



## Diversity, host association and taxonomic checklist of rust fungi (Pucciniales) from Pandharpur, Maharashtra, India

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### Abstract

Rust diseases caused by the obligate parasitic fungi belonging to the order Pucciniales of class Basidiomycota are the most damaging and disturbing to farming, gardening, forestry and wild plant species. These fungal pathogens have complex life cycles, host specificity and adaptability to altering environmental conditions, making their control particularly difficult. The present study provides a comprehensive checklist of rust diseases recorded on various host plants, aiming to document pathogen diversity, host range, symptoms and distribution patterns.

The checklist was prepared based on regular field surveys conducted across diverse locations, collection and microscopic analysis of infected plant materials and critical analysis of present literature. Rust-infected samples were identified using morphological characteristics such as uredospore, teliospores and sori structure, supported by regular taxonomic keys. Each checklist entry includes the scientific name of the host plant, rust pathogen, family and relevant taxonomic explanations. A total of 87 rust fungal species belonging to 14 genera were documented, infecting 93 host plant species. The results expose a high degree of host specificity among rust pathogens. Rust diseases affecting cereals, crops and ornamental plants were recorded, emphasising their potential threat to crop production and superiority.

The checklist identifies rust diseases linked with climate variability, agricultural practices and cropping patterns, showing that high humidity and suitable temperatures promote spore germination and disease spread.

**Keywords:** Host specificity, pathogen checklist, pathology, rust, fungal diversity

### Introduction

India is regarded as a biodiversity-rich hotspot for a diverse range of plants and animals due to its diverse climatic conditions and different seasons. This diversity and variability serve as important factors in the growth and development of various plant pathogenic fungi. Because of this, a broad range of rust fungi has been observed in the country <sup>[1]</sup>. The Rust diseases are generally caused by the obligate parasitic fungi belonging to the order Pucciniales of class Basidiomycota.

The variability in climatic conditions and biological diversity is important in the growth and development of various plant pathogenic fungi. The broad diversity of rust fungi has also been observed in the country due to the availability of favourable agro-climatic conditions required for the initiation of infection and disease development <sup>[1]</sup>. Rust fungi (*Basidiomycota*, *Pucciniales*) are a highly diverse group of obligate biotrophic parasites, distributed in all geographical areas on a wide range of wild and cultivated plants ranging from ferns, Gymnosperms and Angiosperms <sup>[4]</sup>.

These fungi are a unique and fascinating group of organisms that possess diverse structures (spermogonia, two anamorphs, teleomorphs and basidiospores) in their life cycle <sup>[4]</sup>. Because of their obligate parasitic nature, actively growing rusts survive only on living hosts and produce teliospores towards the end of the growing season <sup>[4]</sup>. Rusts are distributed across all geographical areas on wild and cultivated plants <sup>[3]</sup>. The rust fungi have a long research history, largely due to their economic importance in

agriculture and forestry and to their easily noticeable symptoms.

Rust diseases, characterized by the most damaging groups of plant diseases, are identified by the production of diverse rust-colored spots on diseased plant parts, such as leaves, stems, and petioles. Rust pathogens have high host specificity and complex life cycles. The disease involves several spore stages, which enable their determination and spread under favourable environmental conditions. As a result, rust diseases contribute significantly to crop yield damage, deterioration of produce quality and increased management costs.

Most of the rust fungi reported from India were characterized mainly based on the morphological characters of uredia and telia or other successive stages observed on collected samples. However, rust fungi reported from India lack molecular studies <sup>[4]</sup>.

The study area has climatic diversity, rich floral wealth and substantial diversity of rust fungi. Several species of *Puccinia*, *Uromyces*, *Ravenelia* and related genera have been reported on economically important crops, weeds and ornamental plants. Even though this richness, region-specific documentation of rust diseases remains split, mainly at the tehsil or local level. Such local studies are essential for understanding host-pathogen dispersal patterns, disease occurrence and the environmental adaptability of rust fungi.

Pandharpur tehsil, situated in Solapur district of Maharashtra, is an agriculturally significant region characterized by semi-arid climatic conditions, seasonal

rainfall and farming of diverse crops such as cereals, pulses, oilseeds, vegetables and fodder plants. In addition to cultivated flora, the region supports a variety of wild and weed species that can act as alternative hosts or reservoirs for rust pathogens. However, systematic information on the occurrence, host range and diversity of rust diseases in Pandharpur tehsil is largely undocumented.

Preparation of a checklist of rust diseases serves as an essential step in documenting fungal biodiversity and plant disease status of a particular region. Such a checklist provides reference line data on rust fungi and their associated host plants, facilitating future studies on disease epidemiology, pathogen evolution, and climate-related disease dynamics. Moreover, it supports agricultural extension programs by educating disease diagnosis and controlling effective management strategies for farmers and plant protection agencies.

The present study aims to collect a comprehensive checklist of rust diseases occurring in Pandharpur tehsil based on wide field surveys, symptom observation, microscopic examination, and review of available literature. This documentation is expected to improve regional plant pathology records, contribute to national rust fungi records and provide valuable reference material for researchers, educators and agricultural experts.

## Materials and Method

The identification of rust fungi pathogens was done based on the Monograph of rust by Gautam *et al.* (2021) [4].

### 1. Collection of Specimens

The infected host plant materials showing rust symptoms were collected from different field locations of Pandharpur tehsil during year around 2023-2025. Each specimen was carefully documented with field notes and photographs. Collected samples were pressed, dried and preserved following standard herbarium techniques for further examination, microscopic record and reference. All the rust infected specimens have been deposited in Department of Botany, K.B.P. Mahavidyalaya, Pandharpur (Autonomous). All the slides (semi-permanent) have been stored in boxes & deposited in the Botany Department, K.B.P. Mahavidyalaya, Pandharpur.

### 2. Identification of Host Plants

The identification of rust host plants by using standard regional floras, including Flora of Solapur by Dr. S. P. Gaikwad, Flora of Kolhapur by Dr. S. R. Yadav, and Flora of the Bombay Presidency by Cooke. Taxonomic confirmation was done by comparing morphological characters with descriptions provided in these references.

### 3. Identification of Rust Pathogens

The pathogens were identified based on their morphological characteristics by referring to standard mycological identification & relevant literature. Identification was carried out using authoritative literature.

### 4. Slide Preparation and Microscopy

Collections were first examined under the dissecting microscope to see the nature of the infection, sporulation

structures, different spore - states, effects on the host or organs as a result of infection etc.

Then these collections were critically studied with the help of light compound microscope after taking the sections or the scrapping of the spores by usual mycological laboratory methods, spores (pycniospores, aeciospores, urediniospores and teliospores) were mounted firstly in water and then in lacto phenol or glycerine to see their normal size, pigmentation, ornamentations etc. as semi-permanent mountings by slightly warming on spirit lamp flame with stain or without the stain and then sealed by usual sealant.

Many such semi-permanent slides were prepared from these collections of the individual taxon (collection) to note the range of variations. Heavily pigmented or dark spores especially urediniospores or teliospores, e.g. Ravenelia, Uromyces, Puccinia etc., were bleached with different chemicals (1-5% solution) such as KMNO<sub>4</sub> or H<sub>2</sub>O<sub>2</sub> to see their detailed structures *viz.* thickness of wall, wall-layers, ornamentation, pores etc.

Freehand sections were taken passing through the sorus/sori and were stained with 1% cotton blue prepared in lactophenol. These slides were sealed and labelled for a detailed study of the pathogen, examining the location of the sorus, characteristics of the spores, and any accessory structures. The investigation also included the potential impact of the infection on the host plant's cells, tissues, or organs.

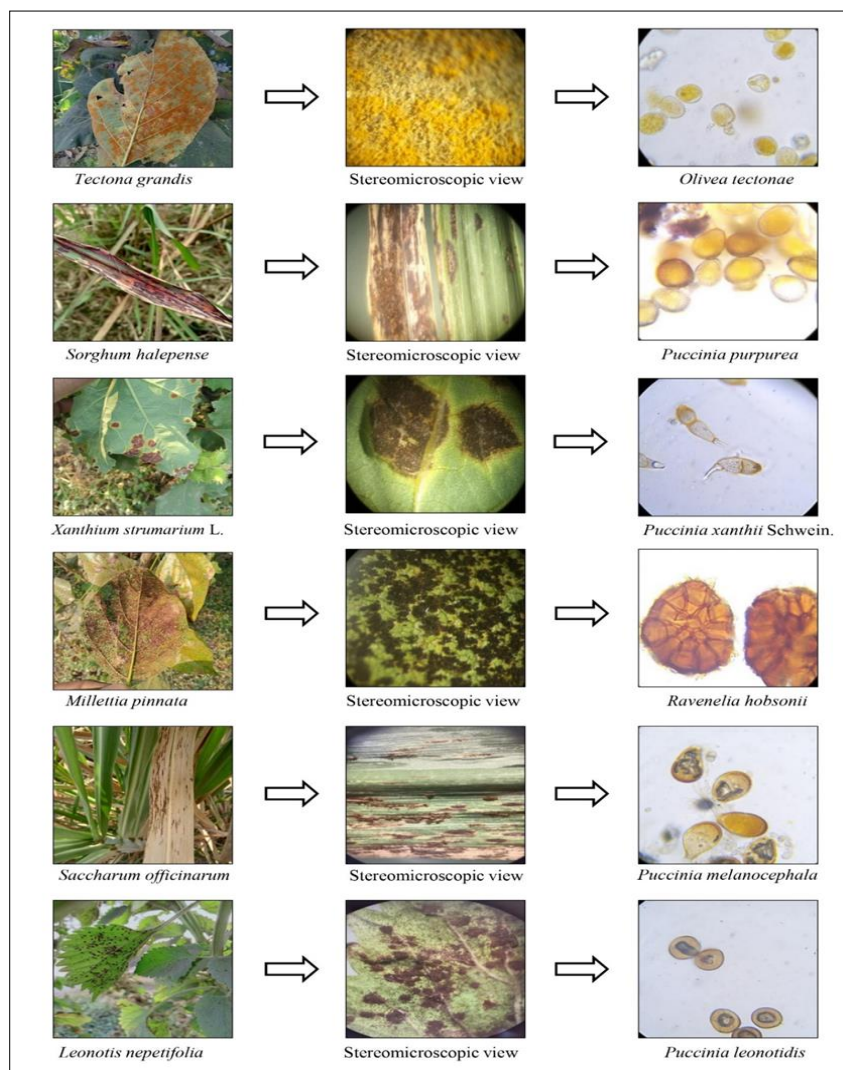
Temporary and permanent slides of infected plant tissues were prepared to study rust spores and sori structures. Microscopic photographs were taken using a Micron Optic BINOC XL 100× microscope attached to an industrial digital camera unit (Model No. E3ISPM20000KPA).

## 5. Documentation and Analysis

All specimens were documented through field photography, macroscopic examination and microscopic imaging. Morphological features such as spore shape, size, ornamentation and sori arrangement were analyzed and compared with standard descriptions for accurate identification.

## Results and Discussion

Considerable variation of rust fungi from 87 rust fungal species belonging to 14 genera was observed in the study area. There have been reports of these fungal taxa from about 93 host plant species. Puccinia has 38 species, making it the most specious, followed by Uromyces (22), Ravenelia, Phakopsora (each 7), Phakopsora (6), Aecidium, Cerotelium, Coleosporium (each 4), Uredo (3), Melampsora, Aecidium, Phragmidium, Austropuccinia, Olivea (each 2), Kweilingia, Maravalia (each 1). Among the documented host plants, members of the family Fabaceae (24), Poaceae (10) and Asteraceae (8) have the highest incidence of rust fungi; all other families show low incidence. Greater disease susceptibility was observed in plant families such as Fabaceae, Poaceae and Asteraceae, possibly due to their high species diversity and continuous availability throughout the year.



**Fig 1:** Rust fungus on leaf: Disease symptoms on host leaf, stereomicroscopic appearance of pustules and microscopic features of spores

**Table 1:** Host plants and their respective families along with associated rust fungal pathogens

Sr. No.	Name of host plant	Host plant family	Name of rust pathogen
1.	<i>Alternanthera bettzickiana</i> (Regel) G.Nicholson	Amaranthaceae	<i>Uromyces alternantherae</i> (Syd.) Arthur
2.	<i>Albizia lebbek</i> (L.) Benth.	Fabaceae	<i>Ravenelia clemensiae</i> Syd.
3.	<i>Allium cepa</i> L.	Amaryllidaceae	<i>Puccinia allii</i> (DC.) Rudolphi
4.	<i>Allium sativum</i> L.	Amaryllidaceae	<i>Puccinia allii</i> (DC.) Rudolphi
5.	<i>Arachis hypogaea</i> L.	Fabaceae	<i>Puccinia arachidis</i> Speg.
6.	<i>Barleria prionitis</i> L.	Acanthaceae	<i>Uredo barleriae</i> Cooke
7.	<i>Brachiaria plantaginea</i> (Link) Hitchc.	Poaceae	<i>Uromyces setariae-italicae</i> Yoshino
8.	<i>Bambusa vulgaris</i> Schrad. ex J.C.Wend L.	Poaceae	<i>Kweilingia divina</i> Syd.
9.	<i>Bauhinia purpurea</i> L.	Fabaceae	<i>Uromyces bauhiniae</i> Cooke
10.	<i>Bidens pilosa</i> L.	Asteraceae	<i>Uromyces bidentis</i> Lagerh.
11.	<i>Boerhavia diffusa</i> L.	Nyctaginaceae	<i>Puccinia boerhaviicola</i> Tranzschel
12.	<i>Canna indica</i> L.	Cannaceae	<i>Puccinia thaliae</i> Dietel
13.	<i>Cannabis sativa</i> L.	Cannabaceae	<i>Uredo kriegieriana</i> Magnus.
14.	<i>Cajanus cajan</i> (L.) Millsp.	Fabaceae	<i>Uromyces cajani</i> Syd.
15.	<i>Cassia tora</i> L.	Fabaceae	<i>Uromyces cassiae</i> Cooke
16.	<i>Cassia fistula</i> L.	Fabaceae	<i>Ravenelia hobsonii</i> . Syd.
17.		Fabaceae	<i>Ravenelia</i> sp.
18.	<i>Cassia auriculata</i> L.	Fabaceae	<i>Ravenelia humphreyana</i> Syd.
19.	<i>Caesalpinia pulcherrima</i> (L.) Sw.	Sapindaceae	<i>Puccinia arechavaletae</i> Speg.
20.	<i>Cardiospermum halicacabum</i> L.	Cucurbitaceae	<i>Puccinia citrulli</i> Henn.
21.	<i>Citrullus colocynthis</i> (L.) Schrad.	Boraginaceae	<i>Aecidium</i> sp.
22.	<i>Cordia dichotoma</i> G. Forst.	Asteraceae	<i>Puccinia chrysanthemii</i> Roze
23.	<i>Chrysanthemum morifolium</i> Ramat.	Fabaceae	<i>Phakopsora pachyrhizi</i> Syd. & P. Syd.
24.	<i>Crotalaria verrucosa</i> L.	Poaceae	<i>Puccinia duthiae</i> Ellis & Tracy
25.	<i>Chrysopogon velutinus</i> (Hook.f.) Bor	Fabaceae	<i>Uromyces ciceris-arietini</i> (Grognot) Jacz.
26.	<i>Cicer arietinum</i> L.	Asteraceae	<i>Puccinia carthami</i> Corda

27.	<i>Carthamus tinctorius</i> L.	Amaranthaceae	<i>Uromyces chenopodii</i> (Pers.) J.Schröt.
28.	<i>Chenopodium album</i>	Cucurbitaceae	<i>Puccinia</i> sp.
29.	<i>Coccinia grandis</i> (L.) Voigt	Cyperaceae	<i>Puccinia philippinensis</i> Syd. & P. Syd.
30.	<i>Cyperus rotundus</i> L.	Fabaceae	<i>Maravalia achroa</i> Syd.
31.	<i>Dalbergia latifolia</i> Roxb.	Acanthaceae	<i>Puccinia ruelliae</i> Syd.
32.	<i>Dipteracanthus prostratus</i> (Poir.) Nees	Poaceae	<i>Puccinia duthiae</i> Ellis & Tracy
33.	<i>Dichanthium foveolatum</i> (Delile) Roberty	Euphorbiaceae	<i>Melampsora euphorbiae</i> (Schub.) Castagne
34.	<i>Euphorbia geniculata</i> Ortega	Moraceae	<i>Cerotelium fici</i> E.J.Butler
35.	<i>Ficus benghalensis</i> L.	Moraceae	<i>Cerotelium fici</i> E.J.Butler
36.	<i>Ficus carica</i> L.	Moraceae	<i>Cerotelium fici</i> E.J.Butler
37.	<i>Ficus racemosa</i> L.	Moraceae	<i>Cerotelium fici</i> E.J.Butler
38.	<i>Ficus religiosa</i> L.	Fabaceae	<i>Phakopsora pachyrhizi</i> Syd. & P. Syd.
39.	<i>Glycine max</i> (L.) Merr.	Malvaceae	<i>Puccinia cacabata</i> Arthur
40.	<i>Gossypium herbaceum</i> L.	Malvaceae	<i>Phakopsora pachyrhizi</i> Syd. & P. Syd.
41.	<i>Gossypium arboreum</i> L.	Asteraceae	<i>Puccinia helianthi</i> Schwein.
42.	<i>Helianthus annuus</i> L.	Malvaceae	<i>Puccinia malvacearum</i> Mont.
43.	<i>Hibiscus cannabinus</i> L.	Fabaceae	<i>Uromyces</i> sp.
44.	<i>Indigofera trifoliata</i> L.	Acanthaceae	<i>Aecidium adhatoda</i> Pawar, M.S. & Patel, R.C.
45.	<i>Justicia adhatoda</i> L.	Oleaceae	<i>Uromyces hobsonii</i> Cooke
46.	<i>Jasminum sambac</i> (L.) Aiton	Lamiaceae	<i>Puccinia leucadis</i> Syd.
47.	<i>Leucas aspera</i> (Willd.) Link	Asteraceae	<i>Coleosporium asterum</i> (Dietel) Syd.
48.	<i>Launaea pinnatifida</i> (Cass.) Kuntze	Lythraceae	<i>Uredo lagerstroemiae</i> Syd.
49.	<i>Lagerstroemia speciosa</i> (L.) Pers.	Lamiaceae	<i>Puccinia leonotidis</i> Syd.
50.	<i>Leonotis nepetifolia</i> (L.) R.Br.	Martyniaceae	<i>Puccinia martyniae-annuae</i> Syd.
51.	<i>Martynia annua</i> L.	Nyctaginaceae	<i>Puccinia mirabilis</i> Dietel
52.	<i>Mirabilis jalapa</i> L.	Moringaceae	<i>Puccinia moringae</i> Syd.
53.	<i>Moringa oleifera</i> Lam.	Musaceae	<i>Uromyces musae</i> Syd.
54.	<i>Musa paradisiaca</i> L.	Oxalidaceae	<i>Puccinia oxalidis</i> Dietel
55.	<i>Oxalis corniculata</i> L.	Myrtaceae	<i>Austropuccinia psidii</i> (G. Winter) Beenken
56.	<i>Psidium guajava</i> L.	Poaceae	<i>Puccinia penniseti</i> Zimm.
57.	<i>Pennisetum glaucum</i> (L.) R.Br.	Fabaceae	<i>Uromyces appendiculatus</i> (Pers.) Unger
58.	<i>Phaseolus vulgaris</i> L.	Phyllanthaceae	<i>Ravenelia emblicae</i> Syd.
59.	<i>Phyllanthus emblica</i> L.	Solanaceae	<i>Aecidium physalidis</i> Syd.
60.	<i>Physalis indica</i> L.	Fabaceae	<i>Uromyces viciae-fabae</i> (Pers.) J. Schröt.
61.	<i>Pisum sativum</i> L.	Portulacaceae	<i>Puccinia portulacae</i> DC.
62.	<i>Portulaca oleracea</i> L.	Portulacaceae	<i>Puccinia portulacae</i> DC.
63.	<i>Portulaca quadrifida</i> L.	Plumbaginaceae	<i>Puccinia plankii</i> Syd.
64.	<i>Plumbago indica</i> L.	Apocynaceae	<i>Coleosporium plumeriae</i> Pat.
65.	<i>Plumeria alba</i> L.	Apocynaceae	<i>Coleosporium plumeriae</i> Pat.
66.	<i>Plumeria rubra</i> L.	Fabaceae	<i>Ravenelia hobsonii</i> Cooke
67.	<i>Pongamia pinnata</i> (L.) Pierre	Polygonoaceae	<i>Uromyces rumicis</i> (Schumach.) G. Winter
68.	<i>Rumex vesicarius</i> L.	Rosaceae	<i>Phragmidium tuberculatum</i> J.Müll.
69.	<i>Rosa indica</i> L.	Euphorbiaceae	<i>Melampsora ricini</i> (Biv.) Castagne
70.	<i>Ricinus communis</i> L.	Fabaceae	<i>Uromyces phaseoli</i> (Pers.) Wint.
71.	<i>Rhynchosia minima</i> (L.) DC.	Poaceae	<i>Puccinia melanocephala</i> H. Syd. & P. Syd.
72.	<i>Saccharum officinarum</i> L.	Fabaceae	<i>Uromyces sesbaniae</i> Syd.
73.	<i>Sesbania grandiflora</i> (L.) Pers.	Asteraceae	<i>Coleosporium asterum</i> Dietel
74.	<i>Solidago canadensis</i> L.	Solanaceae	<i>Puccinia substriata</i> EIL. & Barth.
75.	<i>Solanum melongena</i> L.	Solanaceae	<i>Puccinia pittieriana</i> Henn.
76.	<i>Solanum tuberosum</i> L.	Poaceae	<i>Puccinia purpurea</i> Cooke
77.	<i>Sorghum vulgare</i> Pers. (S. bicolor)	Poaceae	<i>Puccinia purpurea</i> Cooke
78.	<i>Sorghum halepense</i> (L.) Pers.	Fabaceae	<i>Uromyces</i> sp.
79.	<i>Tephrosia purpurea</i> (L.) Pers.	Combretaceae	<i>Olivea terminaliae</i> Thirum.
80.	<i>Terminalia arjuna</i> (Roxb.) Wight & Arn.	Lamiaceae	<i>Olivea tectonae</i> T.S.Ramakr. & K.Ramakr.
81.	<i>Tectona grandis</i> L.f.	Asteraceae	<i>Puccinia lagenophorae</i> Cooke
82.	<i>Tagetes tenuifolia</i> Cav.	Zygophyllaceae	<i>Uromyces salsolae</i> Rabenh.
83.	<i>Tribulus terrestris</i> L.	Poaceae	<i>Puccinia triticina</i> Erikss.; P. graminis Pers. f. sp. tritici
84.	<i>Triticum aestivum</i> L.	Fabaceae	<i>Ravenelia acaciae-arabicae</i> Syd.
85.	<i>Vachellia nilotica</i> (L.) P.J.H.Hurter & Mabb.	Fabaceae	<i>Uromyces vignae</i> Barclay
86.	<i>Vigna unguiculata</i> (L.) Walp.	Fabaceae	<i>Uromyces appendiculatus</i> (Pers.) Unger
87.	<i>Vigna mungo</i> (L.) Hepper	Fabaceae	<i>Uromyces vignae</i> Barclay
88.	<i>Vigna radiata</i> (L.) R.Wilczek	Fabaceae	<i>Uromyces appendiculatus</i> (Pers.) Unger
89.	<i>Vigna aconitifolia</i> (Jacq.) Maréchal	Vitaceae	<i>Phakopsora euvtis</i> Ono
90.	<i>Vitis vinifera</i> L.	Solanaceae	<i>Puccinia withaniae</i> Laz
91.	<i>Withania somnifera</i> (L.) Dunal	Asteraceae	<i>Puccinia xanthii</i> Schwein.
92.	<i>Xanthium strumarium</i> L.	Poaceae	<i>Puccinia sorghi</i> Schwein.
93.	<i>Zea mays</i> L.	Rhamnaceae	<i>Phakopsora zizyphi-vulgaris</i> Dietel

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