the borer is observed from January to April. Female moth lays cream coloured eggs on young buds. Hatched larvae bore into buds my making holes and feed on petals. Grown up stages damage flowers.

Management

i. Collection and destruction of mature larvae reduce the population buildup.

ii. Spray methyl parathion 50 EC @ 1.0 ml/l or fenvalerate 20 EC @ 0.5 ml/l in combination with diflubenzuron 25 WP @ 2.0 g/1 at appearance of eggs on tender foliage

iii. Alternatively spray neem seed kernel extract (NSKE) 4% at weekly intervals.

iv. Spraying of HaNPV @ 250 LE/ha.

5. Whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae)

Tiny, white 1.5 – 4.0 mm long moth like flies lives on the upper regions of the plant. Each female deposits up to 400 eggs in circular clusters on the underside of the leaves. Within 5 – 10 days, the eggs hatch into scale-like nymphs. Optimum temperature for infestation is 18 – 24°C.

Nymphs and adults suck cell sap from lower side of leaves resulting in yellowing and dropping of leaves. In case of severe infestation sooty mold develops on honeydew secreted by nymphs and significantly affects the growth of the plants resulting in production of small flowers.

Management

i. Removal and burning of heavily infested leaves checks pest build up.

ii. Clean cultivation and use of insect proof nets helps in prevention of whitefly incidence.

iii. Install yellow sticky traps to monitor adult flies activities.

iv. Spray with acephate 75 SP @ 1.5 g/l at fortnightly interval alternating with pongamia oil 10.0 ml/l.

v. Spray of *Beauveria bassiana* or *Verticillium lecanii* formulations @ 2.0 ml/l.

vi. If the activity of adults is more, spray with dichlorvos 76 EC @ 1.0 ml/l followed by lambda cyhalothrin 5 EC @ 1.0 ml/l or deltamethrin 2.8 EC @ 1.0 ml/l at 5 – 7 days interval.

6. Tobacco caterpillar, *Spodoptera litura* (Lepidoptera: Noctuidae)

Adult moths lay eggs in groups on lower surface of leaves and damage is seen throughout monsoon period in polyhouses. Early instars are gregarious in nature and feed on leaves by

scraping chlorophyll. Brown coloured mature larvae damage growing buds and flowers during nights resulting in qualitative loss to flowers.

Management

i. Collect and destroy egg masses and gregarious early instar larvae.

ii. Spray quinalphos 25 EC @ 2.0 ml/l at fortnightly interval.

iii. Spray indoxacarb 14.5 SC @ 1.0 ml/l or thiodicarb 75 WP @ 1.0 g/l, if the incidence is severe.

iv. Spray SlNPV @ 250 LE/ha followed by neem formulations 1.0 – 2.0 ml/l are also effective.

v. Spread poison bait made of wheat or rice bran, jaggary and chlorpyriphos (10:1:0.5) for killing grown up larvae.

7. Spider mite, *Tetranychus cinnabarinus* Boisd. and *Tetranychus urticae* Koch (Acari: Tetranychidae)

Feeding of spider mites results in white specks on leaves which later coalesce and produce white patches resulting in reduced photosynthetic activity. Ultimately, affected leaves become mottled, turn yellow and fall. Infested flower petals lose their brightness resulting in a direct loss to the grower. The damage is pronounced during warm and dry seasons. Under greenhouse condition, the prevailing high humidity and temperature is very favourable for the population buildup of spider mites.

Management

i. Cutting and burning of severely infested plant parts, proper irrigation and clean cultivation reduce incidence of mites.

ii. Thorough spray of jet of water to dislodge mites from their webs and plants followed by application of dicofol 18.5 EC @ 2.5 ml/l or wettable sulphur 80 WP @ 3 g/l or profenofos 50 EC @ 1 ml/l or ethion 50 EC @ 1.0 ml/l followed by pongamia or neem at 5 ml/l.

iii. Spraying *Verticillium lecanii* at 5.0 g/l during evening hours.

iv. Spray abamectin 1.9 EC @ 0.5 ml/l followed by flufenoxuron 10 DC @ 1.0 ml/l or fenazaquin 10 EC @ 1.0 ml/l or diafenthiuron 50 SC @ 0.6 ml/l, if necessary on the crop meant for export purpose.

Black leaf spot

Powdery mildew

Dieback of rose

Botrytis blight

Downy mildew

Anthracnose

Crown gall

Mosaic symptom due to virus infection

Scale insects on rose twig

Thrips damage on flower bud

Aphids on rose twig

***Helicoverpa* feeding on flower**

***Spodoptera* egg mass on leaf**

Spider mites on foliage

Spider mites on flower

GERBERA (*Gerbera jamesonii*)

Diseases

1. Leaf spot: *Alternaria gerbericola, A. alternata, A.tenis, A.dianthi*, etc..

The disease is worldwide in distribution and is favoured by moderate temperature and humid conditions.

Symptoms: Circular to irregular, black to brown spots form on leaves and petioles that coalesce to form bigger blotches. Brown specks on ray florets are also noticed. In general, mature plants are more susceptible than younger plants.

Management

i. Maintain low humidity in the polyhouse.

ii. Avoid sprinkle irrigation.

iii. Give alternate sprays of the fungicides mancozeb (0.2%), propiconazole (0.05-0.1%) or chlorothlanil (0.2%) at 10-15 days interval.

2. Bacterial leaf spot: *Pseudomonas cichorii*

It is a destructive disease under warm and rainy conditions.

Symptoms: Leaf spots are small to large and circular in appearance in the beginning. They become irregular and dark brown to black with time. They may or may not have a concentric ring pattern. The crown of the plants may also get infected.

Management

i. Purchase disease-free stock plants from a reliable source.

ii. Rogue out diseased plants early.

iii. Avoid overcrowding of plants.

iv. Avoid overhead irrigation to minimize leaf wetness and disease spread.

v. Space plants apart to promote air circulation and reduce foliage contact among plants.

vi. Control weeds in the greenhouse.

3. Botrytis blight: *Botrytis cinerea*

Symptoms: Infected tissues become covered with grey mass of spores. Petioles develop brown spots. Leaves show chlorosis and die. Stems at soil level may also rot.

Management

i. Remove and destroy infected plant parts on which spores are produced.

ii. Give sprays with carbendazim (0.1%) or chlorothalonil (0.25%).

4. Phytophthora crown rot: *Phytophthora cryptogea*

Symptoms: The disease affects basal part or crown region of the plant that turns brown leading to sudden wilting of plant.

Management

i. Use disease free planting material.

ii. Grow plants in pasteurized soil/rooting medium.

iii. Too much of wet conditions favours infection.

iv. Avoid splashing of water in polyhouse area.

v. Dip seedlings before planting in a suspension of a fungicide such as zineb (0.2%), copper oxychloride (0.25%) or metalaxyl+mancozeb (0.25%). fosetyl-Al (0.25%), iprodione (0.25%), etc.

5. Pythium root rot: *Pythium irregulare*

Unfavourable growing conditions and optimum temperature of about 20°C may lead to infection.

Symptoms: Wilting and death of plants is the most common symptom.

Management

i. Grow plants in pasteurized medium.

ii. Provide good drainage conditions as water stagnation favoursPythium infection.

iii. Dip seedlings before planting in the fungicide metalaxyl-mancozeb (0.25%), fosetyl-aluminium (0.25%) or iprodione (0.25%) .

6. Rhizoctonia crown rot: *Rhizoctonia solani*

It is a world-wide fungus having a broad host range.

Symptoms: Stems at the soil level develop brown lesions. Plants wilt and die.

Management

i. Pasteurize soil before use.

ii. Use disease-free planting material.

iii. Avoid high dose of ammonical nitrogen fertilizers.

iv. Maintain optimum soil moisture in polyhouse area.

v. Dip seedlings before planting in solution/suspension of fungicide carbendazim iprodione (0.2%) or pencycuron (0.3%).

7. Fusarium foot/crown rot: *Fusarium oxysporum*

The fungus can survive in soil for long period of time.

Symptoms: The fungus invades the crown region of the plant. Withering of leaves and wilting of plants is a common symptom.

Management

i. Sterilize soil before use.

ii. Discard infected plants.

iii. Give a soil drench to plants with carbendazim (0.2%). Spot application may also be done if infection is restricted to a limited area.

8. Powdery mildew: *Golovinomyces cichoracearum* (=Erysiphe cichoracearum), *Podosphaera fusca* (=Sphaerotheca fusca)

It is a common disease of gerbera. High humidity, moderate temperatures, cloudy weather and shady conditions favour development of the disease.

Symptoms: The disease appears in the form of a white powdery coating mostly on the upper surface of the leaves. The leaves turn yellow with time and die. The plants lose their vigour. The disease is more severe on the lower than on the upper leaves. Stem/flower stalks may also get infected.

Management

i. Procure disease-free plants from a reliable source.

ii. Give thorough coverage to leaf surfaces with fungicides, *viz*. elemental sulphur (0.2%), dinocap (0.05-0.08%), penconazole (0.1%), azoxystrobin (0.1%), trifloxistrobin (0.1%) at suitable intervals. The fungicides should be used alternatively to prevent resistance build-up in the pathogen.

iii. Grow resistant varieties.

9. Viruses: Tobacco rattle, gerbera mosaic, impatiens necrotic spot and cucumber mosaic virus

Leaves may be mottled, have yellow spotting, dead flecks, line or ring spot patterns. Plants may be distorted or have flower color breaking.

Management

i. Purchase virus-indexed or certified plant material.

ii. Keep insect pests (vectors), especially aphids, whiteflies and thrips under control.

iii. Reduce foliage contact between the plants.

Insect and Non-Insect Persts

1. **Whitefly**, *Trialeurodes vaporariorum* (Westwood), *Bemisia tabaci* Guen. (Hemiptera: Aleyrodidae)

Whiteflies are active during moderately hot and humid conditions (February – July). Small and fragile white adults lay eggs on under surface of young leaves. Nymphs and adults suck cell sap from lower side of leaves resulting in discoloration, wilting and drying. In case of severe infestation sooty mold develops on honeydew secreted by nymphs. Severely damaged plants produce small and deformed flowers with crooked stalks.

Management

i. Install yellow sticky traps for adult management.

ii. Remove and burn the heavily infested leaves.

iii. Spray acephate 75 SP @ 1.5 g/l alternating with 1% pongamia oil for nymph management.

iv. Spray dichlorvos 76 EC @ 1.0 ml/l

2. **Leaf miner**, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)

The incidence of leaf miner is severe during March – June. Adults lay eggs by punching the leaves, which can be noticed as white specks on upper surface of leaves. Maggots mine the leaves by feeding on mesophyll leaving characteristic white serpentine shaped mines. Severely damaged leaves show extensive mining, become brittle and dry up. The affected plants become stunted in growth and produce weak and small sized flowers.

Management

i. Install yellow sticky traps for managing adults.

ii. Remove and destroy severely mined leaves.

iii. Spray abamectin 1.9 EC @ 0.4 ml/l against larvae.

iv. Spray with dichlorvos 76 EC @ 1.0 ml/l or decamethrin 2.8 EC @ 1.0 ml/l for managing adults.

3. Thrips, *Thrips palmi* (Karny) (Thysanoptera: Thripidae)

Both nymphs and adults colonize along the midrib on upper surface of leaves and petals of growing flowers and suck the sap. Silvery greyish spots on leaves, brown spots on petiole and mid rib are symptoms due to thrips infestation. Severely damaged leaves become brittle and curled up. Flowers will be deformed due to thrips feeding and white specks or streaks can be noticed on petals which ultimately reduce the market value of the flower.

Management

i. Spray acephate 75 SP @ 1.5 g/l or dimethoate 30 EC @ 2.0 ml/l with 0.5% pongamia oil, 2 – 3 times at fortnightly interval with onset of new flush.

ii. Apply fipronil 5 SC @ 1.5 ml/l in case of severe infestations.

iii. Soil drenching with chlorpyriphos 20 EC @ 5.0 ml/l for killing pupae in the soil.

4. Aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae)

These aphids mainly attack growing flowers. Both nymphs and adults colonize on lower side of petals and spread to entire flower. Continuous sucking from developing flowers results in discoloration, distortion and wilting of flowers. Development of sooty mold on honey dew secreted by aphids makes flowers look sickly with black dots.

Management

i. Spray dimethoate 30 EC or oxydemeton methyl 25 EC @ 2.0 ml/l at fortnightly interval.

ii. Spray 1% pongamia oil or neem oil.

iii. If the incidence is severe, spray imidacloprid 200 SL @ 0.5 ml/l.

5. Tobacco caterpillar, *Spodoptera litura* (Lepidoptera: Noctuidae)

Adult moths lay eggs in groups on lower surface of leaves and damage is seen throughout monsoon period in polyhouses. Early instars are gregarious in nature and feed on leaves by scraping chlorophyll. Brown coloured mature larvae damage growing buds and flowers.

Management

i. Collect and destroy egg masses and gregarious early instar larvae.

ii. Spray quinalphos 25 EC @ 2.0 ml/l at fortnightly interval.

iii. Spray indoxacarb 14.5 SC @ 1.0 ml/l or thiodicarb 75 WP @ 1.0 g/l, if the incidence is severe.

iv. Spray SlNPV @ 250 LE/ha followed by neem formulations 1.0 – 2.0 ml/l are also effective.

v. Spread poison bait made of wheat or rice bran, jaggary and chlorpyriphos (10:1:0.5) for killing grown up larvae.

6. Two-spotted spider mite, *Tetranychus ludeni* Zacher (Acari: Tetranychidae)

Colonies of red colored mites are seen on both sides of the matured leaves and spread to flowers, in case of heavy infestation. Both nymphs and adults suck the sap resulting in development of brown spots followed by drying of leaves from margin. Severely damaged plants produce few and very small sized flowers.

Management

i. Thinning of old and heavily infested leaves.

ii. Thorough spray of jet of water to dislodge mites from their webs and plants followed by application of diafenthiuron 50 WP or flufenoxuron 10 EC @ 2.0 ml/l, followed by a spray with 1% pongamia oil.

7. Cyclamen mite, *Phytonemus pallidu*s

These mites are very tiny, elliptical in shape and cannot be seen without the help of microscope. These mites tend to hide deep within tender buds or deep in the flowers.Older leaves are curled up, younger leaves are deformed and become leathery. Deformed flowers devoid of petals, discoloration and inward curling of petals are some of the symptoms due to cyclamine mite infestation.

Management

i. Thinning of old and heavily infested leaves. Removing and burning of severely infested plants.

ii. Application of diafenthiuron 50 WP or flufenoxuron 10 EC @ 2.0 ml/l, followed by a spray with 1% pongamia oil.

8. Slugs and Snails

Slugs and snails are problem at moist condition. They hide under plant debris and soil during day times and come out for feeding during night hours. Circular feeding holes on leaves and flower petals can be seen.

Management

i. Application of 2.5% metaldehyde pellets @ 1 pellet/m^2.

ii. Poison baiting with monocrotophos, mix 600 ml of monocrotophos 36 SL with 60 kg rice bran and 6 kg jiggery and apply as small pellets.

Wilt

Powdery mildew

Mosiac symptom due to virus infection

Phyllody due to phytoplasma infection

Whitefly on undersirface of leaf

Leaf miner damage

Thrips damage on flower

Spodoptera larva on gerbera leaf

Spodoptera larva feeding on flower

Fully grown larva of Spodoptera

Spider mite infestation on flower

Cyclamen mite injury on flower

Snail

Slug

CARNATION (*Dianthus caryophyllus*)

Diseases

1. Fusarium stem rot/wilt, *Fusarium oxysporum* f. sp. *dianthi*

The fungus may attack the plant at all stages of its development and cause damage to cuttings during propagation. High temperatures of summer favour infection by the fungus. Optimum temperature for the fungus is between 25–27°C.

Symptoms: The fungus attacks the roots of the plants and colonizes the vascular system and interferes with water uptake. The lower leaves show wilting first. The disease affects typically one side of the plant. Symptoms progress slowly upward and the whole plant withers and dies. Infected plants often show a crookneck symptom. Rotting of the root and basal stem occurs in very advance stage of disease development.

Management

i. Pasteurize/sterilize the soil before use.

ii. Use diseases-free stock/planting material.

iii. Grow carnations preferably on raised beds.

iv. Always give pre-plant dip to cutting in fungicidal solution of carbendazim.

v. Drenching of soil with carbendazim (0.1%) is reported to significantly control the pathogen.

vi. Applications ofbiocontrol agents, such as Trichoderma, Streptimyces, Psudomonas and Bacillus spp., to soil are also reported effective.

vii. Grow disease resistant varieties such as Arbel, Scarlette, Eveline, etc.

2. Alternaria blight Alternaria dianthi, *Alternaria dianthicola*

It is a major disease affecting carnations. The pathogen loves warm and moist conditions and needs free water to germinate and infect the leaves and stem.

Symptoms: Initial leaf symptoms of Alternaria blight of carnation develop in the form of small purple lesions, which enlarge and become covered by a broad yellow green margin. Later on the centers of the lesions become grayish-brown and black powdery masses develop in them if moist weather prevails. Symptoms on branches appear first at nodes and eventually stem may be girdled, eventually leading to yellowing and death of branches.

Management

i. Avoid sprinkler irrigation to the plants.

ii. Provide good ventilation and air circulation to avoid excess free water on leaves.

iii. Alternative sprays of the crop with chlorothalonil (0.2%), mancozeb (0.2%), zineb (0.2%) or difenoconazole (0.1%) at 8 days interval

iv. Use resistant varieties such as Amber Rose, Lena, Yellow Sim, Forca, Cerise Rimo, etc.

3. Rhizoctonia stem/collar rot, *Rhizoctonia solani*

The disease spreads rapidly in a dry and humid weather.

Symptoms: Brownish-black lesions of the disease can be seen on the rooting zone of the cuttings.Infection may extend a few inches up the stem and bark decay follow. Wilting and death of the plants is common. Thick brown mycelial strands of the fungus may be seen on the surface of diseased tissue.

Management

i. Plant in a light, well-drained, pasteurized soil or a rooting medium.

ii. Avoid overcrowding and planting too deeply.

iii. Provide good ventilation and air circulation to reduce humidity.

iv. Drench the soil with carbendazim (0.1%), thiophanate methyl (0.1%) or captan (0.3%). Pre-plant soil application of pencycuron (0.2%) or flutolanil (0.1%) followed by spraying are reported to be effective.

4. Rust, *Uromyces dianthi*

It is a common disease of greenhouse carnations. It is favoured by cool and humid weather. It is air borne and carried over only on living plants.

Symptoms: Carnations affected by the rust disease become deformed and often do not produce any flower. Round or elongate, narrow chocolate-brown or reddish-brown lesions appear on both sides of infected leaves as well as on stem and flower buds. The uredinia and telia of the fungus form in abundance on foliar and stem tissue. Under heavy disease pressure conditions the infected plant give a rusty look. The infected leaves show curling and chlorosis followed by defoliation, drying and stunting.

Management

i. Take cuttings from healthy mother plants.

ii. Prevent moisture accumulation and overhead irrigation.

iii. Apply sprays of zineb (0.2%), oxycaboxin (0.1%), triadimefon (0.1%), propiconazole (0.1%) or tubeconazole (0.1%) at suitable intervals.

5. Phythophthora blight, *Phytophthora parasitica, P. capsici, P. cryptogea*

High temperature and wet growing conditions favour development of the disease. Being a waterborne disease, the spores of the fungus spread through the agency of water.

Symptoms: Infections occur on the basal portion of the stem and cause typical wilting and collapse of the plant. If infection occurs on the upper leaves and stem, they may get blighted.

Management

i. Plant in light, well-drained, pasteurized soil or rooting medium.

ii. Maintain optimum soil moisture as wet conditions favour disease development.

iii. Do not allow water to stagnate.

iv. Dip cuttings before planting in copper oxychloride (0.3%), metalaxyl +mancozeb (0.2%) or metalaxyl M (0.2%).

v. Spraying of the crop may also be taken up with the above fungicides.

6. Septoria leaf spot, *Septoria dianthi*

High relative humidity favors the development of the disease and production of spores.

Symptoms: More or less circular light brown spots with purple margins form on infected leaves and stems. Small black specks are present at the center of the spots. These are the spore producing structures of the fungus. Individual lesions may enlarge and coalesce with adjacent lesions to cause death of the leaf. Dissemination of the fungus is by wind blown rain and splashing water.

Management

i. Keep the foliage dry as far as possible.

ii. Provide good ventilation and air circulation in the polyhouse.

iii. Give alternate sprays of the fungicides chlorothalonil (0.2%), mancozeb (0.2%), carbendazim (0.1), penconazole (0.1) or difenoconazole (0.1%).

7. Bacterial wilt, *Pseudomonas caryophyllii*

Symptoms: The leaves turn grayish green to yellow and ultimately die. Wilting of plants is also a common symptom.

Management

i. Take cuttings from healthy plants.

ii. Avoid overcrowding and placing plants in damp, shady locations.

iii. Avoid overhead-irrigation to minimize leaf wetness and disease spread.

iv. Spray the crop with copper oxychloride (0.3%) + Streptocycline at 10 days interval

8. **Virus**, Carnation mottle, carnation latent, carnation etched ring, carnation ring spot virus, etc.

Carnation is known to be infected by a large number of viruses. Most of these viruses are insect or sap-transmissible.

Symptoms: Plants show a wide variety of symptoms such as mottle, mosaic, streaks, rings. or line patterns.

Management

i. Take cuttings from a healthy mother block.

ii. Subject plants to dry heat (38°C) for 2 months to eliminate virus.

iii. Spray with suitable insecticide to kill insect vector.

Insect and Non-Insect Pests

1. **Thrips**, *Frankliniella schultzei* Trybom. (Thysanoptera: Thripidae)

Females are light-brown to gray color and males are yellow colored. The eggs are inserted into tissues of young leaves, buds, petals, sepals and calyx cups. Nymphs feed by rasping and sucking on plant tissues. Fully grown nymph will fall on to ground and pupate about 50 mm under the soil surface. Each generation will be completed from 10 days to more than a month, depending on the temperature. These thrips are major problem incarnation during summer months, due to hot and dry weather which is favorable for their multiplication.

Both nymphs and adults suck the sap from leaves, buds and flowers. Infested leaves turn yellow and patchy, often with black specks and slight crinkling. Severe attack will adversely affect the growth. Brown streaks on the buds is the characteristic symptom, under severe infestation buds gets distorted. Infested flowers show burnt appearance along the margin, which makes them unmarketable.

Management

i. Install yellow/ blue sticky traps to monitor thrips activity and periodic inspection of individual plants for thrips activity, as it is easy to manage this pest at initial stages of infestation.

ii. Spray dimethoate 30 EC @ 2.0 ml/l or acetamiprid 20 SP @ 0.4 g/l or oxydemeton methyl 25 EC @ 2.0 ml/l at 15 days interval.

iii. Soil drenching with chlorpyriphos 20 EC @ 4.0 ml/l to kill pupae.

iv. In case of severe infestation, spray with imidacloprid 200 SL @ 0.4 ml/l or fipronil @ 5 SC @ 1.0 ml/l or acephate 75 SP @ 1.5 g/l.

2. Bud borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae)

The infestation starts from September – October till March. Female moth lays cream colored, single egg on young buds. Larvae will hatch in two to three days. Larva will bore into the buds and damage the flower by feeding on the developing parts making them hollow. Larvae may also attack young shoots, foliage and open flowers resulting in dropping of petals and significant yield loss.

Management

i. Collect and destroy the larvae.

ii. Spray of quinalphos 25 EC @ 2.0 ml/l or methyl parathion 50 EC @ 1.0 ml/l at fortnightly interval.

iii. Spray indoxacarb 14.5 SC @ 1.0 ml/l or thiodicarb 75 WP @ 1.0 g/l, if the incidence is severe.

iv. Application of HaNPV@ 250 LE/ha followed by spray with any neem formulations at 1.0 – 2.0 ml/l.

3. Two-spotted spider mite, *Tetranychus urticae* (Acari: Tetranychidae)

This is a devastating pest on carnation, infestation will be severe during summer months especially from February – May. Mite colonies are found on lower surface of leaves, covered by dirty webs. Economic threshold is 0.5 mite/leaf. Due to continuous sucking of sap, leaves turn pale colored, withered, bronzed and ultimately dries up. Infestation spreads to buds, flowers and entire plant in severe cases. Infested plant will loose the vigor, shows stunted growth with reduced flower production and market value of flower is reduced.

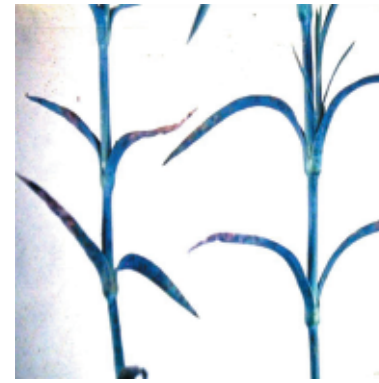
Management

i. Regular inspection of crop for mite infestation and cutting and burn the infested plant parts to avoid further spread.

ii. Thorough spray of jet of water on the plant dislodges the mites from their webs followed by spraying dicofol 18.5 EC @ 1.5 ml/l or wettable sulphur 80 WP @ 3.0 g/l or profenofos 50 EC @ 1.0 ml/l at fortnightly interval followed by 1% pongamia or neem oil spray.

iii. Spray propergite 57 EC @ 1.0 ml/l or abamectin 1.9 EC @ 0.5 ml/l followed by flufenoxuron 10 DC @ 1.0 ml/l or fenazaquin 10 EC @ 1.0 ml/l during summer when infestations are high.

Wilted plant Vs healthy plant



Alterneria blight on leaves

Rust symptoms on leaves

Helicoverpa damage on flower bud

Spider mites on flower bud

Flower bud damaged due to mite feeding

ORCHIDS

Diseases

1. Black rot/ Crown rot/ Heart rot

A serious problem under high humidity condition. Black rot caused by *Pythium* sp. and crown rot by *Phytophthora* sp. results in rotting of pseudostem and finally the complete plant.

Management

i. Remove and destroy the infected plants.

ii. Re-pot the plants around the infected plant in sterilized potting mixture after dipping in fungicide solution.

iii. Metalaxylat 0.05% and metalaxyl + mancozeb at 0.15% found effective in managing the disease.

2. Anthracnose

Caused by *Gleosporium/ Colletotrichum* sp. and characterized by brown to black sunken spots on leaves.

Management

i. Application of captan, benomyl is followed to keep disease under control.

3. Blossom blight/ Petal blight

Caused by *Botrytis* sp. Numerous dark brown spots appear on the petals and severe cases it covers the entire inflorescence and flower drops off.

Management

i. Maintain good ventilation for air circulation once the plant is bloomed.

ii. Avoid development of high moisture condition.

iii. Application of mancozeb 0.25% is used to control the disease.

4. Bacterial soft rot

Caused by *Erwinia* sp. Small water soaked lesions appear on leaves and pseudostem. Pseudobulbs turn soft and gradually rot.

Management

i. Use of oxyteracycline and chloramphenicol is reported to control *E. carotovora*.

ii. Submerging infected plants in 1:2000 solutions of 8-Quinalinol of Natriphene for 1 to 25 hours controls *E.cypripedi*.

5. Viruses

Various symptoms caused by virus infection on different species of orchids include mosaic, mottling, yellowing, ringspot, streaks, necrosis and flower colour breaking.

Management

i. Use of certified virus free clones.

ii. Clean cultivation under insect free environment.

Insect and Non-Insect Pests

1. Scale insects

There are five predominant species of scale insects *viz*., Ti scale, *Pinnaspis buxi*; Florida red scale, *Chrysomphalus aonidum*; Lecanium scale, *Lecanium* sp; Soft brown scale, *Coccus hesperidum* and Boisduval scale, *Diaspis boisduvalli* which damage orchids round the year. The name of these species of scales kept as per their physical appearance and their description are given under.

1.1 Ti scale, *Pinnaspis buxi*

Ti scales are sticky to elongated pear shaped, small sized (about 1.0 – 2.0 mm long), brown to dark brow coloured, flat bodied and without any permanent body organs like wings, legs or eyes. It looks dried rather than plump like dead ones.

1.2 Florida red scale, *Chrysomphalus aonidum*

This type of scale are round or moderately convex shaped, dark reddish brown to almost black or ash grey coloured. Size is almost 2.0 – 2.5 mm in diameter. The exuviae are approximately central, reddish brown or brick red sometimes covered with grayish secretion, surrounded by a reddish brown ring.

1.3 Lecanium scale, *Lecanium* sp.

The lecanium scales are usually bowl or dome or turtle shaped, slightly longer than wide, about 4.0 – 6.0 mm in diameter, smooth and shiny brown coloured. Insect bearing protective covering of wax. Secreted from their body.

1.4 Soft brown scale, *Coccus hesperidum*.

Soft brown scales are oval and more flattened than either the black or hemispherical, small sized (2.0 – 3.0 mm long). They are pale brown, dirty white or grayish mottled with dark brown spots on the back.

1.5 Boisduval scale, *Diaspis boisduvali*

Boisduval scales are circular to oval shaped, thin flat, about 1.20 – 2.25 mm in diameter. White to light yellow and semitransparent. Exuviae (cast skin) ventral to sub central, white to light yellow. The body is fully covered with white cottony growth.

All these scale insects suck the plant sap from leaves, petioles, peseudobulbs, flowers and cause loss of vigor and deformation of infested plants. Yellowing of leaves, leaf drop, stunted growth and ultimately poor quality flower stalk may be seen on heavily infested plant.

Management

i. Clean cultivation and regular monitoring of the crop.

ii. Selection of scale free planting materials.

iii. Pruning and burning of infested plant parts.

iv. Removing scales by rubbing with 70% lsopropyl alcohol or methylated spirit using cotton swab or tooth brush.

v. Spray with malathion 50 EC or monocrotophos 36 SL or acephate 75 SP @ 1.5 ml/lt. or carbaryl 50 WP @ 1.0 g/lt of water.

2. Aphids

Aphids are the major problem in orchids, mainly two species yellow aphid, *Macrosiphum luteum* and black aphid, *Toxoptera aurantii* cause damage to orchids.

2.1 Yellow aphid, *Macrosiphum luteum* (Hemiptera: Aphididate)

This species of aphid is pale green colour during nymphal stage and greenish yellow to yellow colour in adult stage, oval shaped and minute size about 2.0 – 3.0 mm in length. Blackish two cornicles are present on the tip of abdomen. Adults are winged or wingless and wingless form has a brownish patch on the top of the abdomen.

2.2 Black aphid, *Toxoptera aurantii* (Hemiptera: Aphididate)

Black aphids are also oval shaped, small sized about 2.0 – 3.0 mm in length, wingless in nymphal stage and wingless as well as winged in adult stage. One pair of cornicles is situated on the tip of abdomen which secretes honeydew. Aphids colonies on the flower buds and flowers.

Both the nymphs and adults suck the cell sap usually from flower spikes, flower buds and flowers. Small, irregular shaped spots appear on the petals and sepals due to loss of cell sap. They also excrete honeydew on which sooty mould developed that affect the photosynthesis. High humidity and cloudy weather fasten the population buildup. The affected plants retard growth and ultimately deteriorate the quality of flowers. They are also believed to transmit some viral diseases from infested to healthy plants.

Management

i. Clean cultivation and regular monitoring of the crop.

ii. At new spike or flower bud opening stage spray with 1.0 % neem or pongamia oil.

iii. If aphid population persists then spray with malathion 50 EC or monocrotophos 36 SL or acephate 75 SP @ 1.5 ml/l or carbaryl 50 WP @ 1.0 g/l of water at 10 – 15 days interval.

3. Shoot borer, *Peridaedala* sp. (Lepidoptera: Tortricidae)

Shoot borer is also a serious insect of many species of orchids, especially in Dendrobium spp. Adults are small moth, black in colour with white spots on the wings, size about 8.0 – 10.0 mm in length across the wings. Caterpillars are small in size with tiny black head and yellow to creamy in colour.

Young larvae bore downward into the shoots, make tunnel and feed therein by leaving excreta at opening hole. Shoot growth is checked and dead shoots or yellow shoot flag produced as a result plant growth is checked and flower production gets affected.

Management

i. Clean cultivation and regular monitoring of the crop.

ii. Cutting and destroying infested branches.

iv. Spray with malathion 50 EC or monocrotophos 36 SL @ 1.5 ml/l of water at 10 – 15 days interval.

4. Thrips, *Dichromothrips nakahari* (Thysanoptera: Thripidae)

The adults are slender, dark brown to black in colour having apically pointed wings and measures about 1.0 – 2.0 mm length. Nymphs are resemble to the adults in their shape but pale yellow in colour, wingless and smaller size with black eyes. The insects are just visible to the unaided eye and are seem moving briskly on the leaves and flowers of orchids.

Both adults and nymphs damage the plant by sucking the sap from tender parts of the plant. Infested leaves become curled, wrinkled and discolored. Under severe infestation, the leaves, flower buds and flowers will be malformed.

Management

i. Clean cultivation and regular monitoring of the crop.

ii. Cutting and destroying infested branches.

iii. Spray with 1% neem or pongamia oil.

iv. Spray with malathion 50 EC or monocrotophos 36 SL or acephate 75 SP @ 1.5 ml/l or imidacloprid 17.8 SL @ 0.5 ml/l or carbaryl 50 WP @ 1.0 g/l of water at 10 – 15 days interval

5. Mealybug, *Pseudococcus* sp.

These insects cause damage to mainly orchids in nursery. Adults are soft, filamentous pink or yellow coloured and body is covered with white powdery max like cottony growth in irregular shape. It has piercing and sucking type of mouthparts with long antennae.

Both young ones and adult suck the sap from the leaves and petiole or any jointed portion of plants as a result plant become weakened. They also secrete honeydew that attracts ants. In case of severe infestation sooty mould develop on infested plant parts. The attacked plant looks like wilted plant resulting poor quality of flowers production.

Management

i. Clean cultivation and regular monitoring of the crop.

ii. Cutting and destroying infested branches.

iii. Spray with 1% neem or pongamia oil.

iv. Spray with malathion 50 EC or monocrotophos 36 SL or acephate 75 SP @ 1.5 ml/l or imidacloprid 17.8 SL @ 0.5 ml/l or carbaryl 50 WP @ 1.0 g/l of water at 10 – 15 days interval.

6. Red spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae)

All active stages *viz*., nymph and adult feed on undersurface of leaves and flowers by sucking the cell sap from epidermal layer, especially along with midrib and the base. The loss of cell sap causes yellowing of leaves. The injuries due to feeding can be seen as silvery marks left on both the surface of leaves which usually turn brown or black after a period of time. In case of severe infestation, plants covered with webbing as a result, pests can spread from one plant to another plant. Whole plants get weakened, growth stunted and loss of foliage occurs in the infested plants. Flower buds not open properly and flowers are usually abortive, turn brown and fall down before maturation.

Management

i. Weekly monitoring to find out pest build-up.

ii. Removing and destroying infested plant parts.

iii. Clean cultivation and proper ventilation.

iv. Thorough spray of jet of water on the plant dislodges the mites from their webs followed by spraying dicofol 18.5 EC @ 1.5 ml/l or wettable sulphur 80 WP @ 3.0 g/l at fortnightly interval followed by 1% neem oil spray.

v. Spray propergite 57 EC @ 1.0 ml/l or avermectin 1.8 EC @ 0.5 ml/l or imidacloprid 17.8 SL @ 0.05 ml/l. alternatively and repeat the spray at 10 – 15 days interval during summer when mite infestations are high.

7. Snail, *Cryptaustenia verrucosa* and *C. heteroconcha*

Snails are soft bodied animals belonging to Class: Gastropoda of the Phylum: Mollusca. Their body is asymmetrical, spirally coiled which enclosed in a shell. They have small flat foot which used for creeping. It is slime trails leading toward the damage plant.

Both young and adult stage of snails feed on orchid roots, leaves, flower buds and even fully opened flowers. The damage is done on the plant parts through cutting by their mouthparts in irregular shape. Slime trail leading to the plant injury is indicative of their presence. Generally snails prefer shady and dark conditions and its attack prevalent only during night in monsoon period of highly humid conditions. If snails attack in opened flowers, it changes the physical appearance and decreased the beauty of flowers.

Management

i. Clean cultivation and regular monitoring of the crop.

ii. Manually collect the snails and slugs and destroy them by dipping in hot water or 5% salt solution.

iii. Install metal barrier to prevent snails to climb on the racks.

iv. Use cabbage leaves as bait to attract the snails and destroy them.

v. Apply metaldehyde 6% @ 0.7 g/m^2 at 15 – 20 days interval.

Anthracnose on leaves

Leaf spot

Snail

Slug

Snail damage

Photo curtesy by
Dr. P. K. Sudhadevi, KAU, Kerala

CHRYSANTHEMUM (*Chrysanthemum morifolium*)

Diseases

1. Leaf spot (*Septoria chrysanthemella* and *S. obesa*)

It is a common disease of chrysanthemum. It is particularly more serious in standard than in spray chrysanthemum. It is favoured by wet weather conditions and spreads by sprinkler irrigation or splashed rains.

Symptoms: Symptoms on the leaves appear as small circular bronze areas that enlarge and form bigger more irregular spots. The colour of the spots changes to dark brown to black. On lower surface of the leaves the colour is grayish-brown. Symptoms first become evident on lower leaves. *Phoma chrysanthemicola* also causes similar symptoms on the leaves of chrysanthemum though it is also known to cause root rot.

Management

i. Use healthy planting stock.

ii. Avoid wetting of leaves.

iii. Spray mancozeb (0.2%) or zineb (0.2%) at 7 – 10 days interval paying special attention to the lower parts of the plants and underside of leaves.

2. Stemphylium/Alternaria ray speck (*Stemphylium* and *Alternaria* spp.)

The disease appears under moderate temperature and free moisture conditions

Symptoms: The disease appears in the form of brown to reddish brown pinpoint necrotic lesions on the ray florets. Spotting of foliage and rotting of flower tissue is common.

Management

i. Clean up infected plant debris.

ii. Avoid overhead irrigation.

iii. Give spray applications of Dithane M-45 (0.2%) or Dithane Z-78 (0.2%)oriprodione (Rovral, 0.2%).

3. Verticillium wilt (*Verticillium albo-atrum*)

It is a soil borne disease. The pathogen can survive in the soil for many years and can be carried over through cuttings and root divisions.

Symptoms: The disease manifests itself by the yellowing and browning of the leaves that die from the base upwards. The vascular tissues become discolored The onslaught of the disease is sometimes confined to the lower portion of the plant only. Infected plants remain stunted and often fail to produce flowers.

Management

i. Destroy infected plants by burning.

ii. Sterilize the soil before use.

iii. Obtain cuttings from healthy stock, preferably the shoot tips.

iv. Don't grow chrysanthemum in the same field repeatedly.

v. Drenching of soil with fungicides, e.g. Bavistin, helps to control the disease

vi. Grow disease tolerant varieties.

4. Powdery mildew (*Erysiphe cichoracearum*)

The fungus survives only on living plants. It is favoured by high humidity

Symptoms: The leaves and stems of chrysanthemum become covered with a white powdery growth of the fungus. The young leaves may get deformed.

Management

i. Keep relative humidity low.

ii. Spray the crop with Karathane (0.05-0.08%), wettable Sulphur (0.2%), or propiconazole (Tilt, 0.1%) or triadimefon (Bayleton 0.1%) at regular intervals.

5. Blossom blight (*Botrytis cinerea*)

The disease is favoured by cool temperature and high humidity conditions.

Symptoms: The symptoms appear in the form of light brown spots on the flower petals that may become covered with gray mass of spores. The disease may cause rotting of leaves and girdling of stems.

Management

i. Clean up crop refuse that may serve as a source of infection.

ii. Keep humidity at low level.

iii. Improve heating and ventilation.

iv. Avoid frequent use of nitrogenous fertilizers.

v. Apply sprays of chlorothalonil (Kavach, 0.2%), vinclozolin (Ronilan, 0.2%), iprodione (Rovral, 0.2%) at pre-blooming period to protect the flowers.

6. Stem rot (*Rhizoctonia solani*)

The disease is favoured by moist warm weather conditions. The disease is spread through mechanical meana.

Symptoms: The plants get infected near the soil line. The invaded tissue develops reddish brown coloration. The disease is common in the propagation benches and is a major cause for failure of cuttings to root.

Management

i. Plant rooted cuttings in pasteurized/sterilized soil.

ii. Apply fungicides such as pencycuron (Monceren, 0.2%) to protect healthy plants.

Insect and Non-Insect Pests

1. Aphid, *Macrosiphoniella sanborni* Gillette., *Myzus persicae* (Sulz).(Hemiptera:Aphididae)

The most common aphids infesting chrysanthemum are the chrysanthemum aphid, *Macrosiphoniella sanborni* and the green peach aphid, *Myzus persicae*. *Macrosiphoniella sanborni* is large and maroon or dark brown and *Myzus persicae* are yellowish green in color.

Aphids on the terminal shoots and on underside of the leaves feed by sucking the sap. Feeding results in stunting, leaf-curling, withering of flowers and severe infestations resulting in death of the entire plant. Severe damage may reduce the number and size of flower buds and buds remain unopened. Aphids also excrete honeydew on which black sooty mould grows. Aphids feeding on flowers make them unmarketable.

Management

i. Spray pongamia or neem oil @ 20 ml/l.

ii. If the incidence is severe, spray dimethoate 30 EC @ 2.0 ml/l or oxydemeton methyl 25 EC @ 2.0 ml/l or imidacloprid 200SL @ 0.4 ml/l or acephate 75 SP @ 1.5 g/l.

iii. Application of *Verticillium lecanii* @ 3.0 g/1 during evening hours also reduces aphid incidence.

2. Thrips, *Microcephalothrips abdominalis* (Crawford), *Thrips* spp. and *Frankliniella* spp. (Thysanoptera: Thripidae)

Thrips are very small insects and commonly hide in flowers, buds and leaf axils and often go unnoticed until damage appears. They are slender, white to black in colour and feed on growing points causing mottling and distortion of leaves and also leaf silvering due to separation of the upper epidermal tissue from the rest of the leaf. They also damages flowers of summer blooming cultivars. The affected flowers look as if dried due to scorching heat. Microcephalothripsabdominalis infests flowers by causing abrasions on petals, due to which the attacked part turns brown. Heavy infestation results in damage to corolla, stamens and developing seed, leading to premature flower drop.

Management

i. Spray dimethoate 30 EC @ 2.0 ml/l at fortnightly interval.

ii. Soil drenching with chlorpyriphos 20 EC @ 5.0 ml/l to kill pupae.

iii. If the incidence is severe, spray ethofenprox10 EC @ 1.0 ml/l or fipronil 5 SC @ 1.5 ml/l.

3. Leaf miner, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)

This is a major pest of commercially grown chrysanthemum. Eggs are deposited in leaf tissues and larvae tunnel within the leaves between the epidermal layers making characteristic serpentine shaped mines. Fully developed larvae fall off from the leaf to pupate on the ground.

The incidence of leaf miner is severe in March – June. Severely damaged leaves show extensive mining and dry up.

Management

i. Install yellow sticky traps to attract adult flies.

ii. Remove and destroy severely mined leaves.

iii. Spray abamectin 1.9 EC @ 0.4 ml/l against larvae.

iv. Spray with dichlorvos 76 EC @ 1.0 ml/l or decamethrin 2.8 EC @ 1.0 ml/l for managing adults.

4. Mites

a) Two-spotted spider mite, *Tetranychus urticae* Koch. (Acari: Tetranychidae)

The mite colonies usually seen on the lower surface of leaves and population spreads to entire plant in severe case of attack. Damage starts from March and reaches a peak during April – July. Affected leaves shows white specks in the early stage, become discolored, wilt and falloff while the shoots shows dull appearance and dry up.

b) Broad mite or yellow mite, *Polyphagotarsonemus latus* Banks (Acari: Tarsonemidae)

The yellow mites are very small, measuring about 150 µm long. Damage is normally noticeable only when large numbers of mites are present, and takes the form of distorted or brittle, downward curved leaves with hairy undersurface. Adult females live for about 10 days and produce about five eggs daily. The mite life cycle is completed in less than one week at 20°C allowing a rapid population increase.

Management

i. Spray of dicofol 18.5 EC @ 2.5 ml/l or dimethoate 30 EC @ 2.0 ml/l or profenofos 50 EC @ 1.0 ml/l.

ii. Spray with 1% pongamia oil or neem oil at fortnightly interval.

Black leaf spot

Chrysanthemum aphid infestation on terminal shoot

Aphid infestation on flower

Flower discoloration due to thrips damage

ANTHURIUM (*Anthurium* sp.)

Diseases

1. Anthracnose, *Colletorichum gloeosporioide*

The disease has been reported from a number of countries such as Hawaii, Japan, Korea, India etc. The main source of spores is the infected anthurium flowers within the field. Moisture and temperature have a major influence on disease development. Spores are produced in large numbers and are spread primarily by rain splash and irrigation water. It is a problem of high rainfall areas or in moist greenhouse conditions. If the water is allowed to remain on the leaves, the development of leaf blotch is favoured.

Symptoms: The disease primarily affects the individual flowers on the spadix. Infection starts as a tiny, dark spot that expands to a triangle or other angular shape depending on the number and pattern of sepals infected. Each infection site usually remains isolated, is surrounded by adjacent healthy tissue, and may be scattered individually or in narrow or broad zones. Under wet conditions with a high level of inculum, a general rot of the entire spadix may

The fungus may infect leaves following an injury. Petioles and pedicels are also susceptible and develop elongated, diamond - shaped lesions. Symptoms appears on leaf lamina as small brown spots with a characteristics yellow halo which gradually enlarged and developed into irregular necrotic lesions. In severe infections, the leaves shriveled and dried. Numerous black spore pustules are seen in the centre of the dried leaves. .

Management

i. Remove and destroy severely infected leaves or flower parts.

ii. Grow resistant cultivars, like Marian, Seefurth, Uniwai, Manova Mist, etc. in disease prone areas.

iii. Spraying with mancozeb (Dithane M-45, 0.25%) or captan (0.25%) or carbendazim (Bavistin, 0.1%) is reported effective in controlling the disease.

2. Root Rot, *Calonectria crotalariae*, *Pythium splendens*, *P. spinosum*, *P. vexans*, and *Phytophthora* spp., *Rhizoctonia* spp. and *Fusarium* spp.

Symptoms: Symptoms of root rot include reduced plant height (stunted growth), smaller leaves and flowers, lack of leaf and flower sheen, and a general reduction of plant vigour. In severe cases, all the roots, except for a few aerial roots that have not yet begin growth into the medium, may be rotted. Roots often have a strong odour of decay as a result of secondary invasion by bacteria.

Management

i. Use disease-free planting material.

ii. Maintain strict sanitation measures.

iii. Rouge out and destroy dead and disease infected plants.

iv. Improve drainage of media.

v. Drench the medium with metalaxyl +mancozeb (Ridomil MZ-72), mancozeb or thiram @ 2.5 g/l at 7-10 days interval after uprooting the infected plants.

3. Bacterial blight, *Xanthomonas dieffenbachiae*, *X. campestris*. pv. *dieffenbachiae*, *X. axonopodis* pv. *dieffenbachiae*

Symptoms: Symptoms shows young leaves and open wounds are most vulnerable to infection. The bacterium produces two main types of symptoms. The first one is the foliar or leaf symptoms that occur when infection begins in the leaf or spathe. The second is the systemic or vascular symptoms that occur when the bacterium establishes itself in the stem and spreads to other parts of the plant.

Symptoms showed young leaves and open wounds were most vulnerable to infection. Irregular shaped water soaked spots surrounded by very slight yellowing were early symptoms, noticeable on lower surface leaves. As it progresses, leaf tissue is killed and darkened areas become encircled by a striking yellow zone. Affected parts of the leaves may be desiccated causing leaf distortion. Stem infection is characterized by blackening of the stem and leaf sheaths covering young petiole bases. The bacterium invades water-conducting tissue and interferes with the translocation of water and nutrients, causing pale bleached flowers and prematurely yellowing leaves.

Management

i. Strict sanitation measures like minimizing the movement of personnel or tools so as to prevent the disease from entering fields from other sources should be followed. In fields, the spread of the disease could be checked by removing the blighted leaves, providing best cultural conditions.

ii. Application of ammonical forms of nitrogen is to be avoided and the total quantity of nitrogen is to be reduced.

iii. Spraying with streptocyclinsulphate or oxytetracycline (200mg/l) at weekly interval is recommended. Effectiveness of Fosetyl aluminum (Aliette 80 WP) @ 3g/lt. of water against the disease has also been reported against the disease.

Insect Pests

1. Whitefly, *Aleurotulus anthuricola* (Hemiptera:Aleyrodidae)

Both nymphs and adults colonize under flowers, petiole sheath and leaves, and secretes white, powdery, waxy material. Due to continuous sucking by these insects, infested parts turn yellow, deform and dry in severe cases.

Management

i. Remove and burn old and heavily infested leaves.

ii. Spray with acephate 75 SP or methomyl 40 SP or profenofos 50 EC @ 2.0 ml/l of water followed by a spray of pongamia oil 1%.

2. Thrips, *Chaetanaphothrips orchidii* (Moulton) (Thysanoptera:Thripidae)

Thrips suck the sap from leaves and cause mottled effect on foliage and flowers.

Management

i. Spray with profenofos 50 EC or cartap hydrochloride 50 SP @ 2.0 ml/l of water.

LILY (*Lilium* spp.)

Diseases

1. Bulb and scale rot, *Fusarium oxysporum* f. sp. *lilii*

High temperature favours development of the disease. The disease gets transmitted through infected bulbs or thorough infested soil.

Symptoms: Affected plants show pale green foliage and retarded growth. Infected bulb scales develop dark brown stains and eventually rot under favourable conditions if infected near the basal plate.

Management

i. Sterilize the soil with using heat or chemical disinfectants.

ii. Remove infected plants from the polyhouse as soon as detected.

iii. Maintain low temperature as warmer climate favours development of disease.

iv. Give dip treatment to bulbs in the fungicide Captan (0.2%) before planting.

2. Rhizoctonia rot, *Rhizoctonia solani*

The disease is favoured by high temperatures of the summer months.

Symptoms: The fungus mainly attacks the roots but infection is noticed on the young foliage too.

Management

i. Use sterilized soil and prevent its recontamination.

ii. Maintain lowest possible temperature.

iii. Soil drenching with suitable fungicides such Monceren (0.2%).

3. Foot rot, *Phytophthora cactorum*, *P. nicotianae*, *P. parasitica*, etc.

The disease is favoured by high soil moisture and temperatures above 200C

Symptoms: The plants show violet brown spots and wither suddenly. They often remain stunted in growth.

Management

i. Sterilize the soil before planting the bulbs.

ii. Do not allow water to stagnate in the beds

iii. The fungicide mancozeb (0.2%) or metalaxyl + mancozeb (0.2%) may be applied as soil drench.

4. Root rot, *Pythium ultimum*

The fungus prefers moist conditions and thrives best between 20-30°C

Symptoms: Plants remain stunted and foliage turns yellow towards the base. The upper leaves of the infected plants become narrow. Roots develop flecks of reddish brown colour and rot.

Management

i. Sterilize the soil before use.

ii. Avoid wet and soggy conditions in the polyhouse.

iii. Maintain low temperature.

iv. Drench the soil/rooting medium with fungicides such as fosetyl-Al, Captan, or metalaxyl+ mancozeb. (0.25 %).

5. Gray mold, *Botrytis elliptica*

It is a severe and widespread disease of lilium. The resting structures of the fungus, known as sclerotia, help in seasonal carryover the disease.

Symptoms: The fungus infects leaves, stems, flowers and flower buds. The symptoms appear in the form of light to dark brown spots which may extend and form bigger blotches.

Management

i. Collect infected plants and destroy them.

ii. Maintain low humidity in the polyhouse.

iii. Improve circulation of air in the polyhouse area.

iv. Apply sprays of the fungicide chlorothalonil (0.2%) or vinclozolin (0.2%) at 10-14 day intervals.

6. Viruses, Lily symptomless, CMV, Tulip breaking, Tobacco rattle, Tobacco ringspot

Symptoms: Plants loose vigor and produce inferior quality flowers. They may also show stunting or and dwarfing.

Management

i. As the viruses are transmitted mostly by aphids or nematodes, adopt suitable measures to control the pests.

Insect and Non-Insect Pests

1. **Leaf caterpillars**, *Polytela gloriosa* F. and *Brythyscrini* Fb. (Lepidoptera:Noctuidae)

The larvae feed on the green matter of leaves and cause defoliation. The moth is stout with a mosaic pattern of yellow, red and black on the forewings and black hind wings. The smooth larva is pretty looking with black, white and red spots. Round, yellowish eggs are laid in clusters of l5 to 40 on the apical portion of the under surface of leaves. They hatch in 3 to 4 days. The larval period lasts from 16 to 20 days undergoing 5 moults. Pupation takes place in soil for 15 to 20 days. There are two generations per year in North India; the pupae of the second generation hibernate in the soil. The larvae of *Brythyscrini* feed on leaves. In severe infestation, the whole plant is defoliated. The moth completes its life cycle in about 6 weeks.

Management

i. Hand picking and destroying the larvae will reduce the infestation.

ii. Spray with NSKE 5%.

2. **Aphids**, *Rhopalosiphum nymphaease* Linn. and *Myzus persicae* (Sulzer). (Hemiptera: Aphididae)

Rhopalosiphum nymphaease sucks the sap from shoots and floral buds which results in withering of tender shoots and premature falling of buds. While feeding, aphids excrete honeydew on which sooty mould develops. The affected plants lose their elegance. *Myzus persicae* feeds on leaves.

Management

i. Spray dimethoate 30 EC @ 2.0 ml/l.

3. **Lily bulb mites**, *Rhizoglyphus echinopus* (Fum and Rob) and *Rhizoglyphus robini* (Acarina: Acaridiidae)

The bulb mites feed on the bulbs and roots and destroy them. Later, they infest the scales and burrow into stems. The stem and leaves of infested plants become yellow. On the Easter lily, *Lilium longiflorum*, typical symptoms include rosetting, cessation of growth at a height of 3-6 inches, chlorosis and occasional death. Damage by bulb mite also promotes secondary invasion of plant pathogens such as Fusarium, Pythium and Rhizoctonia.

Management

i. Steam sterilization of bulbs at 60°C for 30 min. or 80°C for 20 min.

ii. Bulbs should be grown in properly drained soil.

iii. Crop rotation with non-host crops should be followed.

iv. Fortnightly spray with dicofol 18.5 EC or monocrotophos 36 SL @ 0.5 ml/l.

Aphid infestation on terminal shoot

Aphid infestation on flower bud

Lilium bulb decayed due to mite infestation

Bulb mites feeding on decayed tissue

NEMATODE MANAGEMENT UNDER POLYHOUSE

Nematodes are multicellular, unsegmented, bilaterally symmetrical roundworms belonging to pseudocoelomates animals. Many of them are parasites of plants and insects. Flower and ornamental crops are susceptible to several species of plant-parasitic nematode of which root-knot nematode, *Meloidogyne* spp., and reniform nematode, *Rotylenchulus reniformis* are major ones which cause heavy damage on the crops grown under polyhouse conditions. These nematodes live in the soil and feed on the root system and damage the root system thoroughly. Besides damaging directly, plant-parasitic nematodes also can enhance damage caused by other soil borne fungal and bacterial pathogens.

Damage symptoms

1. **Root-knot nematode** (*Meloidogyne* spp.)

This obligate sedentary endoparasitic nematode complete most of their life cycle inside the host plant. The infective second stage juveniles (J2) of *Meloidogyne* spp. enter roots and cause slight mechanical injury. Second stage juveniles establish specialized feeding structures called giant cells. Hyperplasia (increase in cell numbers) is observed in tissue adjacent to juveniles. Hyperplasia and hypertrophy (increase in cell size) of the surrounding pericycle and cortical cells yield stereotypical root-knots or galls on the root system. Galls are of various sizes and assume innumerable shapes. Above ground symptoms of nematode infected plant shows various degrees of stunting and chlorosis (yellowing). Infected rows or area appear thinner compared to healthy one and give the patchy appearance.

2. **Reniform nematode** (*Rotylenchulus reniformis*)

This obligate sedentary semi-endoparasite of roots complete most of their life cycle inside the host plant. Nematode infestation can cause symptoms in the plant that resemble those of moisture and nutrient deficiencies. reniform nematode causes root necrosis resulting in severe root pruning and subsequent dwarfing of plants. Fibrous or feeder roots are mostly attacked which may reduce the absorption ability and other physiological functions of the plant. Root growth slows and secondary root development is limited. Infested plants shows stunted growth and yellowing of leaves.

Integrated nematode management

i. Use pasteurized or fumigated soil or rooting medium for raising healthy seedlings in nursery bed.

ii. Sometimes plants come from the nursery already infested with nematodes. Avoid introducing nematodes through seedlings. Do not use plants whose roots have galls or have other abnormalities. Use nematode free planting material.

iii. Sterilize the soil before planting by use of chemicals and physical methods.

iv. Avoid introducing nematodes from gardens and other greenhouses by strict sanitation procedures including irrigation water, foot baths or overshoes for visitors

v. If possible, grow marigold for 2-3 months before planting

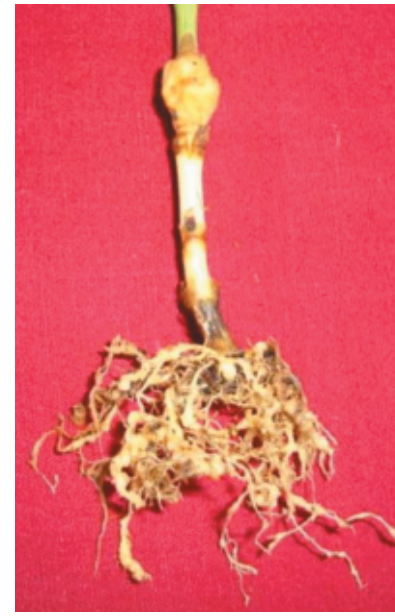
vi. Apply neem/pongamia/caster cake @ 500 g/sq.m.15 days before planting and maintain optimum moisture for proper decomposition of these organic substances

vii. Apply carbofuron or phorate @ 50 g/sq.m. seven days before planting

viii. Apply bio-pesticides such as *Trichoderma harzianum* + *Pseudomonas fluorescens* or *Paecilomyces lilacinus* + *P. fluorescens* (each 50g/sq.m.) two days before planting

ix. If nematode infestation is noticed on standing crop, apply any one of above mentioned bio-pesticides @ 50g/sq.m. + neem or pongamia cake @ 50g/sq.m. on the beds around the rhizosphere of the plant once in two months.

Galls on gerbera roots



Galls on carnation roots

NUTRITIONAL DISORDERS IN ORNAMENTAL CROPS

If the concentration of an essential nutrient element in plant tissue drops below the level necessary for optimal growth of the plant is said to be deficient in the element. Deficiency may occur due to the following reasons: i) low concentration of the element in soil/ nutrient substrate; ii) presence of chemical in an unavailable form for absorption by the plant; iii) excess of some other element that may interfere with its absorption; and iv) disturbance in normal metabolism of the plant.

There are three systems of monitoring nutrient status, which can help understand the problem and develop remedies. These are: i) visual diagnosis; ii) soil testing; and iii) foliar/leaf analysis.

Deficiency symptoms of some common elements

Nitrogen: Nitrogen concentration close to 20 ppm in the soil solution is required for good growth. Nitrogen deficiency symptoms become visible at10 ppm as a pale, yellowish-green coloration of the entire plant. Leaves become narrow and straight, flowers become small, and dieback of basal leaves is noticeable.

Phosphorus: Phosphorus deficiency is difficult to determine by visual symptoms. The premature death of older leaves that accompanies phosphorus deficiency is common in other nutritional problems such as potassium deficiency. To confirm the field diagnosis it is recommended that suspected deficiencies be verified by tissue analysis.

Potassium: Potassium deficiency causes excessive leaf tip burning of the older leaves and off-white spotting of the foliage. Stunted growth, flower stems shorter than normal, small, short, deformed flower buds with tip and marginal yellowing, browning and necrosis of the older leaves.In some flowering plants necrotic spots along with distal margin and older leaves. In many species, leaves become dark green or blue green. Terminal and lateral buds die under severe condition.

Calcium: Calcium deficiency is associated with leaf tip burning of the young leaves. Incorporation of lime to maintain soil pH between 6 and 7 is recommended for optimal production. When pH falls below 5, calcium deficiency shows up.

Boron: Boron deficiency symptoms show on the youngest foliage. Leaves are yellow and twisted, and the terminal bud sometimes is dead. Axillaries shoot proliferation at upper nodes is common, resembling the witch's broom effect caused by virus infections. Flower buds are abnormal and die before opening. The new foliage turns pale brown with a reddish-purple band and partial yellowing of the leaf base ensues.

Magnesium: The typical symptom of magnesium deficiency is interveinal discoloration in older leaves. The leaf area between the veins turns pale yellowish-green, while the veins remain deep green.

Sulphur: The plant as a whole is affected, becomes chlorotic, slight interveinalchlorosis of the young leaves occurs may progress to an overall yellow green colouration of the entire new growth.

Iron: Interveinalchlorosis of the growing leaves. The main veins remain green. If the deficiency continues, the newly formed leaves remain small and eventually become completely pale yellow or almost white.

Copper: Interveinal chlorosis of young foliage. Distorted young leaves with yellow tips that later becomes necrotic. The growing points die and instead short lateral shoots develop.

Zinc: It is identical to those of copper deficiency. Lateral shoots that develop after death of meristem remain severely stunted giving a "Little leaf" or "Rosette" appearance. Reduced leaf size, stunted internodes and irregular chlorosis of young foliage are the other symptoms.

Molybdenum: Browning and necrosis of the tips and edges of leaves. Violet flecks sometimes appear on the parts of the leaves that are still living. In severe cases after necrosis entire plant becomes stunted.

Manganese: Chlorosis on young leaves followed by tan to grey spots develops in the chlorotic areas. Leaves often show an interveinal chlorosis. Plants become dwarfed in severe cases.

Phosphorus deficiency symptom in gerbera

Iron deficiency symptom in gerbera

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Agrisearch with a human touch

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