

## 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-carotene, 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 quarantine authorities.

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

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

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

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

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

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

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

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



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

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

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