Cabbage
Cauliflower
Radish
&
Beetroot

Common diseases in Crucifers

1. Powdery mildew
2. *Alternaria* leaf spot / Black spot / Brown rot

1. Powdery mildew in crucifers

Etiology: *Erysiphe polygoni*

Conidiophores are septate. Conidia are formed singly or in short chains, ellipsoid or ovate. The cleistothecia are sharp, globose. Four to eight asci are formed in each cleistothecium. Asci are ovate or sub-globose. Ascospores are elliptical, hyaline, unicellular.

Symptoms:

The leaves are covered with a fine white powdery growth on the lower surface.

In severe attacks the leaves are badly crippled and they drop later.

- The growth of the plant is reduced and leads to poor yield.
- The roots crack around the crown, resulting in soft rot.

Epidemiology:

The disease is favoured by light dry soils.

Management:

Crop rotation, eradication of crucifer weeds, destruction of volunteer crucifer plants and good soil drainage may be useful.

Fungicides such as benomyl sprays or sulphur dusts may be feasible on early-planted crops.

Grow resistant varieties.

2, *Alternaria* leaf spots / Black spot / Brown rot

Etiology: *Alternaria brassicicola, A. raphani*

Alternaria brassicicola : Conidia are formed in chains. They are cylindrical, muriform, tapering slightly towards the apex and the basal cell is rounded. Conidia are pale to dark brown. *A.brassicae:* Conidia are mostly solitary or in chains of up to 4.

Symptom:

Alternaria brassicicola:

Causes small, dark coloured spots. They spread and form circular lesions .

In humid weather, dark conidiophores are seen on the surface of the lesion in concentric rings.

Linear spots appear on petioles, stems and seed pods.

contd...

A brown discolouration of the cauliflower curds occurs which darkens to an olivaceous colour with age.
A. brassicae causes similar spots, but smaller in size and lighter in colour.
Both species attack cabbage heads mostly after harvest.
Mode of spread and survival:
All these pathogens are seed-borne under the seed coat and thus spreads with seed.
The fungi subsist as mycelium in the infected plant debris. They also survive in susceptible weeds or perennial crops. The conidia are borne abundantly in moist atmosphere and are disseminated readily by air currents.


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Epidemiology:

The disease is favoured by hot moist weather. Optimum temperature for growth is 26 ^{0} C. Dew or rain for 9 h is essential for infection.

Management:

Hot water treatment of seeds at 50°C for 30 min.

Long crop rotation, avoiding cruciferous vegetable crops and eradication of weed host should be followed.

Deep ploughing of diseased plant debris.

Spraying twice or thrice at the early stages of crop with copper oxychloride 0.3 % or zineb 0.25 % or captan 0.2 % controls the disease.

Overhead irrigation should be avoided.

Cabbage

Important diseases of Cabbage:

1. Club root / Finger and toe of cabbage
2. Damping off / Wire stem of cabbage
3. Black leg of cabbage
4. Stalk rot / Cottony rot / White blight
5. Cabbage yellows / *Fusarium* wilt of cabbage
6. Downy mildew of cabbage
7. *Cercosporella* leaf spot of cabbage

1. Club root / Finger and toe of cabbage

It attacks Cauliflower also.

Etiology: *Plasmodiophora brassicae*

Pathogen produces primary and secondary zoospores.

Spores are spherical.

Symptoms:

The leaves turns pale green to yellow.

Flagging and wilting in the noon and recover during the night.

Plants become stunted. Later die.

Young plants may be killed within a short time.

Fails to produce marketable heads.

Clubs decay due to secondary infection.

Small or large spindle-like, spherical, knobby or club-shaped swellings on the root due to hyperplasia and hypertrophy of infected tissues. Clubbed roots disintegrate before the end of the season results in plant stunting and wilting. Become susceptible to secondary, weak parasitic microorganisms.

Mode of spread and survival:

The fungus is soil-borne and survives in the crop residues in the form of minute resting spores for ten years. Spreads through diseased seedlings.

The dung of cattle and sheep fed on diseased roots contain resting spores. Contaminated soil carried by wheels of carts, implements, on tools and on the feet of human being has the inoculation.


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Epidemiology:

Sourness (acidity) of soil, wet weather, poorly drained soil favours the disease. Prevalent on soils with a pH below 7 The optimum temperature lies between 20 and 25°C.

Management:

Avoid cultivation in infected soil

Well drained fields with proper pH level (usually above 7.2)

Cruciferous weeds should be eradicated in and near seed beds and fields.

Soil pH adjustment by adding lime @ 2.5t/ha. Seed treatment with carbendazim @2g/kg.

Nursery drenching with carbendzim or chlorothalanil 0.1%.

contd…

Pre-planting dip in benomyl or carbendazim or thiophanate-methyl 0.05 % has also controlled the disease.

Club root-free seedlings be watered with solution containing Penta Chloro Nitro Benzene (PCNB) 0.1 % .

Use resistant varieties.

Follow seven years crop (rotation free of crucifers).

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2. Damping off / Wire stem

of cabbage

Etiology: *Rhizoctonia solani*

The fungus produces sclerotia which are irregular, brown to black and 5 mm in dia. The fungus produces both terminal and intercalary, barrel-shaped chlamydospores. In the perfect stage *(Thanatephorus cucumeris)* basidia are produced on the host. Basidiospores are hyaline, ellipsoid.

Symptoms:

The fungus produces damping off in seedlings. It causes wire stem in seedlings and bottom rot, head rot and root rot in older plants of crucifers.

Seedlings are attacked at the soil level. The tissues are water soaked and rot leading to toppling of seedlings.

contd...

In cabbage, the discoloured area is constricted and the plant may be bent or twisted without breaking (wire stem).

Management:

Seed treatment with PCNB or carbendazim or benomyl 2 g/kg controls the disease.

Moisture level in the nursery should be regulated by irrigation at regular intervals.

Soil drenching with carbendazim 0.1 % or thiram or mancozeb 0.2 % gives protection to the seedlings.


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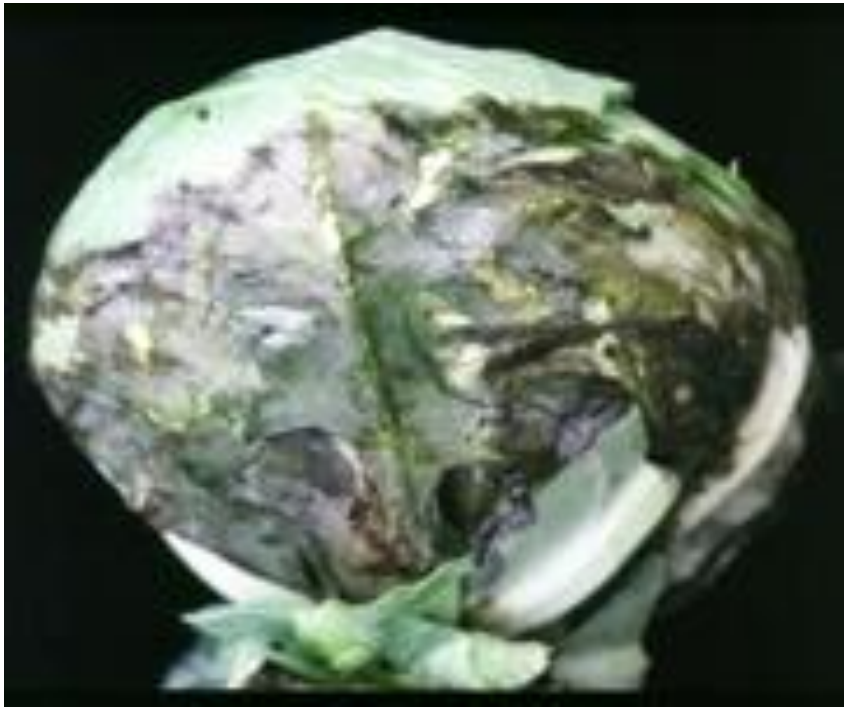

3. Black leg
of cabbage

Etiology: *Phoma lingam*

Mycelium is septate, branched, hyaline when young and become dark at maturity. Pycnidia are flask-shaped, dark coloured. Conidia are hyaline, cyclindrical, unicellular. Ascocarps are globose, black. Asci are cylindrical to clavate , 8-spored**,** yellowish brown.

Symptoms:

The fungus attacks at any stage of crop growth.

The disease appears as oval, depressed and light brown canker near the base of the stem.

Later, canker enlarges and girdles the stem. Attacked roots show dark brown cankers.

contd…

Spots are circular and light brown with ashy grey centres. Elliptical lesions appear on seed stalks and pods.

Mode of spread and survival:

The fungus persists on or in the seed coat. The fungus can live for at least three years in the diseased plant debris. Spores are disseminated by rain and irrigation water. Manure from sheep which feed on diseased plants also serve as an important source of infection.

Epidemiology:

Seed beds with infected seeds, growing under moist conditions with frequent rains result in many infected plants. Persistent dew favours fungus reproduction.

Management:

Good drainage and disease free seedlings

Remove the infected debris and diseased plants.

Seed treatment with hot water at 50°C for 30 min.

Seed treatment with benomyl or thiabendazole (24 h soak in 0.2 % solution) to eliminate the fungus from the seed.

Four year crop rotation with non-cruciferous.

Eradication of susceptible cruciferous weeds.

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4. Stalk rot / Cottony rot / White blight of Cabbage

It also infects cabbage, carrot, cauliflower, celery, and lettuce.

Etiology: *Sclerotinia sclerotiorum*

Mycelium is hyaline, branched, closely septate, inter-and intra-cellular. Microconidia (spermatia) are formed in chains. Sclerotia are globose. Asci are cylindrical. The ascospores are hyaline, 1-celled, ovate.

Symptoms:

The symptoms start appearing from December and continue till the end of the cropping season (May).

Leaves lose their turgidity during the day but regain turgidity during nights and early mornings. Plants become pale yellow. Yellowing starts from tips of the older leaves downwards till the whole leaf is involved, which shed prematurely.

Midrib of the leaves touching the soil and petioles of the lower leaves show dark brown to black soft rot and is covered with fluffy growth of fungus under cool and humid weather.

Rotting from petioles advances to the stalk. Stalk shows dark brown to black spots. They enlarge and girdle the stem at the ground level. Rotting is noticed in pith of the stem up to attachment of the curd, with fluffy mycelium and numerous sclerotia.

Curd show brown to dark brown rotting. The head is exposed and becomes covered with a cottony mass of fungus mycelium in which numerous irregularly shaped hard, black bodies sclerotia are embedded.

Mode of spread and survivial:

The pathogen lives from season to season as mycelium in living and dead plants, especially as black sclerotia. Infection can takes place through ascospores or from mycelial germination of sclerotia in the soil. Sclerotia is found mixed with the seed lots and distributed.

Epidemiology:

Cool (20 to 25°C) and humid (95 to 100 %) weather conditions are ideal for disease development and spread.

Management:

Cauliflower rotation with paddy, beets, cereals, corn, groundnut, onion, spinach or grasses is highly effective.

Soil mulch with pine needle or sunflower inflorescence reduces *Sclerotinia* stalk rot of cauliflower.

Application of benomyl or carbendazim 0.1 % is effective.

Well drained soil helps in reducing the disease.

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5. Cabbage yellows / *Fusarium* wilt of cabbage

The fungus attacks broccoli, cabbage, cauliflower, Chinese cabbage, mustard, radish and turnip.

Etiology: *Fusarium oxysporum* f. sp. *conglutinans,* *F. oxysporum* var. *orthoceras*, *F. conglutinans.*

Mycelium is septate. Chlamydospores, microconidia and macroconidia are produced. Microconidia are hyaline, ovoid to ellipsoid.

Symptoms:

Yellowing is intense on one side of the leaf more often. Lower leaves become yellow followed by upper leaves. Leaves become brown, dies and brittle. When the affected stem is split open yellowing or browning of vascular system can be seen.


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Mode of spread and survival:

The fungus is seed and soil borne. The fungus persists in soil for many years. It spreads far-away through seeds. It is disseminated through diseased seedlings, implements and irrigation water.

Epidemiology:

Disease development is favoured by warm weather conditions.

Management:

Disease free seeds and seedlings.

Proper field sanitation and crop rotation.

Use resistant varieties.

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6. Downy mildew

of cabbage

The fungus attacks broccoli, cabbage, cauliflower, radish and turnip.

Etiology: *Peronospora parasitica*

It is an obligate parasite. Sporangiophores are erect, di-chotomously branched. A single Sporangia is borne at the tip of each branch. Sporangia are broadly oval to ellipsoidal, hyaline. Oospores are globose and yellow.

Symptoms:

The infection on cotyledons and hypocotyl of cabbage seedlings occurs in cool, moist climate. Such seedlings killed. Spots of fluffy white fungal growth appear on lower surface of the leaves, stems and seed pods as small, purplish irregular areas.

Spots enlarge indefinitely to form yellow areas on the upper side and mildew on the lower side.
Purplish spots appear on the matured heads. Cabbage seed pods twist, curl and break open to expose the seeds. Cauliflower curds may also be damaged.

Mode of spread and survival:

The fungus perennates in the soil through oospores in roots or in old diseased plant parts and as contaminant with seeds. It also persists in perennial hosts. Secondary spread of the disease is through water and wind borne sporangia.

Alternaria

Downy

Epidemiology:

The fungus thrive well in cool, moist weather. Optimum temperature is 10 to 15°C. Moisture and temperature are vital in the spreading and development. Heavy fogs, drizzling rains or dews that remain on plants until mid morning for four days is ideal for the disease development.

Management:

Well drained clean soils, hot water treatment and use of clean seed beds.

Spraying on the seedlings in the nursery beds with copper oxychloride 0.3 % is effective.

Spraying Bordeaux mixture 1.0 % or maneb or zineb 0.2 % at 10 to 15 days interval. Proper nutritional management is essential. Use resistant varieties.

7. *Cercosporella* leaf spot of cabbage

Mainly on cabbage grown for seeds.

Etiology: *Cercosporella brassicae*

Symptoms:

The pathogen causes spots on cotyledons, leaves, petioles and seed pods. The spots are sub-circular, have grey to brown or almost paper white centers and have slightly darkened margins. When spots are numerous, affected foliage turn yellow and defoliation occurs. Seedlings are killed when the disease is severe. The size of edible parts in diseased plants are reduced.

Mode of spread and survival:

The fungus is carried in seeds. It also overwinter in volunteer plants and perennial weeds. The fungus is able to survive in fallen leaves also. The fungus spreads by wind and rain splashes to new crops.

Epidemiology:

Disease is most prevalent in early autumn when 13 to 18°C temperatures occur and when moisture is abundant.

Management:

Cruciferous weeds should be eradicated.

Well drained fields.

Spraying chloranil or ferbam is effective when started early.

Use resistant varieties.

Cauliflower

Important diseases of Cauliflower

1. Rings spot (Cabbage)
2. Peppery leaf spot
3. Black rot (Cabbage)
4. Cauliflower mosaic

1. Ring spot

in Cauliflower & Cabbage

Etiology: *Mycosphaerella brassicicola*

The fungus produces 2 types of fructifications on the host. In early stages, black dots representing spermagonia are produced. They are flask shaped. Perithecia are produced in later stage, which are larger than the spermagonia. Asci are 8-spored. Ascospores are two celled and hyaline.

Symptoms:

Outer leaves are more severely affected.

Brown to tan spots of 10 to 20 mm dia are noticed on the leaves. Central portion of the spots turn black and has numerous fruiting bodies in concentric rings.

Diseased leaves fall off.

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Large spots are found on heads of cabbage.
It attacks seed pods also.

Mode of spread and survival:

The fungus is carried by the living infected plants and also by the plant debris. The secondary spread is by wind borne ascospores.

Epidemiology:

Cool, moist weather with rain favours the infection. The optimum temperature is 16 to 20°C.

Management:

Diseased plant debris are to be collected and destroyed.

Soil application of sulphate or muriate of potash is effective.

All seeds should be treated with hot water at 45°C as a dip for 20 min.

Benomyl or chlorothalonil sprays, applied with spreaders for every 14 days, have provide good control.

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2. Peppery leaf spot

in Cauliflower

Etiology: *Pseudomonas maculicola*

It is a rod-shaped bacterium.

Symptoms:

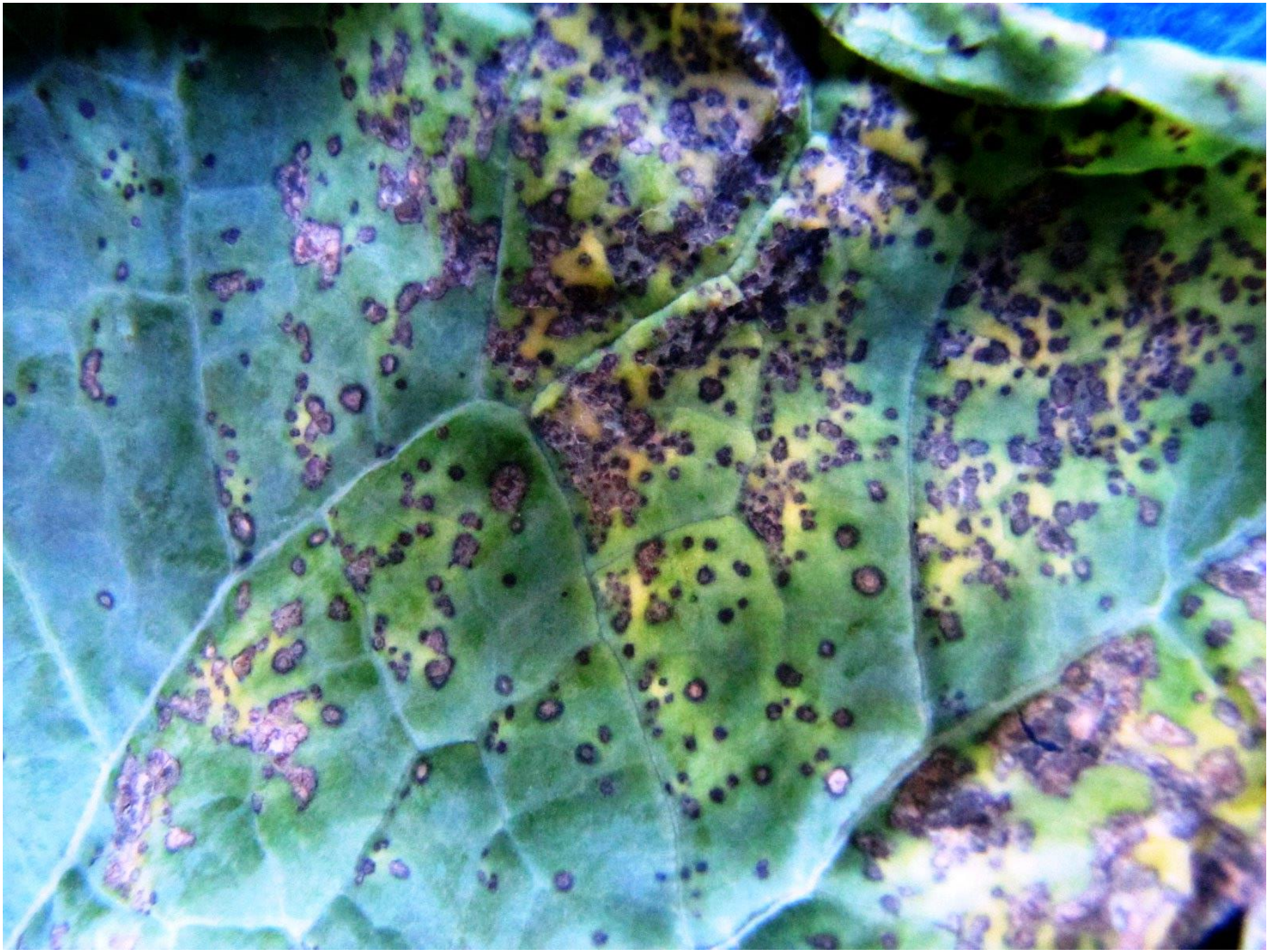
Diseased cauliflower leaves are covered with numerous small, brown to purplish spots with yellow halo.

Spots appear first and most abundantly on the lower side of leaves. Extensive infection causes leaves to drop off.

The bacteria affects stems, leaf petiole and seed pods.

Mode of spread and survival:

The bacteria survive between crops, in infected seed and in diseased cauliflower left in the field. The bacteria are disseminated by running water, washing soil, blowing leaves, splashing rain and by some insects.



Epidemiology:

Peppery leaf spot is most prevalent in wet cool weather and may disappear entirely when the temperature rises to 30°C.

Management:

Disease free seed and seedbed, crop rotations and hot water treatment of the seed.

Soil fumigation of infected soil.

Cauliflower debris should be buried by deep ploughing.

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3. Black rot

in Cauliflower & Cabbage

Etiology: *Xanthomonas campestris* pv. *campestris*

It is Gram negative, short rod with rounded ends, non-capsulated, occurring singly, rarely in pairs and motile with single polar flagellum

Symptoms:

The remaining leaves turn yellow with blackened veins. At first, “V" shaped chlorotic to yellow lesions develop from the leaf margin. Veins and veinlets turn black.

The leaf tissues become necrotic and brittle. The lesions appear on midrib which become black. From midrib the systemic infection spreads into the root.

Cross section of stem and stalks of infected leaves shows blackening of vascular tissue and yellow slime droplets of bacteria. Cabbage heads and cauliflower curds are also invaded and become discoloured.

Mode of spread and survival:

The bacterium lives on or in seeds and in debris from diseased plants in the field. The bacterium survives in plant debris in soil up to 8 months. Spreads through water, by blowing of detached leaves and by handling infected plants.


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Epidemiology:

The optimum temperature for the pathogen growth is from 26 to 30°C. Water in the form of rain or persistent dew is required for the development of the disease. Temperature seems to be more critical than the moisture

Management:

Hot water soaking of seed is effective.

Seed treatment with Aureomycin 1000 ppm for 30 min is effective in killing both the internally and externally seed-borne pathogen.

Avoid cruciferous crops for 3 years.

Direct seeding should be followed wherever possible.

Application of bleaching powder at 10.0 to 12.5 kg/ha controls black rot and soft rot diseases.

Spraying with Agrimycin 200 ppm or carbendazim 0.05 % is suggested for its control.

Use resistant varieties.

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4. Cauliflower mosaic

Etiology: *Cauliflower mosaic virus* (CaMv).

The virus is isometric. It is not enveloped.

Symptoms:

Leaf mottling with a pattern of light and dark green.

Dark green band appears.

Plants stunted and the central leaves are smaller.

Production of small and poor quality heads.

Infection reduces the hardiness of winter cauliflower.

During severe winters infected plants die.


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Mode of spread and survival:

It is transmitted by mechanical means.

The disease is spread by aphids, *Brevicoryne brassicae* and *Myzus persicae* in a semi-persistent manner.

It is not transmitted through seed or soil.

Management:

Infected plants should be rogued out and destroyed.

Seedlings are to be raised in isolated places, 90 m away from cruciferous vegetables.

Two or three rows of barley or oats or corn around the main crop acts as insect barrier crop and reduces the amount of infection.

Use resistant varieties.

Radish

Important diseases of Radish

1. Black root
2. White rust

1. Black root

of radish

It attacks cabbage and cauliflower also.

Etiology: *Aphanomyces raphani*

Mycelium is coenocytic and hyaline. Oospores are thick, hyaline.

Symptoms:

Small, irregular, steel-grey to black area is seen on fleshy root, immediately surrounding the point of emergence of the secondary root. Dark lace-like patches extend into the tissue immediately below the surface. Lesions on young roots coalesce and become black. Lesions on growing roots cause girdling effect. This makes the root to become deformed.

Mode of spread and survival:

Penetration occurs through wound. The fungus persists in the soil for longer period. The disease is serious wherever white radish is grown.

Epidemiology:

Penetration is favoured by warm midsummer temperatures between 20 and 27°C.

Management:

Long crop rotation and avoidance of long rooted varieties help in the control. Proper soil drainage is important. Soil treatments with metham sodium or chloropicrin are effective. Use resistant varieties.

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2. White rust

of radish

It attacks cabbage, cauliflower, mustard, radish and turnip.

Etiology: *Albugo candida*

The fungus is an obligate parasite. Mycelium is intercellular producing knob-shaped haustoria in the host cells. Sporangia are hyaline, spherical and in chain. Each sporangium has 4 to 8 zoospores. Oospore wall is thick and tuberculate.

Symptoms:

Two types of infection. Local and systemic infection.

In **local infection**, isolated pustules or sori develop in leaves and stems.

Sori are closer and merge to form larger patches.

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When young stems and flowering parts are infected the fungus becomes **systemic** and stimulates hypertrophy and hyperplasia. Enlarged and variously distorted organs, which is prominent on flower parts. Sepals become enlarged to several times. Petals enlarge and become green. Pistils and anthers are also distorted. Normal seed development is arrested. Pustules may occur on hypertrophied plant organs also.

Mode of spread and survival:

Overwintering may be through oospores in plant debris in the soil and mixed with seeds and perennial mycelium in weed hosts are primary source of inoculum. Secondary spread is by means of sporangia carried by air currents.


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Epidemiology:

Moisture on the host surface is essential for germination of sporangia through zoospore and infection. Moist and cool (20 to 25°C) weather favours the disease development.

Management:

Spraying with Bordeaux mixture 0.8 % is effective.

Seed beds should dry and laid out in open.

Diseased plant debris should be destroyed or ploughed.

Spraying with difolatan 0.3 % or chlorothalonil or metalaxyl 0.1 % or mancozeb 0.2 % effectively controls the disease.

Beetroot

Important diseases of Beetroot

1. *Cercospora* leaf spot
2. *Alternaria* leaf spot
3. *Phoma* heart rot
4. Beet yellows
5. Curly top
6. Beet mosaic
7. Minor diseases

1. *Cercospora* leaf spot of Beetroot

Etiology: *Cercospora betlicola*

Mycelium is septate and dark in colour. Conidia are hyaline, elongate, filiform and multiseptate.

Symptoms:

Small, circular spots enlarge to about 3 to 5 mm in dia. They have definite margins.

The centre tissue turns brown and when sporulation occurs the spot assumes a greyish cast.

Elongated spots appear on the petioles.

When spots are numerous the whole leaf become senescent, dies prematurely and drops.

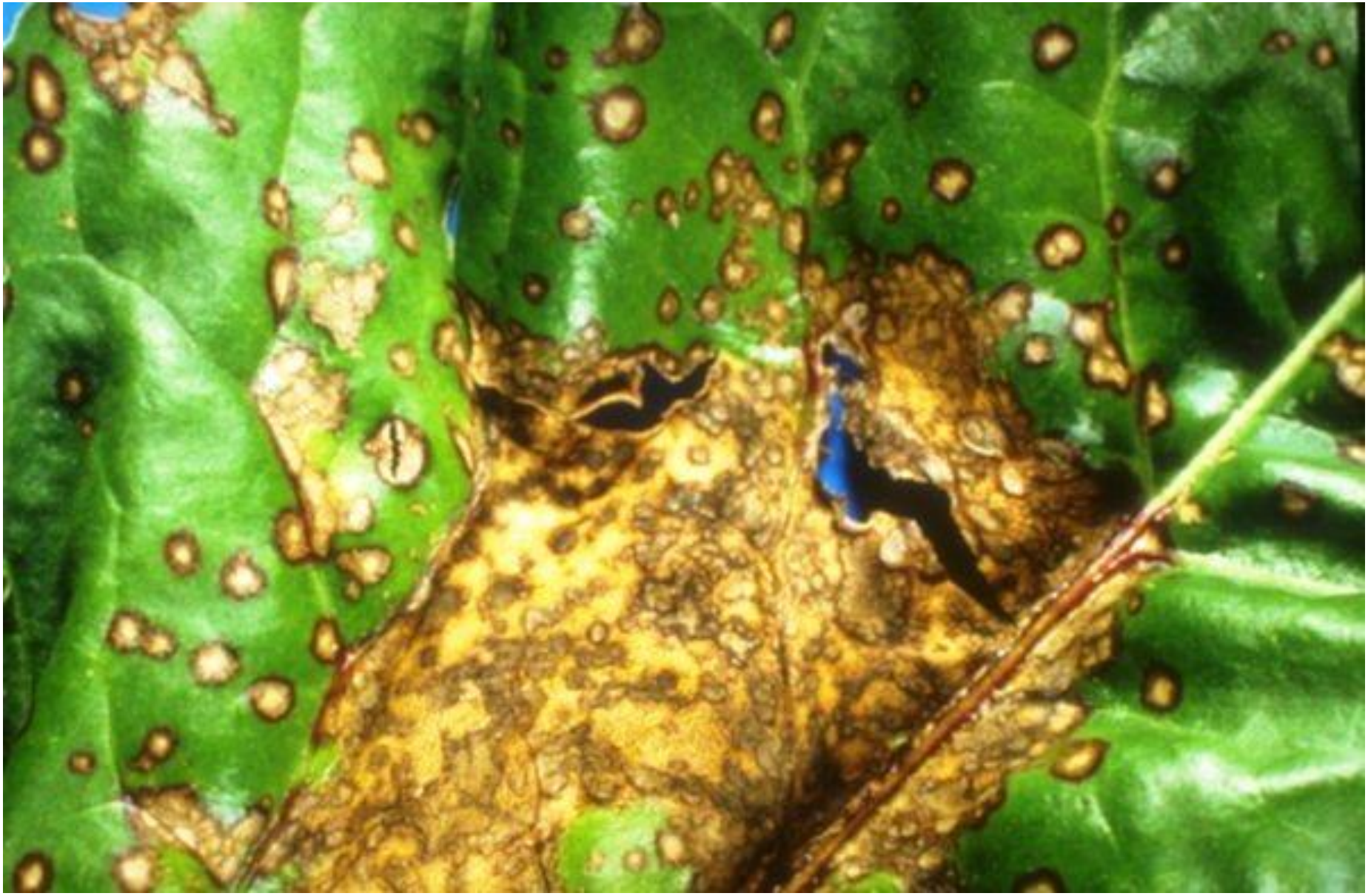
contd...

Older leaves are the most readily affected. When conditions are favourable, progressive blight and defoliation occurs leading to reduction in root growth, yield and sugar content. On seed plants all the above ground parts including the seed clusters are affected.

Mode of spread and survival:

The pathogen is carried with the seed.

The fungus can overwinter in debris from diseased plants, in weed hosts and in beet seeds. The conidia are disseminated chiefly by air. Insects, splashing water, cultivation tools, workers and irrigation water also spread of the disease.



Epidemiology:

High humidity and medium temperature stimulate the fungus growth. The optimum temperature for sproe germination and germ tube elongation is 25 to 29°C. Moist weather is essential for sporulation. Infection occurs only through stomata. Incubation period is 6 to 8 days.

Management:

Providing the plants with plenty of moisture and phosphorus, potassium, boron and sodium gives resistance to the disease.

Seed treatment with captan or thiram.

Three year rotation of beets with other crops is essential.

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Resistant varieties can be used.

Benomyl, thiophanate or carbendazim spray has been reported to be effective. Two spraying with carbendazim 150g + mancozeb 2kg/ha or carbendazim 200g / ha at 20 days interval effectively controls the disease.

***2. Alternaria* leaf spot**

of Beetroot

Etiology: *Alternaria tenuis* and *A. brassicae.*

Symptoms:

Two types of symptoms are observed in the field. The disease incited by *A. tenuis* shows spots up to 1.0 cm in dia which are irregular and dark brown to black and they are more common on the margin. *A. brassicae* form concentrically zonated light to dark brown, circular spots up to 1.5cm in dia. The spots on leaves may appear on any portion of the leaf. Minute, water soaked, sub-circular, brown spots with necrotic flecks in the centre appear on the surface of the leaves.

Under field conditions the spots are found more frequently on lower leaves and to a lesser extent on the leaves of plants grown in full sunlight. The spots usually increase rapidly in size and become light to dark brown or black with water soaked border. However, the central necrotic region of the spots are light in colour. Coalescence of spots is often noticed. Marginal infection of the leaves results in drying and upward curling at the edges A few of the younger seedlings are completely defoliated. In the advance stage of infection, the central necrotic region of the spots gets dried and fall off resulting in shot holes. Small flecks appear on the petioles which gradually enlarge and girdle the petiole.

Mode of spread and suvival:

Under conditions of high humidity (90%) and moderately low temperature (20 to 25°C) the sporulation is abundant and very rapid on the host surface.

Management:

The disease can be controlled by spraying with mancozeb or copper oxychloride or captan.

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3. Phoma heart rot of Beetroot

Fungus: *Phoma betae*

Pycnidiospores are hyaline, 1-celled, oblong. Perithecia are globose with **a** short apical papilla bearing the ostiole. Ascospores are pale yellow green, muriform.

Symptoms:

The infection of leaf is confined to old leaves of plants and early in the season to the lower portion of seed stalks. Later all parts of the seed plants are attacked. The leaf spots are light brown and enlarge up to 2cm in dia. Pycnidia are arranged in concentric rings. On seed stalks brown to black necrotic streaks occur, in which greyish centres bearing pycnidia develop which results in rotting of fleshy roots is in the seedling stage.

Mode of spread and survival:

The pathogen is seed borne and is also carried over in roots used for seed production and in debris. Dissemination is by wind, rain, irrigation water and by insects.

Epidemiology:

The optimum temperature for fungal growth is 24°C. Damage is more at lower temperatures. Rotting of fleshy roots is high at 13°C. *Phoma* never attacks vigorously growing plants that have not been injured.

Management:

Growing beets in well fertilized soil and use clean seeds. When roots are to be stored, close topping and harvest wounds should be avoided. Long rotation is essential.

contd…

Pre and post emergence damping off of sugarbeet is reduced by seed pelleting with thiram and carbendazim at 5 and 10 g / kg of seed. Seed treatment in a copper sulphate solution is recommended. Heart rot can be eliminated by treating the seeds with hot water at 59°C for 8 min then drying for 24 h and retreating with thiram.

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4. Beet yellows

of Beetroot

Etiology: *Beet yellows virus* (BYV) and *Beet mild yellowing virus* (BMYV).

The two viruses can occur alone or together to result in yellows. Infection turns the leaves yellow. BMYV makes the plants more susceptible to fungal attack (powdery mildew).

Symptoms:

Characteristically the outer or middle leaves of sugarbeet become yellow, thickened and brittle. Leaves that become brittle can break

Yellowing begins at the leaf tips and upper margins and spreads downwards between the veins.

contd...

The green and yellow tissues merge with each other.
As the infected leaves mature, older invaded portions turn brown and die. Later, the entire leaf withers.
If infection occurs early, the roots remain small and produce less sugar.
Crops infected in early summer becomes completely yellow and stunted. The yellowing is severe after periods of dry, bright sunny weather.

Mode of spread and survival:

The viruses are spread to healthy plants by aphids.
BYV persists in aphids for few hours, but once infected with BMYV and aphid remains infective for most of its life cycle.

Management:

Early sowing, regularly spaced, dense population of plants and quick growth tend to decrease the incidence of yellows.

Overwintering beet before the end of April should be removed and destroyed.

Three sprayings with methyl demeton is recommended.

Adequate and timely protection can be had by seed furrow treatment with aldicarb (0.5 to 1.0kg/ha) to control aphid infestation.

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5. Curly top
of Beetroot

Etiology: *Beet curly top virus* (BCTV).

Symptoms:

Curly top appears at any growth stage of the crop. But it is most damaging when seedlings are infected. Young plants become dwarfed. Leaves are small and numerous. Veins on the lower side of leaves are most prominent. Petioles become small. Leaf blades are limited in length and width and leaves are crinkled puckered and yellow. The roots are hairy and the root tissue is woody and tough. Sometimes the root crown is darkened and the plants wilted. Badly affected plants die prematurely. Sugar content of beet root is greatly reduced.

Mode of spread and suvival:

The virus is transmitted only by beat leafhopper *Circulifer tenellus.* It is not carried through seeds. It overwinters in weeds such as *Plantago,* pepper grass and Russian thistle.

Epidemiology:

Curly top occurs in areas where relative humidity is low and evaporation is rapid. Shading which lowers light intensity retards evaporation, delays leafhopper activity and limits the number of infection and the severity of symptoms.

Management:

Spraying with systemic insecticides for leafhoppers. Soil application of systemic insecticides effectively controls the disease. Early planting to avoid vector migrations.

6. Beet mosaic

of Beetroot

Etiology: *Beet mosaic virus* (BtMV).

The virus is a flexuous.

Symptoms:

It causes either the regular mosaic type of mottling or mottling with ring like lesions which becomes zonate. On garden beets, vein clearing is also seen.

Infected foliage is leathery, stunted and distorted. Petioles are shorter. An excess redness may develop. On seed plants the foliage often drops and seed production can be limited to 50 %. Roots are smaller and hairy wit side roots. Infected plants seldom die. Mosaic symptoms become less distinct with age.

Mode of spread and survival:

The virus overwinters in seed plants and is distributed from there to nearby beet fields by aphids in a non-persistant manner.

It infects a number of weed and ornamental crops. It is not carried in the seed. The virus is transmitted by mechanical inoculation and by grafting also.

Management:

Plants selected for seed plants should be free from virus and grown in isolation.

Susceptible weeds surrounding beet fields and plants in which the vectors thrive should be eradicated early in the spring.

Planting for seed production should not be near commercial plantings.
If the aphids breeding location is known, the area should be sprayed with a suitable insecticide.

Minor diseases of Beetroot:

a) *Sclerotium* root rot : *Sclerotium rolfsii* Sacc
b) *Rhizoctonia* root rot & Blight : *Rhizoctonia solani* Kuhn
c) Charcoal rot : *Macrophomina phaseolina*
d) Root rot : *Rhizopus oryzae*
e) Violet root rot : *Helicobdsidium purpureum*
f) Root rot complex : *Pythium ultimum, Rhizoctonia solani*
g) *Aphanomyces* black rot : *Aphanomyces cochioides*
h) *Ramularia* leaf spot : *Ramularia beticola*
i) *Septoria* leaf spot : *Septoria betae*
j) Leaf gall : *Urophylyctis leproides*
k) *Colletotrichum* leaf spot : *Colletotrichum capsici*
l) Downy mildew : *Peronospora farinosa* f.sp. *betae*

l) Powdery mildew : *Erysiphe betae*
m) Rust diseases : *Uromyces beta, Puccinia aristidae*
n) Crowngall and leaf gall : *Agrobacterium tumefaciens*
o) Gall disease : *Xanthowonas beticola*
p) Bacterial vascular necrosis and rot : *Erwinia carotovora* subsp. *carotovora*
q) Silvering disease : *Curtobacterium flaccumfaciens* **pv.** *betae*
r) Scab : *Streptomyces scabies*
s) Bacterial blight : *Pseudomonas aptata*
t) Purple top : virus
u) Purple leaf : A strain of TMV

Minor diseases in crucifiers:

1. *Alternaria* blight of radish – *Alternaria alternata*
2. Leaf blight of radish – *Rhizoctonia solani*
3. Turnip *Anthracnose* – *Colletotrichum higginsianum*
4. Cauliflower *Anthracnose* – *Gleosporium concentricum*
5. Bacterial wilt – *Burkholderia solanacearum*
6. Zonate spot of cabbage – *Pseudomonas cichorii*
7. Bacterial soft rot (Turnip) – *Erwinia carotovora*
8. Root rot of radish – *Erwinia rhaphontici*
9. Radish mosaic – *Radish mosaic virus*
10. Turnip crinkle – *Turnip crinkle virus*