

## 7. Diseases of Turmeric

### Rhizome Rot - *Pythium graminicolum*

#### Symptoms

Starting from the margins the leaves get dried up, collar region of pseudo stem becomes soft and water-soaked and plants collapse. The rhizomes decay as a result of the attack of the fungus.



Symptoms

#### Disease cycle

Pathogen is soil-borne, therefore primary inoculum comes from soil. Infected rhizomes used for seed purpose may also transmit the disease. Irrigation water from diseased field helps in the spread of the disease.

#### Management

- Seed material should be selected from disease free areas.
- Avoid water stagnation in the field. Light soil may be preferred and drainage facility to be ensured.
- Grow tolerant varieties like Suguna and Sudarshan.
- Crop rotation to be followed.
- Deep plough in summer. Planting is to be done in ridge and furrow method.
- Remove diseased plants and the soil around plants to be drenched with Mancozeb (3gm/lit) or 3gm Ridomil M.Z.
- Spray the crop with Mancozeb (2.5g/lit) or Carbendazim (1g/lit) +1ml sandovit.

- Keep rhizomes in 3g Metalaxyl or 3g Mancozeb mixed in one litre of water for one hour and shade dry before planting.

### Leaf Spot - [\*Colletotrichum capsici\*](#)

#### Symptoms

Oblong brown spots with grey centres are found on leaves. The spots are about 4-5 cm in length and 2-3 cm in width. In advanced stages of disease black dots representing fungal [acervuli](#) occur in concentric rings on spot. The grey centers become thin and gets teared. Severely effected leaves dry and wilt. They are surrounded by yellow halos. Indefinite number of spots may be found on a single leaf and as the disease advances; spots enlarge and cover a major portion of leaf blade.



Symptoms

#### Favorable condition

- The disease is usually appears in October and November
- Relative humidity of 80% and temperatures of 21 – 23°C favours the primary infection

#### Disease cycle

The fungus is carried on the scales of rhizomes which are the source of primary infection during sowing. The secondary spread is by wind, water and other physical and biological agents. The same pathogen is also reported to cause leaf-spot and fruit rot of chilli where it is transmitted through seed borne infections. If chilli is grown in nearby fields or used in crop rotation with turmeric, the pathogen perpetuates easily, building up inoculum potential for [epiphytotic](#) outbreaks.

#### Management

- Select seed material from disease free areas.
- Treat seed material with mancozeb @ 3g/litre of water or carbendazim @ 1 g/litre of water, for 30 minutes and shade dry before sowing.
- Spray mancozeb @ 2.5 g/litre of water or carbendazim @ 1g/litre; 2-3 sprays at fortnightly intervals.
- The infected and dried leaves should be collected and burnt in order to reduce the inoculum source in the field.
- Spraying Blitox or Blue copper at 3 g/l of water was found effective against leaf spot.
- Crop rotations should be followed whenever possible.
- Cultivate tolerant varieties like Suguna and Sudarshan.

### **Leaf Blotch - *Taphrina maculans***

#### **Symptoms**

This disease usually appears on lower leaves in October and November. The individual spots are small 1-2 mm in width and are mostly rectangular in shape. The disease is characterized by the appearance of several spots on both the surfaces of leaves, being generally numerous on the upper surface. They are arranged in rows along the veins. The spots coalesce freely and form irregular lesions. They first appear as pale yellow discolorations and then become dirty yellow in colour. The infected leaves distort and have reddish brown appearance.



**Symptoms**

#### **Disease cycle**

The fungus is mainly air borne and primary infection occurs on lower leaves with the inoculum surviving in dried leaves of host, left over in the field. The [ascospores](#) discharged from

successively maturing [asci](#) infect fresh leaves without dormancy, thus causing secondary infection. Secondary infection is most dangerous than primary one causing profuse sprouting all over the leaves. The pathogen persists in summer by means of ascogenous cells on leaf debris, and dessicated ascospores and blastospores in soil and among fallen leaves.

### Management

- Select seed material from disease free areas.
- Treat the seed material with Mancozeb @ 3g/litre of water or Carbendazim @ 1 g/litre of water for 30 minutes and shade dry before sowing.
- Spray mancozeb @ 2.5 g/litre of water or Carbendazim @ 1g/litre; 2-3 sprays at fortnightly intervals.
- The infected and dried leaves should be collected and burnt in order to reduce the inoculum source in the field.
- Spraying Copper oxy chloride at 3 g/l of water was found effective against leaf blotch.
- Crop rotations should be followed whenever possible.

### Minor diseases

- |                |   |  |
|----------------|---|--|
| a. Dry rot     | - | <a href="#"><i>Rhizoctonia bataticola</i></a>  |
| b. Leaf spot   | - | <i>Cercospora curcuma</i>  |
| c. Leaf Blight | - | <a href="#"><i>Rhizoctonia solani</i></a>  |
| d. Brown rot   | - | It is a complex disease caused by the nematode <a href="#"><i>Pratylenchus</i></a> sp. associated with <a href="#"><i>Fusarium</i></a> sp. |

## 8. Diseases of Tobacco

### Damping off - *Pythium aphanidermatum*

#### Symptoms

The pathogen attacks the seedlings at any stage in the nursery. Sprouting seedlings are infected and wither before emergence from the soil ([Pre emergence damping off](#)). Water soaked minute lesions appear on the stems near the soil surface, soon girdling the stem, spreading up and down in the stems and with in one or two days stem may rot leading to toppling over of the seedlings ([Post-emergence damping off](#)).



Pre and post emergence

The young seedlings in the nursery are killed in patches and infection spreads quickly. Under the favorable conditions, the entire seedlings in the nursery are killed within 3 to 4 days. A thick web of mycelium may be seen on the surface of the soil.

#### Pathogen

The fungus produces thick, hyaline, thin walled, non-septate mycelium. It produces irregularly lobed [sporangia](#) which germinate to produce vesicle containing zoospores. The [zoospores](#) are kidney shaped and biflagellate. [Oospores](#) spherical, light to deep yellow or yellowish brown coloured, measuring 17-19µm in diameter.

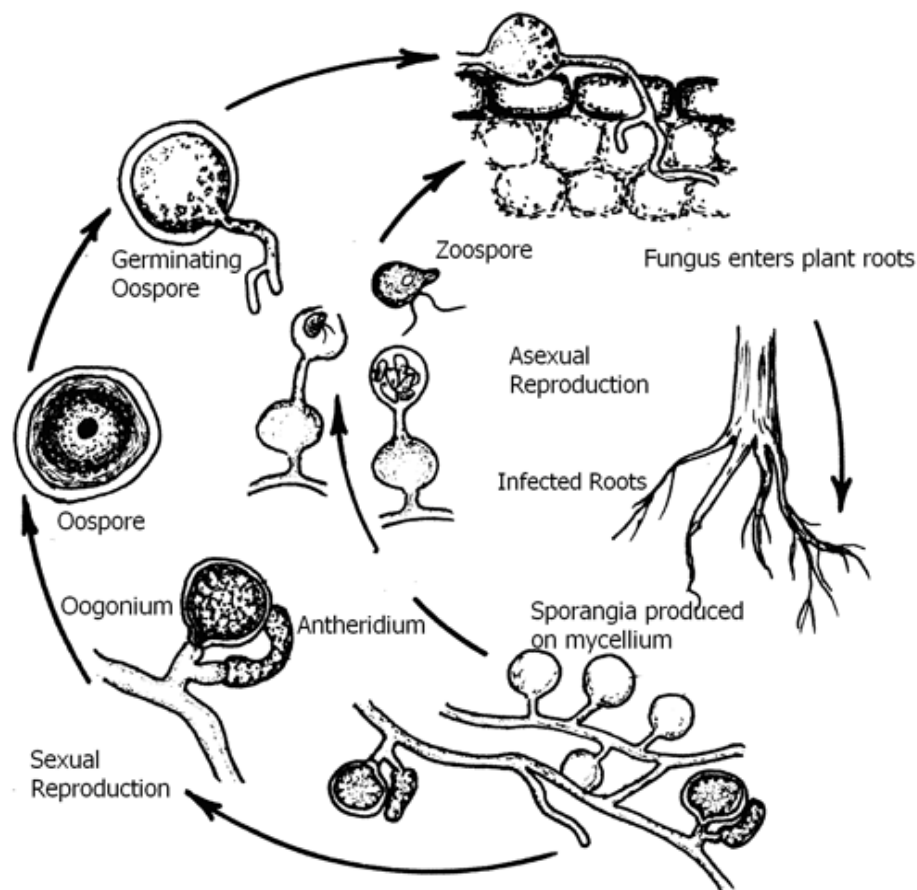
#### Favourable Conditions

- Over crowding of seedling.
- Ill drained nursery beds
- Heavy shade in nursery
- High atmospheric humidity (90-100 per cent)

- High soil moisture
- Low temperature (below 24 °C) and low soil temperature of about 20°C.

### Disease cycle

The pathogen survives in the soil as oospores and chlamydospores. The primary infection is from the soil-borne fungal spores and secondary spread through sporangia and zoospores transmitted by wind and irrigation water.



### Management

- Prepare raised seed beds with adequate drainage facility.
- Burn the seed beds with paddy husk before sowing.
- Drench the seed bed with 1 per cent Bordeaux mixture or 0.2 per cent [Copper oxychloride](#), two days before sowing.

- Avoid over crowding of seedlings by using recommended seed rate (1 to 1.5g/2.5m<sup>2</sup>).
- Avoid excess watering of the seedlings.
- Spray the nursery beds two weeks after sowing with 1 per cent [Bordeaux mixture](#) or 0.2 per cent Copper oxychloride or 0.2 per cent Mancozeb and repeat subsequently at 4 days interval under dry weather and at 2 days interval under wet cloudy weather or spray 0.2 per cent Metalaxyl at 10 days interval commencing from 20 days after germination.

### **Black shank - [Phytophthora parasitica var. nicotianae](#)**

#### **Symptoms**

The pathogen may affect the crop at any stage of its growth. Even though all parts are affected, the disease infects chiefly the roots and base of the stem. Seedlings in the nursery show black discolor of the stem near the soil level and blackening of roots, leading the wet rot in humid condition and seedling blight in dry weather with withering and drying of tips. The pathogen also spreads to the leaves and causes blighting and drying of the bottom leaves. In the transplanted crop, the disease appears as minute black spot on the stem, spreads along the stem to produce irregular black patches and often girdling occurs.



**Symptoms**

The upward movement leads to development of necrotic patches on the stems. The infected tissues shrink, leaving a depression and in advanced condition the stem shrivels and plant wilts. When the affected stem is split open, the pith region is found to be dried up in disc-like plates showing black discolouration. On the leaves large brown concentrically zonate patches appear during humid weather, leading to blackening and rotting of the leaves.

#### **Pathogen**



The fungus produces hyaline and non-septate mycelium. The [sporangia](#), which are hyaline, thin walled, ovate or pyriform with papillae, develop on the [sporangiophores](#) in a sympodial fashion. Sporangia germinate to release zoospores which are usually kidney shaped, biciliate and measure 11-13 x 8-9µm. The fungus also produces globose and thick walled [chlamydospores](#), measuring 27-42µm in diameter. [Oospores](#) are thick walled, globose, smooth and light yellow coloured, measuring 15-20µm in diameter.



**Sporangia**

#### **Favourable Conditions**

- Frequent rainfall and high soil moisture.
- High population of rootknot nematodes [\*Meloidogyne incognita\* var. \*acrita\*](#).

#### **Disease cycle**

The fungus lives as a saprophyte on organic wastes and infected crop residues in soil. The fungus is also present in the soil as dormant mycelium, oospores and [chlamydospores](#) for more than 2 years. The primary infection is by means of [oospores](#) and chlamydospores in the soil. Secondary spread is by wind-borne [sporangia](#). The pathogen in the soil spreads through irrigation water, transport of soil, farm implements and animals.

#### **Management**

- Cover the seed beds with paddy husk or groundnut shell at 15-20 cm thick layer and burn.
- Provide adequate drainage in the nursery. Drench the nursery beds with 1 per cent Bordeaux mixture or 0.2 per cent Copper oxychloride, two days before sowing.
- Spray the beds two weeks after sowing with 0.2 per cent Metalaxyl or 0.2 per cent Captafol or 0.2 per cent Copper oxychloride or 1 per cent Bordeaux mixture and repeat after 10 days.



- Select healthy, disease free seedlings for transplanting.
- Remove and destroy the affected plants in the field.
- Spray Mancozeb 2 kg or Copper oxychloride 1 kg or Ziram 1 lit/ha. Spot drench with 0.4 per cent Bordeaux mixture or 0.2 per cent Copper oxychloride.

### **Frog eye spot - [Cercospora nicotianae](#)**

#### **Symptoms**

The disease appears mostly on mature, lower leaves as small ashy grey spots with brown border. The typical spots have a white centre, surrounded in succession by grey, brown portions with a dark brown to black margin, resembling the eyes of a frog. Under favorable conditions, several spots coalesce to form large necrotic areas, causing the leaf to dry up from the margin and wither prematurely. Both yield and quality are reduced greatly. The disease may occur in the seedlings also, leading to withering of leaves and death of the seedlings.



**Symptoms**

#### **Pathogen**

The mycelium is intercellular and collects beneath the epidermis and clusters of [conidiophores](#) emerge through stomata. The conidiophores are septate, dark brown at the base and lighter towards the top bearing 2-3 conidia. The [conidia](#) are hyaline, slender, slightly curved, thinwalled and 2-12 septate.

#### **Favorable Conditions**

- Temperature of 20-30°C.

- High humidity (80-90 per cent).
- Close spacing, frequent irrigation and excess application of nitrogenous fertilizers.

### **Disease cycle**

The pathogen is seed-borne and also persists on crop residues in the soil. The primary infection is from the seed and soil-borne inoculum. The secondary spread is through wind-borne conidia.

### **Management**

- Remove and burn plant debris in the soil.
- Avoid excess nitrogenous fertilization.
- Adopt optimum spacing.
- Regulate irrigation frequency.
- Spray the crop with 0.4 per cent Bordeaux mixture or [Thiophanate Methyl](#) 750g/ha or Carbendazim 750 g/ha and repeat after 15 days.

### **Powdery mildew - [Erysiphe cichoracearum var. nicotianae](#)**

#### **Symptoms**

Initially the disease appears as small, white isolated patches on the upper surface of the leaves. Later, it spreads fast and covers the entire lamina. The disease initially appears on the lower leaves and as disease advances, the rest of the leaves are also infected and sometimes powdery growth can be seen on the stem also. The affected leaves turn to brown and wither and show scorched appearance. The severe infection leads to defoliation and reduction in quantity and quality of the curable leaves.

#### **Pathogen**

The fungus is [ecotophytic](#) and produces hyaline, septate and highly branched mycelium. Short, stout and hyaline [conidiophores](#) arise from the mycelium and bear conidia in chains. The [conidia](#) are barrel shaped or cylindrical, hyaline and thin walled. [Cleistothechia](#) are black, spherical with no ostiole, with numerous densely-woven septate, brown-coloured appendages. They contain 10-15 asci which are ovate with a short stalk. Each ascus contains two ascospores which are oval to elliptical, thinwalled, hyaline and single celled.



**Conidia and conidiophores**

### **Favourable Conditions**

- Humid cloudy weather.
- Low temperature (16-23°C).
- Close planting and excess doses of nitrogenous fertilizers.

### **Disease cycle**

The fungus remains dormant as mycelium and cleistothecia in the infected plant debris in soil. The primary infection is mainly from soil-borne inoculum. The secondary spread is aided by wind blown conidia.

### **Management**

- Apply balanced fertilizers.
- Avoid overcrowding of plants.
- Remove and destroy the affected leaves.
- Plant early in the season so that crop escapes the cool temperature at maturity phase.
- Spray dinocap at 375 ml or Carbendazim at 500g/ha.

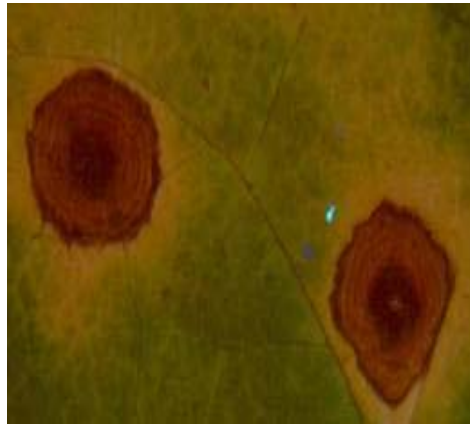
### **Brown spot - *Alternaria longipes***

#### **Symptoms**



Brown spot in contrast to frog-eye spot is not normally observed in the nursery but is very much prevalent in the field. Initially it appears on lower and older leaves as small brown, circular lesions, which

spread, to upper leaves, petioles, stalks and capsules even. In warm weather (30° C) under high humidity, the leaf spots enlarge, 1-3 cm in diameter, centres are necroses and turn brown with characteristic marking giving target board appearance with a definite outline. In severe infection spots enlarge, coalesce and damage large areas making leaf dark-brown, ragged and worthless. On leaves nearing maturity, leaf spots are surrounded by bright yellow halo, due to production of toxin 'alternin' by the fungus.



### Symptoms

### Disease cycle

The fungus over summers in the soil as mycelium in the diseased plant debris such as stems of tobacco, weeds and other hosts. Under favourable weather in the next season conidial production starts which infect the lowermost leaves. As the season progresses, repeated infection cycles of the fungus attack healthy tissues of all aerial parts of tobacco of any age under high humidity. There is enormous spore density in the air near the end of the harvesting. Fungus persists as a mycelium in dead tissue for several months.

### Management

- Removal and destruction of diseased plant debris can check the primary infection promptly.
- Continuous growing of tobacco after tobacco must be avoided in the heavily infected fields.
- Weekly, spraying of fungicides such as [Maneb](#) or [Zineb](#) @ 2g/ha or [Benomyl](#) or [Thiophanate methyl](#) at 1kg/ha.

## **Anthracnose -*Colletotrichum tabacum***

### **Symptoms**

Initially, infection starts on lower leaves as pale-brown circular spots of 0.5 mm diameter with papery depressed centres outlined by slightly raised brown margin. The leaf-spots may remain small with white areas in the centre or coalesce to form large necrotic lesions. Under continuous humid weather, dark brown or black, elongated, sunken necrotic lesions appear on midrib, petiole and stem resulting in petiole and stem rot. Such seedlings do not establish in the field if planted. Primary infection starts from affected bits of aerial parts left in the soil in the previous season. The pathogen is not seed-borne but persists in the soil on dried plant debris.

### **Management**

- Raised seed beds and rabbing with farm wastes help in reducing the initial infection
- Removal and destruction of all diseased debris minimises the pathogen in the soil.
- Rogueing diseased seedlings especially with necrotic lesions on stem
- Protective spraying with Bordeaux mixture at 1.0% (2-2-500) or Zineb @ 2 kg/ha

## **Wild fire - *Pseudomonas tabaci***

### **Symptoms**

The leaf spots may occur at any stage of plant growth including the nursery seedlings. Dark brown to black spots with a yellow halo spreads quickly causing withering and drying of leaves. In advanced cases, lesions develop on the young stem tissues leading to withering and drying of the seedlings. In the fields, initially numerous water soaked black spots appear and latter become angular when restricted by the veins and veinlets.





### Symptoms

Several spots may coalesce to cause necrotic patches on the leaves. In advanced conditions, the entire leaf is fully covered with enlarged spots with yellow haloes. The leaves slowly wither and dry. Under humid weather condition, the disease spreads very fast and covers all the leaves and the entire plant gives a blighted appearance.

### Pathogen

The bacterium is a rod, motile with a single polar flagellum, non-capsulated, non spore forming and Gram negative.

### Favourable Conditions

- Close planting.
- Humid wet weather.
- Strong winds.

### Disease cycle

The bacterium survives in the infected crop residues in the soil, which is the primary source of infection. The secondary spread of the pathogen in the field is through wind splashed rain water and implements.

### Management

- Remove and burn the infected crop residues in the soil.
- Avoid very close planting.

**Tobacco mosaic - [Tobacco mosaic virus](#) (TMV)**

### Symptoms



The disease begins as light discoloration along the veins of the youngest leaves. Soon the leaves develop a characteristic light and dark green pattern, the dark green areas associated more with the veins, turning into irregular blisters.

The early infected plants in the season are usually stunted with small, [chlorotic](#), [mottled](#) and curled leaves. In severe infections, the leaves are narrowed, puckered, thin and malformed beyond recognition. Later, dark brown necrotic spots develop under hot weather and this symptom is called “[Mosaic burn](#)” or “Mosaic scorching”.

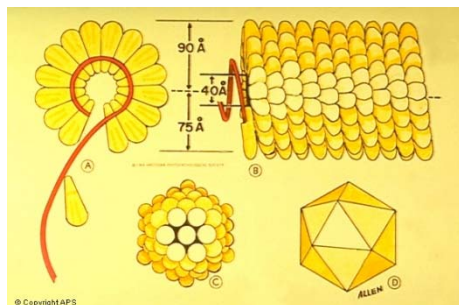


### Pathogen

The disease is caused by [Tobacco mosaic tobamovirus](#). It is a rigid rod measuring 300 X 150-180 nm with a central hollow tube of about 4nm diameter with [ssRNA](#) as its genome.

### Disease cycle

The virus wounds, sap and virus remains



spreads most rapidly by contact farm implements and operators. The virus remains viable in the plant debris in the soil as

the source of inoculum as the longevity of the virus is very high. It is capable of remaining infective when stored dry for over 50 years. The virus has a wide host range, affecting nearly 50 plant species belonging to nine different families. The virus is not seed-transmitted in tobacco but tomato seeds transmit the virus. No insect vector known to transmit the virus.

### Management

- Remove and destroy infected plants.
- Keep the field free of weeds which harbour the virus.



- Wash hands with soap and running water before or after handling the plants or after weeding.
- Prohibit smoking, chewing and snuffing during field operations.
- Spray the nursery and main field with botanical leaf extracts of [Bougainvillea](#) or [Basella alba](#) at 1 litre of extract in 150 litres of water, two to three times at weekly intervals.
- Adopt crop rotation by growing non-host plants for two seasons.
- Grow resistant varieties like TMV RR2, TMV RR 2a and TMV RR3.

### Leaf curl - [Tobacco leaf curl virus](#) (TLCV)

#### Symptoms

The infections may occur at any stage, when young plants are infected the entire plant remains very much dwarfed. Curling of leaves with clearing and thickening of veins; twisting of petioles; [puckering](#) of leaves; [rugose](#) and brittle and development of enations are the important symptoms of tobacco leaf curl disease. Three forms of leaf curl expression are observed. First the leaf margins curl downward towards the dorsal side and show thickening of veins with enation on the lower surface. Second [crinkle](#) form shows curling of whole leaf edge towards dorsal side with enation on the veins and the lamina arching towards the ventral side between the veinlets. Third the transparent symptom shows the curling of leaves towards the ventral side with clearing of the veins and enations are absent.



Symptoms

## Pathogen

It is caused by [Tobacco leaf curl geminivirus](#). [Virions](#) are geminate, non- enveloped, 18 nm diameter circular [ssDNA](#) genome. The virus is a white fly transmitted [Geminivirus](#) with [ssDNA](#) as genome.

## Disease cycle

The virus has a narrow host range in eight plant families. The virus is not transmissible through sap or seed. The whitefly, [Bemisia tabaci](#) is the vector. Due to wide host range of the virus many other plants are acting as source of inoculums.

## Management

- Remove and destroy the infected plants.
- Rogue out the reservoir weed hosts which harbour the virus and whiteflies. Planting tobacco crop during the crop periods when the vector population is low.
- Spray [Methyldemeton](#) at 0.1 to 0.2 per cent to control the vectors.

## [Phanerogamic parasite](#)

**Broom rape - [Orobanche cernua var. desertorum](#)**

## Symptoms

The affected tobacco plants are stunted and show withering and drooping of leaves to wilting. These indicate underground parasitism of the tobacco roots by the parasite. The young shoot of the parasite emerges from the soil at the base of the plants 5-6 weeks after transplanting. Normally, it appears on clusters of 50-100 shoots around the base of a single tobacco plant. The plants which are attacked very late exhibit no external symptoms but the quality and yield of leaves are reduced.



### Parasite

It is a total root parasite. It is an annual, fleshy flowering plant with a short, stout stem, 10-15 inches long. The stem is pale yellow or brownish red in colour and covered by small, thin, brown scaly leaves and the base of the stem is thickened. White-coloured flowers appear in the leaf axils. The floral parts are well developed with a lobed calyx, tubular corolla, superior ovary, numerous ovules and a large four-lobed stigma. The fruits are capsules containing small, black, reticulate and ovoid seeds.

### Disease cycle

The seeds of the parasite remain dormant in the soil for several years. Primary infection occurs from the seeds in the soil. The seeds spread from field to field by irrigation water, animals, human beings and implements. The dormant seeds are stimulated to germinate by the root exudates of tobacco and attach itself, to the roots by forming haustoria. Later, it grows rapidly to produce shoot and flowers. *Orobanche* also attacks other crops like brinjal, tomato, cauliflower, turnip and other cruciferous crops.

### Management

- Rogue out the tender shoots of the parasite before flowering and seed set.
- Spray the soil with 25 per cent copper sulphate.
- Spray 0.1 per cent Allyl alcohol.
- Apply few drops of kerosene directly on the shoot.
- Grow decoy or trap crops like chilli, moth bean, sorghum or cowpea to stimulate seed germination and kill the parasite.