Fungi on Citrus from India

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Next to Mango and Banana, *Citrus* represents the third largest fruit industry of India and ranks 6th among the *Citrus* growing countries of the world. The principal regions of citrus cultivation in India lie in Madras, Madhya Pradesh, Maharashtra, Assam and Mysore.

Citrus fruits are esteemed primarily as articles of diet. They also provide a large number of commercial products such as essential and fatty oils (orange oil, lemon oil, lime oil etc.), citric acid, malic acid, minerals (Calcium, phosphorus and iron), glycosides, pectins, anthocyanins, B-carotine, Vitamin C & B, sucrose and other reducing sugars etc. Fruits are converted into beverages (juices, squashes etc.) and also some canned commercial products.

Oranges are the most refreshing delicious, wholesome and growth promoting juicy fruits. Limes and lemons are rich in vitamins, minerals and salts but are highly acidic. Their juice is mixed with sugar for the popular summer drink "the sherbat". They are also largely used for making pickles and thus preserved throughout the year. Oils obtained from orange, lemon and lime are used for flavouring purposes and also have some medicinal properties.

Citrus trees and fruits are subject to a number of diseases in the field as well as storage incited by fungi, bacteria and viruses of which the fungal diseases predominate. As a result, heavy crop losses are experienced by the orchard owners and also by the 'Fruit Canning Industries'. A number of fungi have been reported on various citrus species from India, an account of which has been published from time to time. A perusal to the 'Indian Literature' shows the scattered nature of this information. Attempt has been made to bring all this information in a single publication, which will serve as useful reference work for future investigators.

The present paper aims to give an up-to-date list of "Fungi" reported on various *Citrus* spp. from India so far, together with nature of diseases incited by them and relevant literature on the subject.

It is hoped that a publication of this nature would be of great value to the mycologists, plant pathologists, horticulturists and also to the plant protection and quarantaine authorities.

The *Citrus* species as well as the Fungi affecting them are arranged alphabetically.

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A statement showiig different Fungi responsible for diseases of Citrus in India

1. Causal Fungi	2. Nature and Type of Disease. — Remarks	
I. *Citrus acida* var. *variegata* L.		
Colletotrichum gloeosporioides Penzig	Leaf blight	Rai (1956) reported from Lucknow (U. P.)
II. *Citrus assamensis* Bhattacharya & Datta.		
Septobasidium pseudopedicellatum Burt.	'Felt' disease	Common and widespread in Assam, Chowdhury (1951).
III. *Citrus aurantifolia* (Christm.) Swingle		
Aschersonia raciborskii Zimm.	—	On *Aleyrodes* infecting the leaves, Banares (U. P.) and also reported by Uppal et al (1935).
Diplodia citrina Diedike	Twig blight	Reported by Uppal et al (1935).
Diplodia natalensis Evans	Twig blight & Fruit rot	General.
Fusarium solani f. sp. *aurantifoliae* (Bhat. & Prasad)	Wilt	Also, a twig disease in Rajasthan, Bhatnagar & Prasad (1966).
Gloeosporium limetticolum Clausen	Anthracnose & Fruit-fall	Studied in detail by Agarwala & Tandon (1957) from Allahabad (U. P.).
Meliola butleri Syd.	Sooty mould	Covers the leaves and fruits, General.
Phyllosticta aurantiicola (Berk. & Cke.) Sacc.	Leaf spot	Lele et al (1968) reported from Delhi in a severe form.
Pleosphaeria citri Arnaud	Leaf spot	Recorded from Poona, Uppal et al (1935).
Trametes cervina (Schw.) Bres.	Limb-break	From North Arcot & Cuddappah (Ramakrishnan, 1955).
Tryblidiella rufula (Spreng.) Sacc.	Canker & Die-back.	An Ascomycete on dead twigs, Cuttack (Orissa), Also reported causing canker & die-back in Rajasthan (Bhatnagar & Prasad, 1966).
IV. *Citrus aurantium* L. (Sour, Bitter orange)		
Alternaria tenuis Auct.	Fruit rot	General.

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Botryodiplodia theobromae Pat.	Soft rot & twig blight.	General.
Cephalosporium sp.	Fruit rot	Reported rarely in literature.
Colletotrichum gloeosporioides Penz.	Anthracnose & Die-back.	General throughout India.
Daldinia eschscholzii (Ehrenb.) Rehm.	Charcoal rot	On wood, reported from Nagpur.
Diplodia indica Diedicke	Saprophyte	Reported on bark (Poona).
Haplosporella hesperidica Speg.	Saprophyte	Reported from Coorg (Mysore) on dead branches.
Illosporium citri Muthappa.	Saprophyte	On dead twigs, Coorg Forests (Mysore), Muthappa (1966 a).
Meliola butleri Syd.	Sooty mould	General distribution.
Meliola camelliae (Catt.) Sacc.	Sooty mould	Reported from Dehra Dun, Pusa etc.
Nigrospora oryzae (Berk. & Br.) Petch.	Saprophyte	Reported by Srivastava et al (1964) in storage.
Oidium tingitanium Carter	Powdery mildew.	Reported from Kotagiri & Shevroy hills of S. India. The fungus covers leaves, twigs and fruits and causes drying.
Oospora citri-aurantii (Ferrar) Sacc. & Syd.	Slimy fruit rot	General in storage.
Pellicularia alba (Dast.) Dastur (Syn = *Corticium album* Dastur)	Pink disease	On living stems, Burhanpur (M. P.), Dastur (1940).
Pellicularia salmonicolor (Berk. & Br.) Dastur (Syn = *Corticium salmonicolor* Berk. & Br.)	Pink disease	Severe in high rainfall tracts of Assam, Balanghat (M. P.), as reported by Dastur (1941) and also at North Arcot & Chittoor Districts of Madras.
Phytophthora palmivora Butler	Fruit decay, Gummosis.	General.
Phytophthora parasitica Dastur	Fruit decay	General.
Penicillium fellutanum Biourage	Fruit decay	General.
Sphaceloma fawcetti Jenkins	Scab (Ashy)	On leaves and fruits, general, first recorded by Patel, Kamat & Bhide (1949), Poona.

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V. *Citrus crysocarpa* Lushington		
Alternaria citri Pierce	Leaf spot	Reported from Kalimpong (W. Bengal).
Aspergillus niger van Tiegh.	Fruit rot	Reported from Kalimpong (W. Bengal).
Botrytis cinerea Pers.	Fruit rot	Reported from Kalimpong (W. Bengal).
Cladosporium herbarum Lk. var. *citricola* Fawcett & Burger	Fruit rot	Reported from Kalimpong (W. Bengal).
Fusarium moniliforme Sheldon	Fruit rot	Reported from Calcutta (W. Bengal)
Penicillium digitatum Sacc.	Fruit rot	Reported from Kalimpong (W. Bengal).
Penicillium expansum Link.	Fruit rot	Reported from Kalimpong (W. Bengal)
Penicillium italicum Wehmer	Fruit rot	Reported from Kalimpong and Allahabad.
Stysanus monilioides (Alb. et Schw.) Corda	Fruit rot	Reported from Kalimpong, Darjeeling (W. Bengal) by Roy (1941).
Trichoderma lingorum (Tode) Herz.	Fruit rot	Reported from Kalimpong (W. Bengal).
VI. *Citrus limonia* Risso		
Calosphaeria fici Kale	Saprophyte	On dead branches, Bhir (Maharasthra), Kale (1967).
Curvularia tuberculata Jain.	Die-back	Serious disease, reported recently from Delhi (Lele et al 1968).
Alternaria citri Pierce	Leaf spot	General, Agarwal & Hasija, reported from Jabalpur (1961).
VII. *Citrus limonum* (L.) Brum.		
Alternaria citri Ell. & Pierce.	Leaf spot & fruit rot	General.
Fusarium limonis Briosi	Seedling disease	Rare occurrence.
Fusarium lateritium Nees.	Root & Stem rot	Allahabad and Dehra Dun (U. P.)
Phyllosticta desciformis Penz.	Leaf spot	Reported by Roy (1968) from Borbheta (Assam).
Hysterium citricola Tilak & R. Rao.	Saprophyte	An Ascomycete on dried stems (Tilak & R. Rao, 1966) described this from Aurangabad (Maharashtra).

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VIII. *Citrus maderaspatana* Hort. ex Tanaka		
Diplodia sp.	Saprophyte	Recorded on the branches.
Sporocybe hybrida Mason	—	Isolated from the roots, Madras.
IX. *Citrus maxima* (Burm.) Merrill (Shaddock) (= *Citrus decumana* L. = *C. grandis* (L.) Osbeck)		
Diplodia natalensis Pole Evans	Twig blight & Fruit rot	General.
Helminthosporium sp.	Fruit spots	Rare, Tandon & Varma (1964).
Hypoxylon deustum (Hoff. ex Fr.) Grev.	Charcoal Stump-rot	Reported by Agnihothrudu (1964) from Toklai (Assam).
Pestalotia citri Mundk. & Kheswalla	Leaf spot	Recorded from Kirkee, Poona.
Phoma nainiensis Bilgrami	Leaf spot	Reported from Naini (Allahabad), described by Bilgrami (1963).
Pleospora herbarum (Pers.) Rabenh.	Leaf spot	Reported from Allahabad by Bilgrami (1963).
Phomopsis citri Fawcett	Melanose	Widespread in Assam with high rainfall (Chowdhury 1955).
Sclerotium rolfsii Sacc.	Die-back	Reported from Kottayam (Kerala), attack branches.
Septobasidium pseudopedicellatum Burt.	Felt disease	First reported by Chowdhury (1951) from Assam.
Sphaceloma fawcetti Jenkins	Scab	General.
X. *Citrus medica* L.		
Alternaria citri Ell. & Pierce.	Black rot	General in storage. Recently reported by Agarwal & Hasija (1967) from Jabalpur.
Ascochyta citri Penz.	Leaf spot	Reported from Kumaon (U. P.)
Chaetomium orientum Saha	Saprophyte	On wood (Saha 1964).
Colletotrichum gloeosporioides Penzig.	Anthracnose & wither tip or die-back	Throughout India.

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Diplodia citrina Died.	Root rot	Reported from Sholapur (Maharasthtra), rare.
Fusarium semitectum Berk. & Rav.	Fruit rot	Allahabad (U. P.)
Gloeosporium spegazzinii Sacc.	Anthracnose	Allahabad (U. P.)
Melanomma citricola Syd. & Butler	Black bark spot	Barnihat (Assam)
Mycosphaerella citricola Tilak	Leaf-blight	First described by Tilak (1963) from Poona.
Septoria cattanei Thuem.	Leaf spot	Kanara (Mysore).
Tryblidiella rufula var. *microspora* Ell. & Ev.	Saprophyte	An Ascomycete on dead twigs, Varanasi (U. P.)
XI. *Citrus medica* var. *acida* L. (Lemon, Nimbu)		
Aspergillus niger v. Tiegh.	Soft rot	General on fruits, in storage.
Botryodiplodia theobromae Pat.	Fruit rot	General on fruits.
Cladosporium herbarum (Pers.) Link	Fruit spot	Tandon & Varma from Allahabad (1964).
Curvularia lunata (Wakker) Boedijn	Fruit spot	Tandon & Varma from Allahabad (1964).
Fusarium semitectum Berk. & Rav.	Soft rot (Fruits)	General.
Geotrichum candidum Link.	Waxy rot	General, first report by Rao (1966) from Poona.
Glomerella cingulata (Stonem.) Spauld. & Shrenk.	Anthracnose	General.
Memnoniella echinata (Riv.) Galloway	Soft rot	On fruits in storage.
Meliola amphitricha Fr.	Sooty mould.	On leaves, Calcutta.
Phoma macrophoma McAlp.	Wither-tip.	On twigs and branches, with dark pustules.
Phyllostica limonum Lucas & Da Camara.	Leaf blight	First reported by Rao (1964) from India.
Sphaeropsis tumefasciens Hedges & Tenny.	Leaf spot, tumors or branch knots.	First discovered by Prasad & Bhatnagar (1961), from Ajitgarh (Rajasthan), also at Jabalpur (M. P.).
XII. *Citrus nobilis* Lour. var. *deliciosa* Sw.		
Diplodia natalensis Pole Evans.	Fruit rot	General.
Phytophthora palmivora Butler	Fruit rot	General.

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XIII. *Citrus paradisi* Macf. (Grape Fruit) or *Papnas.*		
Elsinoë fawcetti Bitanc. & Jenkins.	Leaf spots	Reported from Kallar (Madras).
Geotrichum candidum Link.	Waxy rot in storage.	General on fruits.
Gloeosporium citri Cke. & Mass.	Fruit rot	General.
Pythium debaryanum Hesse	Seedling rot.	Kanpur (U. P.).
Rhizoctonia solani Kuehn.	Seedling rot.	Kanpur (U. P.)
Uredo citri Cooke	Rust.	Alisagar (Hyderabad Dn.), Reported by Vaheeduddin (1955).
XIV. *Citrus reticulata* Blanco (Mandarin orange) (= *C. nobilis* Lour.) *Alternaria tenuis* Auct.		
	Black core rot.	General, detailed studies by Singh & Khanna (1966).
Meliola butleri Syd.	Sooty mould.	General.
Penicillium digitatum Sacc. (Green mould)	Fruit rot	General.
Penicillium italicum Wehmer (Blue mould)	Fruit rot	General.
Phomopsis citri Fawcett	Melanose	Widespread in Jorhat, Burnihot (Assam), Chowdhury (1955).
Phytophthora palmivora Butler	Leaf fall & fruit rot	Serious at moist zones of Wynad & Coorg, (S. India).
Septobasidium pseudopedicellatum Burt.	'Felt' disease	Wide-spread in Assam. (Chowdhury 1951).
Uromyces nilagiricus Ramakr. T. S. & K.	Rust.	On leaves of Loranthus sp. parasitic on *Citrus reticulata*, Kotagiri (Madras).
Rhizoctonia bataticola (Taub.) Butler.	Fruit rot	First reported by Parashar & Chohan (1966) from Ludhiana (Punjab).
XV. *Citrus sinensis* (L.) Osbeck. (*Musambi*) (Lemon, Sweet orange)		
Alternaria citri Pierce	Leaf spot & fruit rot.	General. First recorded by Uppal, Patel & Kamat from Poona (1935).

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Aspergillus fumigatus Fres.	Fruit	Sinha (1964).
Botryodiplodia theobromae Pat.	Leaf spot & fruit rot	General.
Colletotrichum gloeosporioides Penz.	Anthracnose	Common.
Diplodia indica Died.	Bark infection.	Poona. (Uppal, Patel, Kamat, 1935).
Diatrypella verruciformis (Ehr.) Nke.	Saprophyte	On dead branches, Muthappa (1966).
Fusarium moniliforme Sheldon	Fruit rot.	General, first recorded by Ghatak (1938).
Fusarium solani (Mart.) App. & Wollenw.	Twig blight.	Darjeeling and Sikkim (Chatopadhyay & Sen Gupta 1967).
Gloeosporium citri Cke. & Mass.	Anthracnose	General.
Haplosporella cosmopolitus Muthappa	Saprophyte	On dead branches at Coorg, Muthappa (1966).
Illosporium citri Muthappa	Saprophyte	On dead twigs at Coorg, Mysore, Muthappa (1966).
Meliola citricola Syd.	Sooty mould	General.
Nectria heterosperma Kalchbr. & Cooke.	Cankers (Orange)	On branches causing die-back. Bombay (Uppal et al, 1935).
Phomopsis citri Fawcett (Perfect = *Diaporthe citri* (Fawcett) Wolf)	Melanose	Widespread in Assam (Chowdhury 1955 b).
Phytophthora palmivora Butler	Gummosis.	Detailed study by Uppal & Kamat (1936), a leaf fall disease by Devarajan & Aiyappa 1945) from Coorg.
Rhizoctonia bataticola (Taub.) Butler	Fruit rot	General.
Rhizopus stolonifer (Fr.) Linder	Fruit rot	General.
Rosselinia bunodes (Berk. & Br.) Sacc.	—	Recorded by Uppal, Patel & Kamat (1935), Bombay.
Septobasidium citricolum Sawada	Black felt.	General.
Trametes cervina (Schw.) Bres. (Agaricales)	Limb breakage	Reported from N. Arcot & Cuddapah (Andhra) by Ramakrishnan (1955).
Trichurus gorgonifer Bain.	Fruit infection	Calcutta (West Bengal).
Tryblidiella rufula (Spreng.) Sacc.	Saprophyte	An ascomycete on dry twigs, at Coorg (Mysore).

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XVI. *Citrus* sp.		
Aspergillus fumigatus Fres.	Damping-off.	A seedling disease, recently reported by Lele et al. (1967) from New Delhi.
Botrytis cinerea Pers.	Gray-gummosis.	A serious disease in Assam.
Capnodium citri Berk. & Desm.	Sooty mould	On leaves and fruits, General.
Cercospora penzigii Sacc.	Leaf spot.	Pusa (Bihar).
Chaetomium sp.	Saprophyte	Rarely reported.
Cladosporium herbarum Link.	Black mould.	On leaves and fruits, common in Assam.
Colletotrichum capsici (Syd.) Butler.	Anthracnose	On leaves and fruits, reported from Bihar.
Curvularia lunata (Wakker) Boedijn.	Leaf spot	Chaudhuri (1936) from Punjab.
Cytospora citri Died.	Leaf spot	On fading leaves, Pusa (Bihar).
Macrophoma paraphysata	—	Reported by Lal (1960) from Bombay.
Dothiorella phaseoli (Maubl.) Petr.	Root rot	From Poona (Uppal, Patel & Kamat, 1935).
Phoma macrophoma McAlp.	Twig blight	From Poona (Uppal, Patel & Kamat, 1935).
Pleospora herbarum (Pers.) Rabenh.	Leaf spot	General.
Pythium debaryanum Hesse	Damping-off	Seedling disease in nursery (Srivastava & Singh, 1954).
Rhizoctonia solani Kuhn.	Damping-off	Seedling disease in nursery (Srivastava & Singh, (1954).
Rhizopus sp.	Fruit rot	General.
Rhynchodiplodia citri Briosi & Farnetti	Fruit rot	Reported by Uppal, Patel & Kamat (1935), from Poona.
Rhytidhysterium rufulum (Spreng.) Petrak.	Saprophyte	An Ascomycete, rare.
Sporocybe hybrida Mason.	Root infection	Reported from Madras.
Tryblidiella rufula (Spreng) Sacc.	Saprophyte	An Ascomycete on dead branches, Pulliyanur (Travancore-Cochin).