- Leaf margins die and dry off.
- Presence of light to dark brown lesions and discolouration on the lower portion of the stem adjacent to the ground. This is followed by drooping and wilting of infected leaves and gradual wilting of the whole plant.
- Shredding of bark in the collar region can be seen in few cases.
- Roots appear dark brown or black and few or no healthy, white roots or root tips.
- Root system is partially or fully decayed and the plant could be removed with little effort.
- In case of *Sclerotium rolfsii* infection, thick, white mycelia threads along with brown sclerotial structures can be seen on the stem near the soil surface.

Management

- Grow resistant varieties.
- Avoid over watering and under watering.
- Treat the seeds with biological agents like *Trichoderma, Bacillus* @ 10g/100g seed.
- Biological control: In Nursery, apply talc formulation of bio-agent (Goa Bio-2)/ *Trichoderma* @ 50 g m^{-2} (soil application or mixed with water and apply if plants are established). In main field, apply the bio-agent @ 1.25-1.5 g per plant as drenching.
- Drench the root zone soil with tebuconazole @ 0.1%, carboxin @ 0.25% after 7-10 days after transplanting for *S. rolfsii* management. Drench Thiophanate-methyl @ 0.2-0.3%, mefenoxam 0.1% for *Phytophthora* management.

Powderymildew (*Leveillula taurica*)

Symptoms

- Symptoms first appear on older leaves and progress to younger leaves.
- White to grey powdery growth is seen on the under surface of the leaves. Corresponding upper surface of the leaf shows chlorotic/ necrotic spots.
- The necrotic lesions gradually turn brownish black with the appearance of fungal fructifications.
- Severe infection leads to defoliation and severe yield loss.
- Dieback of twigs and branches and stunting of plants followed by fruit drop in case of severe infection.

Management

- Grow resistant varieties.
- Follow sprinkler irrigation wherever possible.
- Spray fungicides like Wettable sulphur @0.2%, Carbendazim @0.1%, Triademefon @0.1%, Tebuconazole @0.1% at 10-15 days interval starting with disease appearance.

Fruit rot/ anthracnose (*Colletotrichum capsici*)

This is more of a post-harvest problem compared to field problem.

Symptoms

- Presence of small, circular spots on the skin of the fruit which later turns into large brown/ straw colour.
- Severely affected fruits turn straw coloured from normal red. On the discoloured area, numerous black fungal structures (acervuli) are seen.
- Inside of the diseased fruit is covered with black stromatic masses of the fungus. Seeds are also infected and turned into rusty colour.
- Die-back symptoms during vegetative growth period.

Management

- Grow resistant varieties.
- Remove the sources of inoculum like infected fruits and infected plant debris from the field.
- Seeds should not be collected from the infected fruits as they serve as primary source of infection.
- Treat the seeds with Carbendazim/ Captan/ Thiram @0.3%.
- Spray Carbendazim, Mancozeb @ 0.2% when foliar infection is observed.
- Biological control: Treat the seeds with biological agents like *Trichoderma, Bacillus, Pseudomonas* @ 10g/100g seed. In Nursery, apply talc formulation of bio-agent (Goa Bio-2)/ *Trichoderma* @ 50 g m^{-2} (soil application or mixed with water and apply if plants are established).

Integrated Management of Chilli Diseases

Any of the above diseases may occur during the crop growth period as the Coastal climatic conditions are very congenial to the development of these diseases. Hence we recommend an integrated disease management approach rather than individual disease management. The following measures are recommended for chilli disease management.

- Adjust the date of sowing so as to avoid vector population build up.
- Grow resistant varieties.

Management in nursery

- Raise nursery in fumigated soil
- Seed treatment: Imidacloprid @ 5-10g per kg of seeds + Thirum @ 2g per kg of seeds
- Nursery application: Talc formulation of *Trichoderma/ Bacillus* (Goa Bio-1& 2) @ 50g per m^{-2} before sowing
- Cover the nursery area with insect proof net
- Vector control in nursery: Spray Acephate @ 1g per litre of water or Metasystox @ 1mL per litre of water at 15 days after sowing

Management in main field

- Soil amendment with lime @ 8-10t per ha
- Avoid frequent watering and flooding
- Raise barrier crops like maize/ sorghum in the borders and inside if the field is large
- Soil application/ seedling drench during transplanting: Talc formulation of *Trichoderma/ Bacillus* (Goa Bio-1 &2) @ 1.25 to 1.5g per plant
- Follow insect/ vector and other disease control in the field as per the schedule given below

Spray No.	Insecticide	Dose	Spray date
1	Imidaloprid	0.3 mL per litre	15 DAT
2	Acephate + Dicofol	2g per litre 3mL per litre	30 DAT
3	Dimethoate(and) Wettable Sulphur	1mL per litre 3g per litre	45 DAT
4	Fipronil + Carbendazim	0.5mL per litre 2g per litre	60DAT

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Important diseases of chilli (*Capsicum annum* L.) in Coastal regions and their management

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Chilli (*Capsicum* spp.) is an important commercial spice and vegetable crop. Chilli is extensively cultivated and is an indispensable ingredient in the cuisines of India and many other countries. Among the five cultivated species of the genus *Capsicum, C. annum* is the most widely cultivated in India for its pungent (chilli syn. Hot pepper) and non-pungent (sweet pepper syn. Capsicum, Bell pepper) fruits. The cultivation of *C. frutescens, C. chinense,* and *C. baccatum* is limited and usually restricted to homestead gardening in different regions.

Diseases of chilli have been a major limitation to its cultivation. Following are the major and important diseases of chilli cultivated in the Coastal regions.

1. Bacterial wilt
2. Viral diseases
3. Fusarium wilt
4. Fungal root rot disease
5. Powderymildew
6. Fruit rot/ anthracnose

Bacterial wilt (*Ralstonia solanacearum*)

Symptoms

- Symptoms manifest initially as leaf drooping followed by wilting of entire plant within a few days.
- Recently wilted plants look green, a distinct symptom when compared to other vascular wilt diseases which develops yellowing of the leaves.
- Vascular discoloration (brown) is also seen in the wilted plant.
- Disease develops very rapidly in warm weather.
- Symptoms are very clear during morning or immediately after irrigation.

Management

- Plant chilli in a disease-free field.
- Grow resistant varieties.
- Soil amendment with lime @ 8-10t per ha.
- Prevent the spread of pathogen by removing the infected plants from the field and avoiding flood irrigation.
- Biological control: In Nursery, apply talc formulation of bio-agent (Goa Bio-2) @ 50 g m^{-2} (soil application or mixed with water and apply if plants are established). In main field, apply the bio-agent @ 1.25-1.5 g per plant as drenching.

Viral diseases (Begomovirus, Potyvirus, Tospovirus)

Symptoms vary depending on the viruses present, the variety infected, environmental conditions and age of plant at the time of infection. Field plants are usually infected by more than one virus. Multiple infections result in symptoms more severe in appearance and more complex than those caused by a single virus. General symptoms include, upward and downward curling of leaf margins and leaves, puckering or presence of dark green blisters in the leaves, mosaic pattern and yellowing of the leaves, leaf distortion and thick leaves, small sized leaves, clustering and dwarf plants, small and twisted or deformed fruits, presence of insect vectors *viz*. aphids, whitefly and thrips. Major viral diseases are described below.

Chilli leaf curl disease (Begomovirus: Chilli leaf curl virus)

Vector: Whitefly (*Bemisia tabaci*)

Symptoms

- Upward curling of leaves, puckering and reduced size of leaves.
- Shortening of internodes, vein clearing, vein swelling, vein thickening, and stunted growth.
- As infection progresses, symptoms of chlorosis, mosaic and mottling develop, and distortion is more prominent.
- The size of leaves and branches is reduced considerably in severely affected plants resulting in a bushy appearance. Such plants bear very few flowers and very few fruits.
- Severely affected plants are stunted and produced no fruit or fruit are small, discolored and distorted.
- If the disease persists later in the life cycle, flower buds will abscise and anthers will set without pollen grains, which ultimately results in poor fruit setting, resulting in distorted or underdeveloped fruit.

Chilli veinal mottle disease (Potyvirus: Chilli veinal mottle virus, PVy)

Vector: Aphids (*Aphis gossypii, Myzus persicae*)

Symptoms

- Mottling, vein banding, narrowing and distortion of leaves followed by stunted growth.
- Leaf mottle and dark green vein-banding are the most characteristic symptoms.
- Leaves of some cultivars are smaller and distorted.
- Symptoms are most obvious on the younger, smaller leaves.
- Plants infected when young become stunted and have dark-green streaks on their stems and branches.
- Most of their flowers drop before fruit formation. A few mottled, distorted fruit may be produced. Such symptoms contribute to significant yield losses.

Necrosis virus disease (Tospovirus: TSWV, GBNV, WBNV, CaCV)

Vector: Thrips (*Thrips tabaci, Frankliniella schultzei, Scirtothrips dorsalis*)

Symptoms

- Yellow spots or patches followed by occasional chlorotic concentric rings on leaves.
- Bronzing and veinal necrosis of leaves.
- Necrosis of terminal bud/ die-back of shoots are the characteristic symptoms.
- Plants infected early are bushy, stunted and die prematurely. In older plants, the symptoms are restricted to a few branches only.
- Leaf distortion in some cases.
- Chlorotic and necrotic spots and rings on leaves and fruits.

Management of viral diseases

- Use seeds from virus-free plants.
- Adjust the date of sowing so as to avoid vector population build up.
- Grow resistant varieties.
- Control insect vector spread by practicing the following measures.
- Seed treatment: Imidacloprid @ 5-10g per kg of seeds
- Cover the nursery area with insect proof net.
- Raise barrier crops like maize/ sorghum in the borders and inside if the field is large.
- Vector control in nursery: Spray Acephate @ 1g per litre of water or Metasystox @ 1mL per litre of water at 15 days after sowing.
- Vector control in main field: Four sprays of insecticides starting from 15 days after planting and at 15 days interval.

Fusarium wilt (*Fusarium oxysporum* f.sp. *capsici* & *F. solani*)

Symptoms

- Symptoms may appear at two stages, viz. seedling wilt and adult plant wilt.
- Seedlings show wilting after 3-4 weeks of planting. Foliage of such seedlings turn yellow and plants exhibit wilt symptoms and later dry.

- Disease symptoms often appear later in the growing season and are first noticed on the lower (older) leaves. In older plants, the foliage turns to yellow and gradually leaves wilt.
- As the disease progresses, the younger leaves will also be affected and the plant eventually dies.
- In many cases, only one branch or part of the plant shows symptoms (partial wilt).

Management

- Grow resistant varieties.
- Avoid use of high nitrogen fertilizers and use a slow-release organic fertilizer.
- Remove the weeds as many weed species host the disease pathogen.
- If the disease persists, remove the entire plant and solarize the soil before planting again. To solarize the soil, spread a clear plastic tarp on the soil surface for 4-6 weeks during the hottest part of the year.
- Drench the root zone soil with Carbendazim/ Benomyl/ Thiophanate-methyl @ 0.2-0.3%
- Biological control: In Nursery, apply talc formulation of bio-agent (Goa Bio-2)/ *Trichoderma* @ 50 g m^{-2} (soil application or mixed with water and apply if plants are established). In main field, apply the bio-agent @ 1.25-1.5 g per plant as drenching.

Fungal root rot disease (*Phytophthora capsici, Sclerotium rolfsii, Macrophomina phaseolina, Rhizoctonia solani*)

Root rot disease of chilli is a complex problem caused by more than one fungus and hence proper diagnosis of the causal agent is important to select the proper management strategy.

Symptoms

- Seedlings affected by this infestation die soon after germination.
- Growth of infected plants is retarded compared to healthy plants.
- Yellowing of older leaves and falling of the leaves.