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Concepts of taxonomy, genetic epidemiology and management of *Puccinia recondite:* A review

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Abstract
The main purpose of present study was to provide an overview about survival and management of *Puccinia recondite* the causal agent of leaf rust of wheat. Leaf rust was first referred as Uredo rubigo-vera that produce urediniospores to cause disease on leaf tissue. The resistant wheat cultivars have extensive ability to reduce the production of such uridinospore productions. Such type of cultivars possesses resistant genes such as *Lr1, Lr3* which cause impenetrability to rust. Similarly, *Lr3ka, Lr3bg* and *Lr16* have little uredinia encompassed by putrefaction and lines with *Lr11* appeared by little uridinia encomposed by chlorosis. In susceptible cultivars, the cultural practice does not ensure flexibility from rust in light of the fact that urediniospores are conveyed long separations by wind. Moreover, other epidemiological factors such as temperature, relative humidity, and rainfall have significant role in breakdown of resistance mechanism of resistant and susceptible cultivars. To overcome these challenges, this paper summarize the recent information of the *P. triticina* /wheat contact with highlighting on the rust resistance genes in wheat, epidemiology of brown rust, Ordred history and the management of *Puccinia Recondita*.

Keywords: Leaf rust, epidemiology, management, resistance genes

1. Introduction
Brown rust, which is initiated by *Puccinia triticina* Eriks., the best well-known wheat (*Triticum aestivum* L.) of rust illness. In winter season, there is a severe attacks of leaf rust found every where, which gave inmportant significant and economical losses [13, 26].

Brown rust happens all the more routinely and in extra overall areas than the stripe of wheat rust (*P. striiformis f. sp. tritici*) and stem rust of wheat *(P. graminis f. sp. tritici*). The growth of pathogen is is heteroecism and along these lines needs a uredinial/telial have (generally wheat) and an option (aecial/ pycnial) have (*Isopyrum fumaroides* or *Thalictrum speciosissimum*) to finish the full life rotation. In this way it appears to be expected that the *P. triticina* focus of cause is the productive hemispherical district of Middle East, where the characteristic scope of essential and option has cover [8].

Yield misfortunes of wheat from the *P. triticina* diseases are typically the after effect of diminished quantities of pieces per crown and lower portion weights. The *Puccinia triticina* that caused brown rust, is currently perceived as a critical pathogen in wheat creation around the biosphere, causing the significant yield misfortunes ended expansive land regions [18, 23, 28, 29]. The Brown rust caused a 15% misfortune in winter season wheat yields in (Kansas Department of Agriculture), the main wheat-creating state in the US 2007. Keeping this in view, the study was designed to observe the disease causing mechanism of *Puccinia recondite*, its survival, taxonomy, and genetics under natural environmental conditions.

2. Identification
Brown rust is defined as the uredinial organize. Uredinia are erumpent, up to 1.5 mm in width, with orange to darker, round ovoid uredinia which are dispersed on both the lower and upper leaf surfac of the essential host. Uredinia deliver urediniospores those are normal 20 µ m in width, sub-globoid and are dark–orange colored, up to eight germ pore dispersed in the thick, echinulate divider.

3. Infection indications

Wheat assortments which are completely powerless has extensive uredinia deprived of causing putrefaction or chlorosis in host tissues. Safe wheat assortments are described by different reactions from little excessively touchy flecks to little to direct size uredinia that might be encompassed by necrotic and additionally chlorotic zones.

4. Ordered History

Rust parasites have a place with the request Uredinales are in the Basidiomycetes. This ordered classification of leaf rust of wheat has experienced a few amendments. On wheat the brown rust was first allotted as Uredo rubigo-vera (DC) by [5]. In winter (1884) later set wheat brown rust in the complex species of P. rubigo-vera. *Eriksson* [9]. That was the first to depict wheat leaf rust as a solitary animal varieties *P. triticina*, which is specific to wheat. Cummins *et al.* [3] comprised wheat brown rust in the species complex of *P. recondita* that has brown rusts with telial hosts and covering spore morphology of a few types of grasses, rough wheat and rye. In view of nomenclature, *P. recondita* were additionally divided into formae speciale in view of this host range, and wheat brown rust were set into the *P. recondita f. sp. tritici* [37]. All the additional as of late [1] suggested that brown rusts which have *T. speciosissimum* (family Ranunculaceae) as the option have been viewed as a different animal categories from brown rusts with elective has, for example, *Anchusa* spp. (family Boraginaceae). Brown rust of the wheat with the *T. speciosissimum* as the selection have is sexually contradictory with brown rusts that has Anchusa as the option have [1]. In light of sexual variation, the causal specialist of wheat brown rust is presently viewed as an animal groups particular from the brown rusts on wheat relatives and on rye. The partition of wheat brown rust from *P. recondita* is upheld by phylo-genetic ribosomal DNA arrangement examinations brown rust of normal wheat (*Triticum aestivum L.*) [30] and disease structure morphology [38] spore morphology [31] of durum wheat is as of now portrayed as *Puccinia triticina* Eriks.

5. Brown Rust Resistance Genes

Increasing problems of brown rust have been found in last years, wheat varieties which have extraordinary level of cultivar resistance alongside leaf rust quiet plays an significant role in low incidence and harshness of these diseases [14, 36].

Hereditary investigations of the leaf imperviousness to rust in the wheat has been led through wheat specialists around the biosphere. Firstly research that was made by, [22] who discovered that the varieties of Wheat like Malakof and Webster which showed quality that adapted leaf imperviousness to rust, later assigned as *Lr2 and Lr1*, separately (Soliman *et al* [32] Ausemus *et al.* (1946) have given recognition of chromosomes that were responsible to creat imperviousness in leaf against rust that chromosomes were *Lr1, Lr3, Lr11*. By deciding the nearness of 3 alleles at Lr2 locus [6] showed the variety in Lr1 qualities. Lr1 to Lr60 showed Leaf imperviousness to rust qualities [24]. Qualities were portrayed as, tetraploid durum wheat, hexaploid wheat and numerous diploid wild wheat species. Hexaploid wheat showed more leaf imperviousness to rust qualities over the genome, being available on almost every one of the forty two chromosome arms. 4 allelic arrangement have additionally been depicted. Qualities *Lr2a*, *Lr2b* and *Lr2c* were arranged to a locus on the chromosome arm 2DS [25]. *Lr3a, Lr3ka* and *Lr3g* were at a locus on the chromosome arm 6BL (Haggag and Dyck, 1973). *Lr17a* and *Lr17b* were at a locus on chromosome arm 2AS [7]. *Lr22a* and *Lr22b* at a locus on chromosome arm 2DS [27]. Qualities *Lr14a* and *Lr14b* were firmly connected on the chromosome 7BL (Dyck and Samborski, 1970) and are deliberated as alleles for every pragmatic reason. More leaf imperviousness to rust qualities compelling protection from races of *P. triticina* specifically.. Race-specific protection is generally showed through an overly sensitive reaction (HR) of quick cell passing that led to contagious haustoria on host cells in the epidermal and mesophyll layers.

Diverse protection qualities ss trademark protection phenotypes or disease writes. For model, the protection reaction of the wheat lines *Lr2a* has just light flecks which are difficult to understand, and *Lr3* is described by plainly describe extremely sensitive flecks. Further race-specific protection reactions, for example, those molded by the wheat lines with *Lr3bg*, *Lr3ka*, and *Lr11* are showed through the little uredinia encompassed via chlorosis, and the lines by *Lr16* has little uredinia encompassed through putrefaction. Protection molded through this latest qualities are presumably communicated at the later opinion in disease and establishment procedure of the *P. triticina*. Race-specific of *Lr* of seedlings plants are powerful and stay viable in grown-up plant organize. In any case, the protection molded by a few qualities, for example, *Lr22, Lr13* and *Lr122a* are the best communicated in the grown-up plant. In the wheat lines that has mixes of the protection qualities, quality by most noteworthy safe contamination write are epistatics to qualities by less safe disease composes. 3 qualities, to date, which present race-specific protection has clone: Lr10 and Lr1, initially from the regular wheat, and *Lr21*, initially from *T. tauschii* [4, 10, 11]. Hereditary parts of leaf imperviousness to rust in wheat were already looked through *Kolmer* [16]

6. Epidemiology

There are conditions present which favor the disease like brown rust which cause minimum to maximum losses of yield. Free moisture and high relative humidity and temperature ranging 15 degrees C to 24 degrees C are conducive for brown rust to develop. Urdiniospores can have best place for germination is 67 degrees F. If these entire situation take place diseases infection can take charge within 6 to 8 hour. Brown rust epidemic severity is increases exponentially over time. Spores which are dispersed through dry and windy days, this can also favor brown rust epidemics. The urediniospores, which serve as initial inoculum by benefit of extensive distance spread by high wind swiftness [33].

6.1 Epidemiological factors Vs. leaf rust severity

The association of low temperature with brown rust is constructive. Cultivars showed increasing disease severity trend with increase in the minimum temperature at 15-19 ^{0}C. This clarifies the response of brown rust standards of the verities to low temperature. The association of high temperature with brown rust severity is also conducive. Varieties gave beneficial reply with increasing in the temperature 29-33 ^{0}C. Similarly relative humidity, rainfall and wind speed demonstrate significant relationship with increasing these parameter from 60-90%, 0.3-1 mm and 2.9-3.4 Km/h respectively [34].

7. Management

Leaf rust keeps on causing misfortunes worldwide in wheat creation because of dependence going on varieties and with the race-specific protection then abnormal state of the harmfulness variety in *P. triticina*. Advancement of the wheat varieties with the powerful level of sturdy protection will depend on qualities which gives non race-specific protection. Wheat varieties with blends of *Lr46, Lr 34* or supplementary non-race-specific protection qualities is exceedingly safe and promptly accessible wellsprings of sturdy protection [33]. Mixes of the Lr34 with seedling protection qualities has additionally given elevated amounts of powerful protection that have stayed viable for various year [19]. Cloning of the qualities Lr46 and *Lr34* and exams of how those qualities is communicated which may give model to considerate natural premise of non-race-specific protection. Numerous parts of the wheat brown rust has all around considered, yet minute is thought about atomic and the hereditary parts of the *P. triticina* pathogenicity. Organisms in the rust, minute is thought about inherent capacity of the *Avr* protein in good communications or how *Avr* proteins collaborate with protection quality encoded protein to evoke safeguard reaction. The flax rust pathogen (*Melampsora lini*) has cloned through 4 *Avr* qualities. Spite of the fact that their capacity in harmfulness is not known, this qualities code little, discharged protein which is perceived into plant cell [21]. Practically identical inquiries still can't seems the led for *P. triticina*. Study on *P. triticina* could progressed through genomis sequence. Genome arrangements of the *M. laricipopulina* (Famous rust) and *P. graminis* has as of late discharged and will an essential asset meant for *P. triticina* relative genomic. Fresh methods which is useful investigation of the *P. triticina* qualities. *Hu et al*., [12] shall give better chances for contemplate these important however ineffectively comprehended parts of this dynamic pathogens.

7.1 Cultural Control

It is suggested to apply practices which include suppression of volunteer plants and the crop debris, which can harbor inoculum over the winter. Urediniospores are carried from long distance through air due to which cultural practices does not ensure to eradicate rust at large level. Dodge early sowing before the time and surplus nitrogen applications. Tillage practices and crop rotation can keep away rust summer spores from the field which are produces in large numbers and can travel from a long distance under reliable conditions

7.2 Foliar Fungicides

Early in the epidemic, like all the other rust it is very important to apply fungicide. Early in the season in susceptible cultivars, if s severe epidemic devolps, then it is essential to make 2 applications of fungicide. Grain yield is largly affected by early rust after ear devoplent. It is prescribed to actualize hones that incorporate the destruction of volunteer plants and harvest flotsam and jetsam, which can harbor inoculum over the winter. This social practice does not ensure opportunity from rust on the grounds that urediniospores are conveyed long separations by wind. Keep away from early sowing and overabundance nitrogen applications. Overwhelming touching or the utilization of herbicides amid harvest time to dismiss self-sown powerless wheat shell reduce the measure of rust in ensuing products. In any case, if spring conditions are positive for leaf rust improvement, at that point even little measures the rust which persisted the fall can duplicate to root genuine yield misfortunes near in spring.

There is no of numerous foliar fungicide which are enrolled for the management for brown rust wheat. Fungicides ought not be viewed as alternative for developing resistant cultivars. They are all the more a reinforcement for when another race of rust develops and for the use in areas wherever sufficient protection isn't accessible. A fungicide reaction is improbable in safe or reasonably safe assortments.

Earlier in season when a rust endemic begins then more significant the prospective yield losses. Yields should be checked to identify rust right on time as timing is basic for powerful governor of rust disease with the fungicides. Rust rises could be hazardous and can never be easy to contain.

Single azoles has been found significant to reduce leaf rust in field in recent years [2, 15, 20]

7.3. Seed Treatments

There is a no of seed treatment available which will destroy initial contaminations of brown rust. Seed treatment is vital in susceptible cultivars, particularly in the event that they are sown early or subsequent a rainy summer favoring development of the volunteers.

8. Conclusion

This effort provides us the availability of seed standard in our markets that is very alarming. It is proved that major losses of yield are due to pathogen which is widely present due to favorable environmental conditions and host plant. plant pathogenic fungi are prevailing in seeds and that ultimately transferred in farmer fields which cause losses in the form of poor germination and early disease spread. Lines of wheat should be crossed to attain the variety which is resistance to brown rust because without resistance varieties it rearly difficult to control crop from rust pathogen. Single azoles has been found significant to reduce leaf rust in field in recent years. Cultural practices should be prefer to control disease at first. there is a big need to screen the seed for healthy crop and maximum yield average.

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