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An overview of the fungal rot of tomato

A. H. Wani

Section of Mycology and Plant Pathology, Department of Botany University of Kashmir 190006, India
**Correspondence E-mail: ahamidwani@yahoo.com*

Abstract

Tomato (*Lycopersicum esculentum* L.) is the most popular vegetable world-wide. Tomatoes crop and yield is suffered every year due to number of pathogenic diseases. Such diseases are caused by fungi, bacteria, viruses and nematode, develop through soil-borne, above-ground infections and in some instances are transmitted through insect feeding. Although some general review on the fungal diseases of vegetables have been compiled by different workers. However, no comprehensive review is available on the fungal rot of tomato. The present review gives inclusive information regarding various pathological aspects on the fungal rot of tomato and management strategies opted for post harvest diseases of tomato.
Keywords: Review, Fungi, Rot, Tomato, Morphology, Fungicides.

Introduction

Tomato (*Lycopersicon esculentum* L.) originated South America belongs to Solanaceae family is a widely grown vegetable in the world. The leading producer of tomato in the world is USA followed by China, Italy, Turkey, Egypt, Spain, Romania, Brazil and Greece. In Kashmir Valley (India), the crop is grown over an area of 1200 hectares with an average yield of 250-300 quintal per hectare (Anonymous, 2002).

In Kashmir, tomato is attacked by variety of pathogens; predominant being the fungal fruit rots (Taskeen-un-Nisa *et al.*, 2011). These fungal rots are responsible for causing serious production problems and become menace for successful cultivation of tomatoes in valley. Fungal rots are world-wide in occurrence and have been reported almost in all parts of the world. According to Sokhi and Sohi (1982), the destructive pathogen causing fruit rots on tomato is present in parts of the country where moisture is plentiful and temperatures are moderate to favour their development. The principal fungal fruit rots reported all over the world with varying intensities on tomato includes *Alternaria* rot caused by *A. solani* and *A. tenuis*, *Phytophthora* rot caused by *Phytophthora infestans*, *Phytophthora nicotianae* var. *parasitica*, Anthracnose ripe rot caused by *Colletotrichum phomoides*, *Phoma* rot *Phoma destructiva* and *Fusarium* rot caused by *Fusarium* spp. (Jones, 1991; Iqbal *et al*., 2003; Patel *et al*., 2005; Ali *et al.*, 2005).

In current paper a review on the fungal rot of tomato is described with reference to occurrence, symptomology, severity/incidence, pathogenicity, losses and disease control with fungicides.

***Alternaria* rot** has been considered as the most common disease of tomato fruits and causes heavy losses in quality of the fruits, thus rendering large quantity of tomato fruits unfit for consumption. The disease was reported by Douglas (1922) from the California. The causal organism was isolated from the dead leaves of potato and afterward it was reported from the decaying tomato fruits. Samuel (1932) reported that *A. solani* was mainly responsible for the tomato decay and typical symptoms occurred on stem were brown to black, depressed and usually with distinct rings. Warner (1936) reported that the spot range in size from minute pin-heads to areas extending completely across the surface of the fruit giving it a flattened appearance.

The fungal rot was also reported from India (Thomas, 1944; Agarwal *et al.*, 1950; Rao, 1965). Barkai and Fauchs (1980) and Hassan (1996) have reported that *Alternaria* is main decay causing organism of post harvest tomato fruits while responsible for black rot lesions on tomato fruits.

Buckeye rot of tomato was first reported by Sherbakoff (1917) from Florida is caused by *Phytophthora parasitica*. Lesions due to Buckeye rot infection appears as water soaked later form concentric rings of various shades of brown (D'|Ericle, 1980). McCulloch and Worthington (1952) reported that the typical lesions of tomato were brown to black, flattened or slightly sunken with indefinite margin. The disease has also been reported to occur in USA (Kreutzer and Bryant.

1946), Greece (Sarejanni, 1952), India (Sharma, 1971; Sokhi and Sohi, 1974).

***Phytophthora* rot of tomato** is caused by *Phytophthora infestans* (Mills, 1940). The symptoms of *Phytophthora* rot of tomato occurred on affected fruits as hard, lumpy, reddish brown lesions with indefinite margin but under humid conditions developed soft consistency and he designated this rot as dry *Phytopthora* rot. Fontma *et al*. (1996) found that despite weekly sprays, crop losses due to *A. solani* and *P. infestans* was 12-67% in early season and 14-52 % in the late season. Byrne *et al.* (1997) recorded 91.8% losses due to Phytophthora rot of tomatoes.

Anthracnoses rot of tomato caused by *Colletotrichum phomoides*. Succeeding early report of the disease was found in Europe in 1878, USA in 1981 and in France in 1892 (Sherf and Macnab, 1986). Anthracnose rot appears in young fruit in form of circular lesions later becoming dark, sunken and partially covered with salmon pink spore mass often in concentric circles (Illman *et al.,* 1959). Infected fruit have a short shelf life and disease results in serious fruit loss if not controlled. Some authors also reported *Colletotrichum coccodes, C. dermatum* and *C. Gleosporoides* as casual organism of anthracnose ripe rot (Stevenson, 1991).

Phomopsis blight of tomato is caused by *Phoma destructiva*. This disease was known to occur in eggplant producing area of the world. In India, the disease was noticed as an epiphytotic (Vasudeya, 1960). Morgan-Jones and Burch (1988) recorded *P. destructiva* as an important fungal pathogen of tomato. Since then its occurrence has been reported in USA, India, Canada and Poland (IIman *et al*., 1959; Grovers, 1965). Fournet (1971) and Sokhi and Sohi (1974) observed that rot spots are leathery, somewhat sunken and usually light coloured at margins and the fungus produced pycnidia in dark portions.

In India, average loss due to *Phoma parasitica* was reported to be 7-10% in winter season (Aulakh and Grover, 1969). Leorakkar et *al.* (1986) recorded tomato crop losses up to 100% due to *Phoma audina* in Columbia.

Fusarium rot is considered most destructive on ripe tomatoes has been reported from US (Pool, 1908; Ramsey and Link, 1932). Number of different Fusarium species has been found associated with this rot. Thakur and Yadav (1968) isolated *F. nivale* as causal organism. Mehta *et al*. (1975) observed *A. solani* and A. *tenius* on fruit rot of tomato. Banyal *et al.* (2008) reported that the rot is incited by *Fusarium oxysporum, F. pallidoroseum* and F. *accumunatum.*

Watery rot of tomato fruit was the first reported in Turkey, caused by powdery mildew fungus, *Oidium neolycopersici* (Jones *et al.,* 2001) and may become a problem in greenhouse grown tomatoes in near future.

Blue mould rot on tomato was noticed in Korea and is caused by *Penicillium* spp. Onwuzulu *et al.* (1995) found that *F. oxysporum* and *A. alternata* are the main fungal species responsible for deterioration of fruits of tomato during storage at ambient conditions. Kwon *et al*. (2008) revealed that blue mould rot caused by *P. oxalicum* occurred only on mature fruits but not on immature or young fruits. The first symptom appeared as small water soaked lesion at the wound site further developed into watery rot. It is assumed that the epidermal cells of tomato are collapsed by pathogen penetration at high temperature and humid conditions. Umemoto *et al*. (2009) noticed that *P. oxalicum* caused stem rot of tomato plants and develop green crusty lesions on the stem of tomato plants.

***Mucor* rot** has been observed to originate primarily from infection of wounds on the fruit skin. The decayed area appeared light brown to brown with a sharp margin, becomes very soft and juicy and can be readily separated from the healthy tissue. The disease moves progressively upward and enlarges into circular spots with target-like markings (Michailides and Spotts, 1990). Hassan (1996) noticed that the first symptom on the tomato fruits was a grayish green or brown with water soaked spot which develops where the fruit touches the soil. Lesions that enlarge on the surface of infected fruit have a characteristic pattern of alternating light and dark brown concentric rings resemble the marking that develops as in buckeye rot lesions which have a smooth surface and lack a sharply defined margin. These features distinguish the disease from late blight caused by *Phytophthora infestans*, which is characterized by lesions with a rough surface and a definite margin (Hansen, 2000). Fernandez-Pavia *et al*. (2003) observed that initially the lesions developed on tomato fruits in contact with the soil are brown to black, becomes enlarged and dark zonate "buckeye" bands in the affected area.

Looses due to fungal rot of tomato: Significant yield losses have been documented due to different types of fungal rots of tomato. Yield losses of 30-90%, 18-25% and 20-25% have been reported in Himachal Pradesh, Karnataka and Haryana of India due Buckeye rot of tomato (Sharma, 1971; Sokhi and Sohi, 1982; Thareja *et al.,* 1989). Jaworski *et al.* (1977) reported crop losses in the range of 25-50% due to *P. infestans*

in USA. Sharma (1994) reported that the incidence of fungal rot in tomato fruits from vegetable markets and stores houses was 0.5-19.7% and 81.3% of the total spoilage due to *Fusarium equisetica*, *F. pallidoroseum*, *Geotrichum candidum*, *Didymella lycopersici*, *Alternaria alternata* and *Phytophthora nicotianae* var. *parasitica*. Mallek *et al*. (1995) reported that *A. alternata*, *Rhizopus stolonifer* and *Aspergillus niger* were the most common pathogens and caused loss of 52.7%, 35.9% and 25% in tomato fruit in Egypt. Fontma *et al*. (1996) reported that despite weekly sprays, crop losses due to *A. solani* and *P. infestans* ranged from 12-67 % in early season and 14-52 % in the late season. Byrne *et al.* (1997) recorded 91.8 % losses by Phytophthora rot (*P. infestans*) and 30-70% by anthracnose ripe rot (*C. coccodes*) in USA.

Pathogenicity: Literature revealed that several methods of inoculation have been adopted by different workers for confirming the pathogenicity of the causal fungi isolated from collected rotten tomato fruits. Granger and Horne (1924), checked pathogenicity by a well method. They also studied the pathogenicity levels by injuring the fruits inflicting shallow wounds with a curved scalpel. Jones and McCarter (1947) conducted pathogenicity test of different causal fungi on tomato. Cork borer prick method of Hasija and Batra (1979) performed pathogenicity test on raw and ripe tomato fruits. Their findings indicated that the *Phoma destructiva* pathogen was a wound parasite and observed that more disease severity in ripe than in raw fruits. Yen Hui *et al*. (1994) studied the biology and pathogenicity of *Alternaria solani* on tomato and revealed that wounds as a necessary for successful invasion of pathogen. Kwon *et al*. (2008) observed on the basis of pathogenecity test that infection of *Penicillium oxalicum* on tomato occurred through wounds and cracks on the tomato fruits. Taskeen-un-Nisa *et al*. (2011) also revealed that infection of various fungi on tomato occurred through wounds and cracks on the tomato fruits.

Disease control with fungicides: In earlier studies, much thrust for the control to tomato fruit rot diseases was given to chemical sprays. Dharamvir *et al.* (1967) observed that post harvest dips in aureofungin prolonged the life of tomato fruits by 11-12 days from the attack of *Alternaria* rot which generally occurred naturally within 2-3 days in untreated fruits. Chlorothalonil, maneb and mancozeb have been found most effective when applied as protective sprays against fungal fruit rots (Jones, 1973). Chlorothalonil sprays have been suggested against anthracnose fruit rot of tomato by Byrne *et al.* (1997). Daradhiyar (1980) reported that difolatan 80WP, captafol 80WP, phenylphenolate and aureofungin were effective in controlling fruit damage by *A. alternate* on tomato when applied as post-inoculation dips at 200 mg L^{-1} or more.

Various fungicides have been used for controlling post harvest fruit rot diseases caused by many fungi in storage houses and markets (Kassim, 1980; Monga, 1990; Bharadawaj, 1991; Bharadawaj *et al*., 1995). Khalid *et al.* (1995) achieved best control of *Phytophthora* disease with sandofan-M (mancozeb + oxadixyl) as compared to captan 50WP, chlorothalonil and mancozeb. Shyam and Gupta (1996) recommended a schedule consisting of single spray of Ridomil MZ-72 (metalaxyl + mancozeb) followed by two sprays of mancozeb, captan or copper oxychloride for the economic and effective management of fruit rots caused by *P. nicotanae* var. *parasitica* and *Alternaria* rot. Cohen *et al.* (1997) reported that fungicidal products of systemic and non-systemic fungicides have proved least effective for the control of fruit rots, initiated by *Phytophthora* spp.

Garlic and neem were also reported as effective bio-fungicides against different rot fungi (Tiwari and Nayak, 1991). Patel *et al.* (2005) results revealed that copper oxychloride and mancozeb were more effective in inhibiting the growth and spore germination of *Alernaria*. Gutierrez *et al*. (2006) findings indicate most of *Colletotrichum* isolates were sensitive to azoxystrobin, chlorothalonil, and mancozeb. However, some *Alternaria* isolates were less sensitive to azoxystrobin and chlorothalonil than the *Colletotrichum* isolates. Sharma (2006) evaluated several fungicides such as carbendazim, mancozeb and captan for the control of storage rot of tomato caused by various *Fusarium* species. Banyal (2008) evaluated ten fungicides such as carbendazim, mancozeb, captan, chlorothalonil, thiabendazole, carboxin, campanion, propineb, tebuconazole and indofil M-45 for the control of collar rot of tomato caused by *Sclerotium rolfsii.* Other reports also suggest the effective control of fungal rot of tomato with fungicides (Patel and Patel, 1991; Dillard and Cobb, 1997; Lewis *et al*., 2002; Taskeen-un-Nisa *et al*., 2011).

Conclusion

It was concluded from the above comprehensive review that fungal rot of tomato is caused by several pathogenic fungi under storage conditions. Many studies have been carried out with respect to occurrence, causal organisms, severity, losses, pathogenecity and disease control

with fungicides. This review may help the future researchers to devise a concrete strategy for evaluating different pathological aspects and management of the post harvest fungal diseases of tomato. However, further study is needed to reveal all the other recent reports about various pathological aspects on the fungal rot of tomato and management strategies opted for post harvest diseases of tomato**.**

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