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## Anthracnose on Spice Crops

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Small cardamom (*Elettaria cardamom* Maton) is a large perennial, herbaceous, rhizomatous monocot, belonging to the family *Zingiberaceae*. The cardamom of commerce is the dried ripe fruit of cardamom plant and is often referred to as the "Queen of spices". It is cultivated as a monocrop under forest canopy and also as an inter crop in arecanut or coffee gardens of high ranges of Karnataka, Kerala, and Tamil Nadu contributing approximately 60, 31 and 9% of total area respectively. Uttara Kannada, Shimoga, Hassan, Chikamagalur and Kodagu districts in Karnataka and northern and southern foothills of Nilgiris, hill regions of Madurai, Salem and Thirunelveli, Anamalai and Coimbatore districts of Tamil Nadu state, Wyanad and Idukki districts as well as in the Nelliampathy hills of Palghat district in Kerala are the important areas of cultivation in India. (Korikanthimath, 2002) The crop is susceptible to a number of diseases caused by fungi, bacteria and nematodes both in the main plantations and in nurseries. As many as 25 fungal, bacterial and nematode diseases have been reported in cardamom besides the three viral diseases viz. Katte, Kokkekandu and Nilgiri necrosis. Based on disease severity, spread and damage the diseases of cardamom are grouped into major and minor diseases (Thomas and Suseela, 2002). Major diseases such as capsule rot, rhizome rot, leaf blight and nematode infestations are often wide spread and lead to crop loss while minor diseases generally affect the foliage and occur in low proportions. The minor diseases occur only sporadically and include various types of leaf spots, capsule spots and stem infections. The leaf infections of importance are leaf blotch caused by *Phaeodactylium alpiniae* (Sawada) (Ellis, 1971), *Leaf blight* caused by *Phytophthora nicotianae* var. *nicotianae* (Suseela Bhai, 1998) leaf rust caused by *Phakospora eletariae* (Racib.), and leaf spots caused by *Spaceloma cardamomi*, *Cercospora zingiberi*, *Glomerella cingulata*, *Phaeotrichoconis crotalariae*, *Cercospora eletariae* and *Colletotrichum gloeosporioides*. In addition to leaf spots, capsule spots are also observed in cardamom caused by *C. gloeosporioides*, *Rhizoctonia solani*, *Fusarium moniliforme* and *Marasmius* sp. Among the diseases, the leaf and capsule infections caused by *C. gloeosporioides*

is of serious nature in cardamom plantations and nurseries leading to crop loss directly or indirectly. Infection by *Colletotrichum* occurs in the cardamom plantations as leaf blight ('Chenthal') and anthracnose. Leaf spots due to these fungi are found in the secondary nursery also. In India, Black pepper infection by *C. capsici* is called anthracnose or pollu disease meaning hollow berry where as in Malaysia and Indonesia, it is called black berry disease. The fungus infects both leaves and spikes (Anandaraj, 2000) and the infection on the spike is leading to spike shedding common in the higher altitudes of Karnataka and Kerala.

India is the world's largest producer, consumer and exporter of Turmeric and Andhra Pradesh is the largest producer (Ravindran, 2007) having an area of 25,000 ha with a production of 79,600 tons of cured rhizomes. The state ranks second in area and first in production of turmeric in India (Anonymous, 1986). The other major producing states are Tamil Nadu, Orissa, Karnataka, West Bengal and Maharashtra and to some extent in Kerala. Among the foliar diseases of turmeric, leaf blotch caused by *Taphrina maculans* and leaf spots caused by *C. capsici* are important besides leaf spots caused by *Corticium sasaki*, *Phyllosticta zingiberi*, *Myrothecium* sp. *Cercospora* sp. and *Pyricularia curcumae*. The leaf spot disease of turmeric caused by *Colletotrichum* was first reported from Coimbatore by McRae (1917, 1924).

### 1. Occurrence and Distribution

Leaf blight ('Chenthal') of cardamom makes its appearance mostly during the post monsoon period and becomes severe during summer months. The disease has been first reported in cardamom plantations by George *et al.* (1976) from Idukki district of Kerala State. Afterwards the occurrence of the disease has been observed in many other plantations. The spread of disease is found faster in deforested areas and less shaded plantations. Anthracnose on cardamom capsule as a new disease was reported by Suseela Bhai *et al.* (1988) during 1985-86 crop season from Udumbanchola area of Idukki district and later it was observed in plantations of Vandiperiyar area of Idukki district and Anamalai areas in Tamil Nadu and in the subsequent years the disease appeared in increasing proportions ranging from 10-28% in Anamalai areas. The disease was noticed during the post monsoon period of September - December.

Anthracnose of black pepper, though sporadic in nature in the major pepper growing tracts of Kerala, this disease is becoming severe in parts of Karnataka where pepper is grown on shade trees in coffee plantations (Anandaraj, 2000). The fungus is reported to survive on *Dioscorea triphylla* which is found to be an alternate host (Wilson, 1960).

Leaf spot of turmeric caused by *Colletotrichum* sp. was reported by McRae (1917) and later by Ramakrishnan (1954). The disease is prevalent in all the turmeric growing tracts in India, but it has been reported to be severe only in Madras and Andhra Pradesh (Ramakrishnan, 1954). The infection of *C. capsici* reduced rhizome yield by 62.7%. The disease is found severe in regions like Cuddapah, Kurnool, Krishna and Godavari districts of Andhra Pradesh. A survey conducted on foliar diseases of turmeric in northern Karnataka during 202-2003 showed the high intensity of *Colletotrichum* leaf spot. A crop loss of more than 50% due to this disease was reported (Ramakrishna, 1954; Gorawar *et al.*, 2006). The crop loss was studied by Nair and Ramakrishnan, 1973).

## 2. Economic Impact

Presently leaf blight of cardamom is an alarming threat and it is spreading to newer areas. Anthracnose (brown spot) occurring on cardamom capsule was reported as a minor disease in certain localities of cardamom cultivation. Often less than 2% disease incidence was noticed. But in Anamalai areas of Tamil Nadu as high as 10-28% incidence was recorded (Suseela Bhai and Thomas, 1988). Severity of anthracnose occurring on black pepper berries vary and a range of 28-34% has been reported causing a crop loss of 1.9-9.5% (Nair *et al.*, 1987). In turmeric the infection of *C. capsici* reduced rhizome yield by 62.7%. The disease is found severe in regions like Cuddapah, Kurnool, Krishna and Godavari districts of Andhra Pradesh. A survey conducted on foliar diseases of turmeric in northern Karnataka during 202-2003 showed the high intensity of this disease. A crop loss of more than 50% due to this disease was reported (Ramakrishna 1954; Gorawar *et al.*, 2006).

## 3. Diagnostic Symptoms

In cardamom leaf blight ('Chenthal') symptoms develop on the foliage as water soaked rectangular lesions which later elongate to form parallelly arranged streaks. The length of these streaks varies from a few millimeters to up to 5cm. The lesion areas become yellowish brown to orange red in colour and often the central portions become necrotic. Usually the two younger most leaves are free from infection. As the disease advances more and more lesions develop on the older leaves and adjacent lesions coalesce and begin to dry up. Severely affected leaves show a burnt appearance. George and Jaysanker (1979) reported reduction in plant height panicle length and crop loss due to failure in panicle formation in severely affected plants. However Govindaraju *et al.* (1996) studied the symptomatology in detail and found that Chenthal infection affects only the leaves and not the tiller length, panicle emergence or crop yield.

Leaf spot is also observed in 6-12 months old seedlings in the secondary nursery (Thomas and Bhai, 2002). This disease is characterized by the development of many rectangular water soaked lesions on the foliage which enlarge longitudinally and are parallelly arranged along the side of the veins. As they mature, they exhibit a muddy red color, become necrotic and the lesions coalesce and finally the leaves dry off. On capsule the symptoms appear as reddish brown round or oval spots of 1-3 mm diameter, often with soft depressed center. The symptoms first appeared on fresh capsules as small water soaked spots which later developed into characteristic reddish brown lesions resembling typical anthracnose symptoms. The affected capsules showed 1-6 lesions per capsule. The lesions vary in number and size and in rare cases coalesce to form large lesions. Disease symptoms are clearly visible on the cured capsules also (Suseela Bhai *et al.*, 1988). A similar infection by *C. gloeosporioides* on capsules resulting in the formation of much larger lesions often extending up to three fourth areas of the capsules was also observed in plantations of Karnataka state. This severe form of anthracnose leads to decay and loss of infected capsules. In black pepper anthracnose symptoms on berries depend on the stage of maturity. On younger berries infection lead to blackening. On mature fruits brownish lesions are formed (Ayyar *et al.*, 1918; Sebastian, 1982). When the infection occurs on the stalk end of spike, the entire spike is shed prematurely and brown lesions are produced on the leaves. In turmeric the Symptomatology, etiology and epidemiology of the disease have

been clearly worked out (Ghogre and Kodmelwar, 1986, Palarpawar and Ghurde (1989b, 1992, and 1995).

#### 4. Identity and Biology of Pathogen

Leaf blight ('Chenthal') was originally reported as a bacterial disease caused by *Corynebacterium* sp. (George and Jayasankar, 1977). Later Govindaraju *et al.* (1996) conducted detailed investigations on Symptomatology, etiology and management strategy of this disease and established beyond doubt that the causal organism of 'chenthal' is the fungus *C. gloeosporioides* (Penz.) Penz and sacc. *C. gloeosporioides* (Penz.) Penz and sacc has been shown to be the causative organism of anthracnose on cardamom capsules (Suseela Bhai *et al.*, 1988). The fungus grows profusely in Potato dextrose Agar medium producing dark, gray colored dense mycelium. Setae are dark brown, conidia abundant, cylindrical, straight 12-24 $\mu$ m x 2.5-5 $\mu$ m. Anthracnose in black pepper was reported to be caused by *C. necator* (Rao, 1926; Thomas and Menon, 1939). *C. gloeosporioides* was also reported from India. The fungus *C. gloeosporioides* Penz causing leaf blight ('chenthal') disease of cardamom closely resembles *C. gloeosporioides* causing anthracnose disease of capsule reported by Suseela Bhai *et al.* (1988). Both the leaf and capsule isolates showed similar cultural and morphological characters and were cross infective to capsule and leaves and vice versa. However, these two isolates exhibited considerable differences in their period of occurrence, type of symptoms and distribution and spread of the disease. However, no detailed studies have been conducted so far to study the variability of the pathogen causing these three infections on cardamom. No work has been even initiated to characterize the pathogen morphologically, pathologically or molecularly. The Symptomatology in the case of leaf spot of turmeric varied with different cultivars. In susceptible cultivars, the spots spread rapidly and scorched the leaf whereas in resistant cultivars, the spots were restricted and surrounded by yellow halo and the infected leaves did not dry.

#### 5. Host Resistance

No detailed work has been done so far on identifying resistant sources against *Colletotrichum* sp. either for cardamom or for black pepper. But in a mixed cropping system experiment involving coconut and five cultivars of black pepper showed that all five cultivars are susceptible to the disease of which Panniyur-1 recorded maximum incidence followed by Balankotta (Radhakrishnan and Nair, 1983). Reddy *et al.* (1963) and Sarma and Dakshinamurthy (1962) reported the reaction of long term and short term cultivars of turmeric for their reaction to leaf spot diseases. Among the sixty two cultivars screened for resistance /tolerance to leaf spot under field conditions in an endemic location for three years, it was found that majority of long duration entries were highly susceptible whereas some of the short duration entries and CLI cultures were highly resistant to the leaf spot disease (Rao *et al.*, 1992). The natural incidence of anthracnose disease in black pepper was recorded in 26 accessions including four hybrids, 10 selections and 18 cultivars. Panniyur-5, IISR Girimunda and Hybrid 780 were found highly resistant at high altitudes (Anon, 2007).

### 5. Integrated Diseases Management

Since leaf blight of cardamom was earlier considered as caused by *Corynebacterium* sp. (George and Jayasankar, 1977), penicillin spray was recommended for controlling the disease. As later workers could neither isolate *Corynebacterium* sp. nor could control the disease with penicillin sprays, the bacterial etiology was suspected and the cause of the disease remained obscure for more than a decade. Govindaraju *et al.* (1996) studied the etiology in detail and reported that three sprays at monthly intervals with carbendazim (Bavistin 0.3%) or mancozeb (0.3%) or copper oxychloride (0.25%) could be effective in controlling the spread of leaf blight ('chenthal') disease in the field. Leaf spot of cardamom occurring in the secondary nursery is reported to be controlled by spraying the foliage with mancozeb (0.25%) spread (Thomas and Bhai (2002). Fungicides such as Cuman L, Foltaf or Bavistin when sprayed three times at 0.3% concentration were found effective in controlling the anthracnose disease. But no effort has been made on developing an integrated management strategy for the disease other than testing few fungicides individually. To manage the spike shedding /anthracnose of black pepper, Bordeaux mixture 1% was recommended by Sundaraman (1928) and Nair *et al.* (1987). Difolatan was also found effective. Besides, Benomyl, Thiophanate ethyl, Thiophanate methyl, carbendazim, captafol and Tridemefon were also reported as effective from Sarawak. Kueh *et al.* (1993) reported that the disease could be controlled by providing 40% shade.

Fungicidal control of leaf spot of turmeric was studied as early as 1925 by Sundaraman (1925). Later, Rangaswamy (1972) and Singh and Edison (2003) studied the effect of shade on the severity of the disease. Rao and Rao (1987) tested three fungicides for the control of leaf spot of turmeric caused by *C. capsici*. They found that six sprays with Dithane M 45 at 0.25% at an interval of 15 days significantly reduced the incidence and increase the yield. The yield increased was 0.975 tons of cured rhizomes /ha. But yield was negatively correlated with disease incidence. Fytolan depressed the yield due to its phytotoxic effect on the turmeric leaves. The benefit cost ratio of the fungicide was found to be 2.44. Management of *Colletotrichum* leaf spot of turmeric using sanitation was reported by Ali *et al.* (2002).

*In vitro* studies were conducted on the role biocontrol agents in the management of foliar diseases in turmeric and found that species of *Trichoderma* are best in inhibiting the mycelial growth of *C. capsici* (Gorawar and Hegde, 2006). Gorawar *et al.* (2006) studied the effect of certain leaf extracts on the growth of *C. capsici* and found that 10% concentration of Duranta leaf extract and Parthenium leaf extract are effective under *in vitro* conditions.

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