

# Disease problems in fennel (*Foeniculum vulgare* Mill) and fenugreek (*Trigonella foenum graceum* L.) cultivation and their management for production of quality pathogen free seeds

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## Abstract

Fennel and fenugreek are two important seed spices grown in India. They occupy privileged position in Indian kitchen. Fennel and fenugreek are two important seed spices grown in India. They occupy privileged position in Indian kitchen. Both have medicinal properties. Both the crops suffer due to diseases which are described with methods for their control for the production of high quality pathogen free seed.

**Key words :** Diseases management, fennel, fenugreek

## Fennel (*Foeniculum vulgare* Mill)

Fennel, a seed spice is native of Southern Europe and Mediterranean area. It is mainly grown in Gujarat, Rajasthan and Uttar Pradesh and in small quantities in some other states also. The odour in fennel is due to anethole in seed due to which it has medicinal value. It has digestive, stomachic, carminative, stimulant, appetizer properties and is used in diseases like cholera, biliousness, dysentery, diarrhea, cough, cold, constipation and ailment of chest, lungs and kidney (Malhotra and Vashishtha, 27; Singh *et al.* 49; Anonymous 1; Champawat and Singh 8). The crop is attacked by pathogens causing diseases influencing the production negatively.

## Fennel diseases

### Damping off of seedlings (*Pythium aphanidermatum*)

When the seed germinates and emergence of seedling takes place, seedlings exhibit water soaked areas on the stem portion, the whole cortex dies and the seedlings topple down. Even some seedlings do not emerge but die exhibiting pre-emergence mortality. The disease is favoured by high soil moisture. The fungus is soil borne. The disease is more common in nurseries where the seedlings are transplanted in the field. Under direct field sowing, the damping off occurs in patches which are usually low lying.

### Ramularia blight (*Ramularia foeniculi*)

Ramularia blight is a serious ubiquitous and most

destructive disease of fennel in this country. All the above ground parts are infected. Minute angular, brown to black spots are formed which later enlarge and get covered with grayish white erumpent growth. The basal leaves get defoliated. The seeds formed on diseased plants are shriveled and black. Such seeds result in poor germination. The cardinal temperatures for conidial germination are 12, 22 and 32°C. Favourable conditions for disease development are sufficient water deposition on host during February-March. Wet and humid conditions predisposed the conidia to germinate and light helped the infection and disease development (Lakra 24). Parashar and Lodha (33) reported that a period of 14 weeks from sowing is favourable for initiation and further spread of blight disease. Choudhari and Patel (10) found Difolatan and Mancozeb spray at 10 days interval most effective in controlling the disease. Mancozeb 0.2% was found best by Patel & Patel (35) in checking the disease and it also resulted in maximum seed yield. Lakra (24) observed three spray of benomyl 0.2%, Tridemorph 0.1% and carbendazim 0.2% most effective against the disease.

### Cercospora blight (*Cercospora foeniculi* Magn)

Brown spots with pale centers are formed on leaves, stems, petioles and pedicels. Light brown conidiophores are formed in clusters which emerge through stomata. Under severe condition the whole foliage gets blighted and the yield is highly reduced. The pathogen is seed borne. Higher temperature and humidity favour the disease.

In case the crop gets infected early, yield losses are more as there is no seed formation. The soil borne infected plant debris is important in recurrence of the disease (Prasad *et al.*, 40; Champawat and Singh, 8; Chupp and Sherf, 11). The blight is commonly observed in India and has also been reported from Pakistan and Bulgaria (Kamal and Khan, 19). Kranthansen and Kreisilmaier (22) have reported an outbreak of *Cercosporidium punctum* in Germany.

#### **Alternaria blight (*Alternaria alternata*)**

The disease coincides with the appearance of the inflorescence. It turns pale yellow and loose, the infected buds turn light brown and get dried up and shed. Seeds are also attacked. Heavy losses are caused by the disease (Deshpande and Sehgal 12). In Spain Bassimba *et al.* (4) found leaf necrosis symptoms caused by *A. patoselinion* on basal leaves. The fungus causes leaf blight and damping off of fennel in other European countries (Pryor *et al.* 41). According to Choudhari and Patel (10) Mancozeb and Difolatan 0.2% are excellent in controlling the disease when sprayed at 10 or 20 days interval in Gujarat.

#### **Angular leaf spot (*Pasalora kirchneri* (Hegy.) Patrak)**

Pillai and Sarwar (37) first reported the disease. Spots are formed on leaves giving appearance of blight.

#### **Ascochyta blight (*Ascochyta foeniculum* Mc Alpine)**

The disease has been reported from Australia. Elongate spots are formed on the stem with dark margin and ashy centre. Several pycnidia are formed in the spots which are large, black and globular. The spores are colourless and septate. The fungus is seed borne.

#### **Phytophthora blight (*Phytophthora syringae* (Kleb.) Kleb.)**

Water soaked spots are formed on petioles and lamina which become weak and collapse on the soil giving appearance of watery, secondary soft rot. Besides *P. syringae* bacteria are found associated with rotted portions. Noviello and Snyder (30) have reported the disease in severe form from Italy. Cocciola *et al.* (7) have reported brown, soft rot of thickened leaf bases with yellow leaves due to *Phytophthora megasperma* in Calabria region in Italy. The plants remain stunted and wilt. Cocciola *et al.* (7) reported brown rot and wilting of plants due to *P. megasperma* in Italy. Symptoms were brown soft rot of leaf base, yellowish leaves and wilting of entire plant in fields.

#### **Fusarium wilt (*Fusarium oxysporum* f.sp. *funiculi*)**

Vascular wilt caused by *Fusarium oxysporum* f.sp. *funiculi* is a commonly occurring disease of fennel. The disease

occurs when temperatures are high. The foliage droops down. The vascular tissue exhibits brown discoloration. The plants finally dry up. Fusarium stem and crown rot caused by *F. avenaceum* (*Gibberella avenacea*) has been reported from Arizona, USA (Koike *et al.* 21). The lower stems in contact with soil became chlorotic. White mycelium and orange sporodochia are formed on the affected tissues near the soil line. Diseased stems later wilt and dry. The disease was observed in patches.

#### **Rhizoctonia root rot (*Rhizoctonia solani*)**

Root and stem gummosis, sugary disease is caused by *Rhizoctonia solani*. The root gets shredded; stem rot results in some type of ooze. The plant ultimately dries up (Mehra 28).

#### **Stem rot (*Sclerotinia sclerotiorum* (Lib.) deBary)**

Sehgal and Agrawat (47) have reported the disease from Rajasthan as exhibiting 'drooping off' around the infected portion. The fungus grows in the vascular tissue and forms black, hard water supply. The plants exhibit drooping symptoms. Gaetan *et al.* (15) also reported stalk rot due to the pathogen. Panchal *et al.* (32) have controlled the disease treatment with garlic extract, Carbendazim was significantly superior in reducing seedling mortality and also increasing germination.

#### **Foot rot (*Rhizoctonia solani* Kuhn.)**

The pathogen attacks seedling and causes rot of root tip. Brown to reddish brown depressed lesions are formed below the soil level. Under favourable conditions the attacked area enlarges and results in a canker (Chupp and Sherf 11).

#### **Downy mildew (*Plasmophara nivea* (Casparg) Schroeter)**

Typical downy mildew symptoms appear with yellow spots on the upper parts of leaflets and dusty white growth on the corresponding by lower surface of numerous branched conidiophores with globose conidia at the tip of branchlets. Oospores are formed which are responsible for recurrence of the disease (Chupp and Sherf 11).

#### **Powdery mildew (*Leveillula taurica* var *languinosa* Salm.)**

Powdery mildew appears on the crop in February-March in Rajasthan. The disease results in heavy loss in yield. The green foliage, tender stem and branches get infected. Talcum like powder spreads on whole of the plant. The plant gets dried under severe infection (Chattopadhyaya and Maiti 9).

#### **Galls (*Protomyces macrosporus* Unger)**

The disease was first reported by Awashi *et al.* (2).

The symptoms of the disease on fennel are similar to those on coriander. The disease gets exhibited when fennel is grown in heavily infected coriander field. The disease cycle, life cycle, method of recurrence and spread are similar to that of coriander, hence the management practices also.

#### **Rust (*Aecidium foeniculi* Cartague)**

The rust of fennel has been reported from various places in Europe exhibiting aecial stage only. Detailed investigations are needed (Chupp and Sherf 11).

#### **Seed borne microorganisms**

Several fungi have been observed associated with seeds, some are pathogens causing diseases like *Alternaria alternata*, *Fusarium oxysporum* f.sp. *funiculi*, *Stemphylium botryosum*, *Protomyces macrosporus*, *Cercospora funiculi* etc., some cause seed rot like species of *Aspergillus*, *Penicillium*, *Cladosporium*, *Fusarium* etc. Odstcilova *et al.* (31) observed 26 fungi associated with fennel seeds in Czech Republic. *Verticillium dahliae* is seed borne in fennel. It caused wilt disease. It can be detected by planting the seeds on moist blotters at pH 9.5-10 (Ghoneem *et al.* 10). Jain and Jain (18) found species of *Alternaria*, *Aspergillus*, *Cercospora*, *Cladosporium*, *Curvularia*, *Drechslera*, *Memnoniella* and *Penicillium* associated with fennel seeds.

#### **Root knot nematode {*Meloidogyne javanica* (Treub) Chitwood }**

Root knot is a common problem in fennel. Root knot can be controlled by the application of oil cakes like neem cake (100 kg) + phorate (1 kg) or 1000 kg castor cake + 1 kg phorate (Patel *et al.* 36). Patel *et al.* (35) managed root knot problem by soil solarization with 25 micron LLDPE film and rabbing with castor husk at 7 kg/m<sup>2</sup>.

#### **New disease of fennel**

Rodeva & Gabier (44) reported umbel browning and stem necrosis caused by *Phomopsis foeniculi* from Bulgaria. The umbels get destroyed completely with no seed yield. Stem necrosis resulted in death of many twigs and even the whole plant. Pycnidia of the fungus are formed on diseased plants producing both alpha and beta conidia. Perithecia with matured ascospores are also formed on the over wintered plant parts. *Diaporthe angelicae* is the perfect stage. The disease has also been reported from Germany (Kusteer *et al.* 23).

#### **Bacterial soft rot (*Erwinia caratovora* Kusterer)**

The germinating seeds develop soft rot giving water soaked appearance. They emanate foul odour. Normal emergence of seedlings is checked. High moisture favours the

disease.

#### **Bacterial streak (*Pseudomonas syringae* pv *apii*)**

Jardini *et al.* (17) reported bacterial streak of fennel caused by *Pseudomonas syringae* pv. *apii* in Salinus valley of California, USA. Small, dark brown to black lesions were formed on leaves and stems. As the disease progressed the lesions expanded in a linear fashion moving to stem.

#### **Phyllody**

Bhat *et al.* (6) reported phyllody of fennel from India confirming the presence of Phytoplasma which belonged to peanut witches brown group.

#### **Little leaf**

Samad *et al.* (45) reported little leaf of fennel caused by Phytoplasma from Lucknow, India. The main symptoms were growth retardation with excessive proliferation of axillary shoots and formation of small, narrow leaves which give witches broom appearance. The diseased plants do not form inflorescence. The disease range was 5-125 in commercial fields. Transmission electron microscopic studies revealed the presence of pleomorphic bodies in the tetracycline hydrochloride the symptoms were temporarily suppressed.

#### **Virul disease**

Common mosaic infect fennel. Southern celery mosaic also infects fennel. Affected plant leaves are mottled with yellow and green. The plants remain dwarf. The leaflets are slightly savoyed and crinkled. Curly top virus attacks fennel also. The leaves remain small and more in number and the plant remains dwarf (Chupp and Sherf 11).

#### **Management of diseases**

1. Resistance- The best method for management of a crop disease is to search for resistance. The fennel variety AF-1 is tolerant to *Alternaria* and *Cercospora* blight, PF-35 is moderately tolerant to sugary disease, leaf spot and leaf blight.
2. Seed treatment- Seed should be treated with captan or thiram 2.5g/ kg seed or thiram+ Bavistin (2:1) 2.5 g/kg seed to control seed borne pathogens.
3. Spray-For control of foliar diseases, spray of Zineb, Mancozeb @ 2g/l water is essential.
4. Cultural practices- Rotation of crops is essential to avoid soil borne pathogens.
5. Solar treatment of nursery beds should be done to reduce the inoculum level of pathogens in soil.

6. For control of powdery mildew wettable sulphur needs to be sprayed @ 2.5-3 kg/ha
7. Through surveys disease free areas must be located for the production of high quality pathogen free seed.

#### **Future strategies**

It is necessary to collect germplasm and screen them for source of resistance to various diseases so that newer varieties with resistance may be evolved. As organic agriculture is encouraged, cultural practices, botanicals and antagonistic microbes may be used to manage pathogen causing diseases. Survey should be undertaken as per direction of WTO to find disease free seed production. Spots with high disease intensity have to be identified for screening the cultivars and germplasm lines for resistance.

#### **Fenugreek**

Fenugreek an important seed spice is native of South Eastern Europe and South Western Asia. Two types of methi are common (*Trigonella foenumgraceum* L.) with larger seed and kasuri methi (*T. corniculata* L.) with small seed. The crop is grown in India and in Morocco, Bulgaria, Pakistan, Afghanistan, Lebanon, Spain, Egypt, Turkey and Algeria. Rajasthan is the main methi growing state of the country. It is also grown in Gujarat, Madhya Pradesh, Chhattisgarh and Uttar Pradesh. The crop is cultivated for seed and leaves both fresh and dried. In 2010-11 the total area under methi in India was 81.2 thousand hectare with 1.18 lac tons production and 1.5 tons productivity per hectare. The seeds have great medicinal value and they are rich in oils, alkaloids, vitamins and minerals. It is used as diuretic, tonic, carminative, aphrodisiac, galactagogue, digestive, astringent etc. Methi seeds are used in Ayurvedic medicines (Champawat and Singh, 8, Malhotra and Vashishtha, 27, Singh *et al.* 49, Anonymous 1). The crop is attacked by several fungi, bacteria, viruses and nematodes causing various diseases resulting in reduced yields. Their symptoms, disease cycle, epidemiology and management practices are discussed in this paper with requisite requirements for seed certification for high quality seed.

#### **Fenugreek diseases**

##### **Damping off of seedlings (*Pythium aphanidermatum*)**

The emerged seedlings exhibit water soaked discoloured, soft basal rot of the stem due to the death of cortical tissues. The rotted seedlings emit bad odour, the whole seedling topples over.

##### **Root rot (*Rhizoctonia solani*)**

The diseased plants exhibit yellowing of foliage when the crop is about one month old. The disease is severe under high moisture in soil or water logged conditions. The root are poorly developed, finer roots are either not formed or rot. Diseased plants remain stunted and can be easily pulled out. Heavy losses are incurred due to root rot. Besides *R. solani* several other fungi like *Fusarium solani*, *R. bataticola* also result in root rot symptoms. Dwivedi *et al.* (13) reported a severe root rot in methi caused by *Alternaria alternata*. The cultivar Co-1 and Lam selections are tolerant to root rot and moderately resistant to root rot complex (Malhotra and Vashishtha 27).

##### **Collar rot (*Sclerotium rolfsii*)**

The tissues at collar region exhibit water soaked areas on which fluffy white mycelium grows. Mustard like sclerotia are formed on the hyphae around the diseased portion. Finally the plant dies. Plants are affected singly or in groups. No treatment works at this stage, only turning of soil helps in checking the spread of the disease.

##### **Wilt (*Fusarium oxysporum*)**

Typical symptoms of vascular wilt are observed. The foliage droops down and on splitting the roots exhibit brown discoloration. Heavy yield losses are observed when the disease is severe.

##### **Leaf spot (*Cercospora traversiana*)**

Spots are formed on foliage which are round, white at the center and brown at periphery. Spots are also formed on stems, petioles and young pods. Spores are produced within the spots. The pathogen is internally seed borne (Khare *et al.* 20). It is observed where ever methi is grown (Lapik 26). Rastogi *et al.* (42) have described the location and transmission of the pathogen. Khare *et al.* (20) have described a new species of *Cercospora*, *C. foenumgraceum* causing disease on methi.

##### **Leaf spot (*Stemphylium botryosum*)**

The aerial plant parts are infected. The leaves develop light to dark brown spots with a number of spores of the fungus. The symptoms also appear on stem and umbel. The pathogen is seed borne.

##### **Leaf blight (*Corynespora cassicola*)**

The disease starts as very small reddish brown spots which spread all over the leaf. The spots are elongated on stem and petiole. Under favourable conditions the foliage appears fully blighted. Later the plant dries. The fungus produces septate conidiophores on which conidia are produced at the terminal end. The conidia are elongated, multiseptate and brownish. The pathogen is seed and soil

borne. The crop is more susceptible towards maturity.

#### **Downy mildew (*Peronospora trigonella*)**

The leaflets exhibit yellow patches on the upper surface and grayish growths on correspondingly lower surface are the main symptoms. The downy mildew infection is more at flowering and pod formation. The grayish cottony growth called downy growth consists of conidiophores which are dichotomously branched and at the tip conidia are formed on sterigmata. Oospores are formed towards maturities which are responsible for the recurrence of the disease. The conidia spread the disease. According to Lakra (25) oospore formation is favoured by 24-27 C at 40% relative humidity. Praksh & Sharan (39) observed that 12 h old conidia and 18C are the best for causing infection. Mehra *et al.* (29) found fenugreek seeds with green tan seed coat highly resistant to downy mildew. Malhotra & Vashishta (27) have recommended Hisar Mukta, resistant and Hisar Suvarna moderately resistant to downy mildew.

#### **Powdery mildew (*Erysiphe polygoni* DC, *Leveillula taurica* (Lev)AM)**

On the leaf surface on both the sides white floury patches are formed. This white powdery mass contains conidia in large number. All the aerial parts exhibit the symptoms. The number of pod per plant and number of seeds per pods are highly reduced (Rathi *et al.* 43). In *L. taurica* the recurrence of the disease is through ascospores formed in cleistothecia which are formed on leaf surface towards crop maturity as small black bodies immersed in the mycelium mass. Bansal *et al.* (3) observed localization of various metabolites in different places in diseased leaf and stem of fenugreek.

Saxena *et al.* (46) evaluated 173 germplasm lines of fenugreek against powdery mildew and identified one resistant and five moderately resistant lines. Prakash and Sharan (38) have reported GC-39 and UM-32 free and GC-7, GC-20 and UM-34 resistant to powdery mildew. Rmt-305, Hissar Suvarna, Hissar Madhuri are resistant and Rmt-1 and Lam selection-1 tolerant to powdery mildew (Malhotra and Vashishta 27).

#### **Rust (*Uromyces anthylidis* (Grev.) Schroet)**

Circular brown coloured pustules are formed on leaves which are very small. The leaves turn yellow, shrivel, dry and fall off. Detailed investigations are needed on the disease cycle and epidemiology.

#### **Virus diseases**

Fischer & Lockhart (14) have reported Turnip Mosaic Virus on fenugreek, Bhaskar and Summanwar (5) described mosaic wilt virus disease with symptoms of vein clearing, severe molting, leaves curled at the margin and reduced

leaf size. Pods if formed are very small with curled thin and shrunken seeds. Pea Mosaic, Bean Yellow Mosaic, Wisconsin pea streak, Cucumber mosaic and Pea enation mosaic have also been reported on fenugreek (Champawat and Singh 8).

#### **Nematode problem**

The crop is attacked by several parasitic nematodes like *Meloidogyne incognita*, *Rotylenchulus reniformis*, *Tylenchorhynchus brassicae* and *Helicotylenchus indicus*. Oil seed cakes of neem, castor, linseed, mustard and groundnut checked the nematodes (Tiyagi *et al.* 50). The cultivar Rmt 305 is resistant to root knot nematode (Malhotra & Vashishta 27). Application of botanicals like *Argemone mexicana*, *Calotropis procera*, *Solanum xanthocarpum* and *Eichhornia echinulata* also controlled these nematodes (Tiyagi *et al.* 51). Sharma and Trivedi (48) obtained reduced population of *M. incognita* when *Paecilomyces lilacinus* was raised on goat dung or sesame cake as substrate and mixed in soil. The *P. lilacinus* penetrated the eggs, fed upon their contents and left the egg shells empty.

#### **Management**

The soil inhabiting fungi which infect fenugreek like *Macrophomina phaseolina*, *Fusarium oxysporum*, *Rhizoctonia solani*, *Phyllosticta phaseolina* and *Sclerotium rolfsii* and cause diseases are checked by the application of oilseed cakes-neem, castor, linseed, groundnut and mustard (Tiyagi *et al.* 50). Botanicals like *Argemone maxicana*, *Calotropis procera*, *Solanum xanthocarpum* and *Eichhornia echinulata* also check the above mentioned soil borne fungi (Tiyagi *et al.* 51). Seed treatment with Thiram, Thiram+ Bavistin, Captan, Difolatan, Mancozeb 0.2% by weight is helpful. For the management of foliar diseases spray of Macozeb 0.25% is useful.

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