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A Comprehensive Survey and Assessment of Rice Blast Disease Incidence from Major Rice Growing Districts of Telangana State, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of this study was to assess the incidence and severity of rice blast disease caused by *Pyricularia grisea* in various rice cultivars grown in Telangana State during the kharif season of 2019.

Methodology: A purposive disease survey was conducted in major rice-growing areas of Telangana State. Disease incidence and severity were recorded from the tillering to grain hardening stage. Percentage disease incidence and severity were calculated at each sampling location.

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Additionally, pathogenicity tests were conducted on susceptible rice cultivar TN-1 using different isolates of *P. grisea*.

Results: The study revealed significant variations in rice blast disease incidence and severity across the surveyed areas. Disease incidence ranged from 18.5% in Mancherial to 79.41% in Peddapalli, while severity ranged from 22.2% to 85.1%. All sampled cultivars exhibited varying degrees of susceptibility, with severity scores ranging from moderately resistant (2.0) to highly susceptible (9.0). TN-1 showed the highest blast severity, while WGL 1368 exhibited the least severity. Pathogenicity tests showed significant differences among *P. grisea* isolates, with reactions on TN-1 ranging from moderately susceptible (4.0 to 5.0) to highly susceptible (8.0 to 9.0).

Conclusion: The study highlights the widespread occurrence of rice blast disease in Telangana State and underscores the varying susceptibility levels among rice cultivars. These findings emphasize the importance of continued monitoring and management strategies to mitigate the impact of rice blast disease on rice production in the region.

Keywords: Rice blast; Pyricularia grisea; percent disease index; disease severity.

1. INTRODUCTION

Rice (*Oryza sativa* L.) assumes a pivotal role as a primary staple nourishment source for a significant proportion of the global population. Its cultivation demonstrates adaptability across a diverse spectrum of climatic and edaphic contexts. In India, major rice growing states are West Bengal, Uttar Pradesh, Bihar, Madhya Pradesh, Orissa, Andhra Pradesh, Telangana, Karnataka and Chhattisgarh. There was enormous increase in cultivated area under rice in Telangana State attributed to the augmentation of irrigation infrastructure and proactive agricultural policies endorsed by the State Government. In spite of this phenomenal increase in area and production of rice, its productivity is limited by various biotic and abiotic stresses.

Among the biotic stresses, Rice blast caused by *Pyricularia grisea* is considered as one of the major recurrent problems that affects rice production and continues to threaten the socio-economic status of rice-farmers in the state**.** Blast disease is known to strike all parts of the plants from seedling to heading stage of the crop [1] resulting yield loss as high as 70-80%. "The spread of disease has extensively increased in terms of both occurrence and intensity on most of the improved varieties viz., BPT 5204, JGL1798, JGL 384, Swarna, MTU1010, MTU1061 and MTU1075 currently grown in the state" [2]. Though, presently available blast management strategies reduce disease significantly, blast epidemics are still common, thereby causing devastating yield losses. "Keeping in view the importance of the crop and losses caused by this disease, a roving survey was carried out during *June-September,* 2019 to provide baseline information on the status of the disease in the major rice growing areas of Telangana which is prerequisite to take decision regarding management practices of different diseases" [3].

2. MATERIALS AND METHODS

2.1 Collection of Diseased / Infected Samples

A roving survey was carried out to collect blast infected rice samples from major rice growing areas of Northern Telangana zone (Mancherial, Jagtial, Karimnagar, Nizamabad and Peddapalli), Southern Telangana zone (Rangareddy, Nalgonda and Mahbubnagar) and Central Telangana zone (Medak, Warangal, Mahabubabad and Khammam) of Telangana State during *kharif,* 2019. From each village randomly 3-5 paddy fields were selected when the crop was at tillering to maturity stage. Three plots in each field having an area of one square meter were selected at random. During collection of the samples, data on place of collection, crop cultivar, part of plant, stage of the crop, GPS coordinates from each location, disease severity and incidence was recorded. Both leaf and neck blast samples were collected from both farmers' fields and PJTSAU research stations. The samples were collected in polythene bags and brought to the laboratory for isolation and identification of the blast pathogen.

Per cent Disease Incidence (PDI) was recorded by using the following formula:

$$\text{PDI} = \frac{\text{Diseased hills observed}}{\text{Total no. of hills}} x\ 100$$

Disease severity will be calculated by using the following formula:

$$\text{Disease severity} = \frac{\text{Sum of the scores}}{\text{Number of observations x highest number in the rating scale}} x\ 100$$

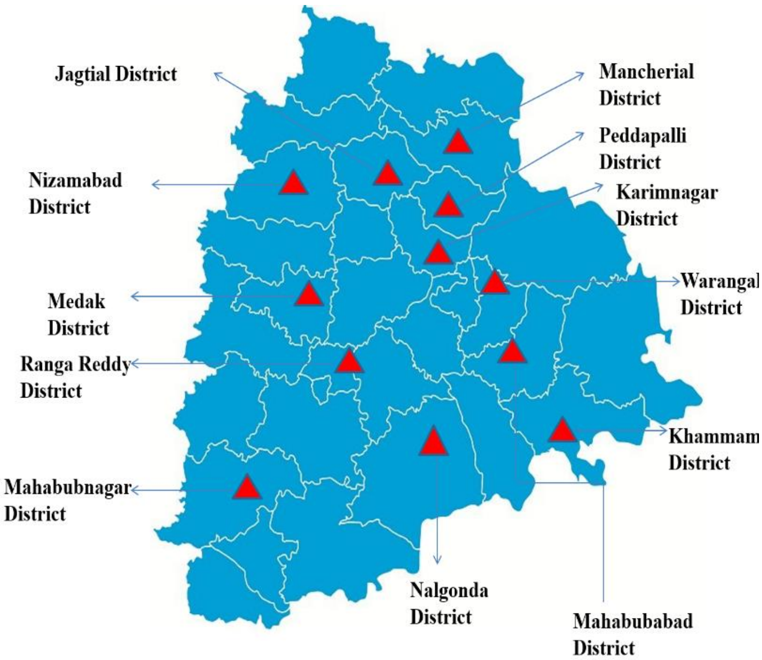

Fig. 1. Map depicting the collection of different isolates of *P. grisea* from blast infected rice fields in different districts of Telangana State

2.2 Isolation of Mono-Conidial Isolates of *Pyricularia grisea*

"Twenty blast infected rice samples were brought to the laboratory and washed under running tap water to remove dirt particles. Leaf bits of diseased tissue along with some healthy portions were cut with the help of a sterile scalpel blade and surface sterilized with 1 per cent sodium hypochlorite solution for one min, rinsed thrice in sterile double distilled water and dried on sterilized filter paper. Later, it was transferred aseptically onto the sterilized Petri dishes containing OMA medium and plates were incubated at 25 ± 1°C for 7 days. The mycelial growth in plates was recorded for every 24 hours. Twelve isolates were isolated from 20 samples by tissue segment technique. All the isolates were identified as *Pyricularia grisea* based on the characteristics of the colony, hyphae, conidiophores and conidia" [4]. The isolates were designated as Pg1, Pg2 and up to Pg12. where, 'Pg' denotes *Pyricularia grisea* and numerical refers to sample number.

2.3 Pathogenicity Test

Pathogenicity test was conducted by using rice cultivar TN1 (susceptible to rice blast pathogen). Seedlings were grown in 15 cm diameter plastic pots filled with sterilized soil-sand-FYM (farmyard manure) mix (2:1:1) and placed in polyhouse which was maintained at 25°C for testing the pathogenicity of each *P. grisea* isolate.

2.3.1 Inoculation

"Fourteen days old culture plates were flooded with 20 ml of distilled water and the fungal growth containing mycelium and conidia was gently removed by scrapping with a sterile plastic inoculation loop. The harvested spores were

Table 1. Standard Evaluation System Scale (SES) used for recording leaf blast severity in Uniform Blast Nursery [6]

Grade	Disease severity	Host reaction
0	No lesion observed	Highly Resistant
1	Small brown specks of pin head size	Resistant
2	Small roundish to slightly elongated, necrotic grey spots, about 1-2 mm in diameter, with a distinct brown margin. Lesions are mostly found on the lower leaves	Moderately Resistant
3	Lesion type same as in 2, but significant number of lesions on the upper leaves moderately	Moderately Resistant
4	Typical susceptible blast lesions, 3 mm or longer infecting less than 4% of leaf area	Moderately Susceptible
5	Typical susceptible blast lesions of 3 mm or longer infecting 4-10% of the leaf area	Moderately Susceptible
6	Typical susceptible blast lesions of 3 mm or longer infecting 11-25% of the leaf area	Susceptible
7	Typical susceptible blast lesions of 3 mm or longer infecting 26-50% of the leaf area	Susceptible
8	Typical susceptible blast lesions of 3 mm or longer infecting 51-75% of the leaf area many leaves are dead	Highly Susceptible
9	Typical susceptible blast lesions of 3 mm or longer infecting more than 75% leaf area affected	Highly Susceptible

filtered through a double-layer muslin cloth and the resultant concentration was adjusted to 1×10^5 conidia ml^{-1} using a haemocytometer. Tween 20 was added to the suspension just before the inoculation" [5]. Fifteen-day old seedlings grown in pots were inoculated artificially by spraying the inoculum on the foliage using a hand-operated atomizer. Inoculated plants were allowed to partially dry for 10 min to avoid dislodging of the spores and incubated at 25°C with >95% relative humidity.

2.3.2 Data recording

Leaf blast severity of each isolate was recorded on individual plant basis using a progressive 0 – 9 Standard Evaluation System scale [6]. Pathogenicity test was conducted and re-isolations of each isolate from the artificially inoculated plants were made and culture obtained was compared with the original culture by proving Koch's postulates.

3. RESULTS AND DISCUSSION

During the survey in major rice growing regions of Telangana State, insect pests and diseases were the main biotic stresses causing significant losses to the rice production. Blast, bacterial leaf blight, brown spot and sheath blight are the major diseases of rice causing yield losses in Telangana State. Among the fungal diseases, rice blast is a serious predominant problem in all surveyed areas where minimum night temperature ranges from 20°–26°C, with the association of >90% of relative humidity and cloudy drizzling weather during all the crop growth stage.

Results revealed that among the ten districts, highest mean per cent disease incidence (PDI) 79.41 % was recorded in Peddapalli district. It was followed by Rangareddy, Nizamabad, Karimnagar, Nalgonda, Khammam and Mahbubnagar districts with PDI of 77.41 %, 69.4 %, 56.2 %, 48.38 %, 46.6 % and 41.1 %, respectively. The lowest blast disease incidence was recorded in Mancherial district (18.5 %) followed by Mahabubabad (20.68 %), Medak (25 %), Jagtial (32 %) and Warangal (34.4 %) districts (Table 2). The present results on the incidence of rice blast disease are in accordance with Bhaskar et al. [7] who recorded "the assessment of blast disease incidence in major rice growing areas of Andhra Pradesh state where highest mean blast incidence 38.99 % was recorded in Kovvur Mandal of Nellore district and the lowest incidence 15.41 % was noticed in Madugula Mandal of Visakhapatnam district". Similarly, Onaga and Asea [8] highlighted "the significant impact of rice blast in Uganda, affecting over 50% of fields, notably in Bugiri, Butaleja, Mbale, and Lira, resulting in yield reductions exceeding 30%".

Among the sampled areas, rice blast disease severity ranged from 22.2 to 85.1%. The disease severity of rice blast from the other areas were in the range of 33.3 (Mahabubabad) to 70.3 % (Nizamabad). Similarly, Yashaswini et al. [9] surveyed in different districts of Telangana and Andhra Pradesh during *kharif,* 2014 and reported that rice blast severity was ranged from 50.0 to 74.0%.

All the cultivars sampled in these surveyed areas have shown disease severity of rice blast ranged from Moderately resistant (2.0) to highly susceptible (9.0) reaction. Highly susceptible reaction was noticed was recorded at Rangareddy (9.0) and Peddapalli (8.0) districts. Whereas, moderately susceptible reaction was noticed at Mahbubnagar (4.0), Medak (4.0), Warangal (4.0), Khammam (5.0) and Jagtial (5.0) districts. Susceptible reaction was noticed at Karimnagar (6.0), Nalgonda (6.0) and Nizamabad (7.0) districts. Moderately resistant reaction was recorded from Mancherial (2.0) and Mahabubabad (3.0) districts.

When compared with the locations, blast incidence was highly varied among the cultivars. Cultivar-wise, the mean blast disease incidence as indicated by PDI ranged from 34.4 (WGL 1368) to 77.4 % (TN-1). Highest PDI was observed on TN-1 (77.4%) cultivated at Rice Research Centre (RRC), ARI, Rajendranagar, Hyderabad. For the remaining cultivars, the PDIs during *Kharif*, 2019 were JGL 24423 (69.4 %), MTU 1010 (42.4 %), Sriramagold (41.1 %), BPT 5204 (39.25 %) and WGL 1368 (34.4 %). Overall, our results as per the survey conducted during *kharif*, 2018 in Telangana State indicated that blast severity was highest on TN-1 and least in cultivar WGL 1368 (Table 3.). Similarly, Bhaskar et al., [7] noticed “highest mean disease incidence was observed in cultivar MTU-7029 (59.44%) followed by BPT-5204 (33.07%) whereas the lowest mean incidence was recorded in NDLR-8 (3%) followed by MTU-3626 (4.46%) and MTU-1121(5.89%)”.

3.1 Pathogenicity Test

The pathogenicity test of 12 *P. grisea* isolates collected from different locations of Telangana State were tested on susceptible rice cultivar TN-1 under polyhouse conditions. The inoculated plants showed visible symptoms 6-7 days after inoculation under appropriate environment conditions maintained by providing high humidity and low temperature. Percent disease index was recorded for all the isolates. The fungus was re-isolated from the inoculated plants which gave the similar morphological and cultural characters as the original isolates described earlier.

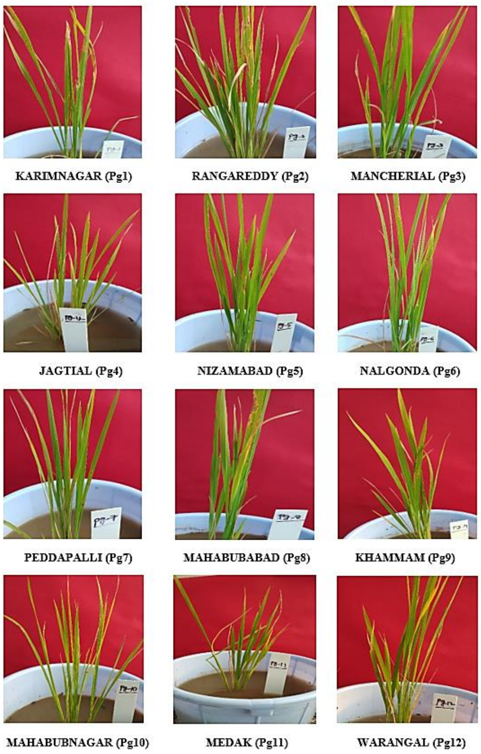

Fig. 2. Pathogenicity studies of twelve isolates of *P. grisea* in susceptible rice cv.TN1 under polyhouse conditions

Table 2. Per cent disease incidence of rice blast from major rice growing areas of Telangana State

S No.	Location	Name of the District	Latitude	Longitude	Rice variety	Crop stage	Plant part	Disease incidence %	Disease severity %	0-9 scale
1.	Gangadhara	Karimnagar	18.581081	79.008758	MTU-1010	Milky stage	Neck	56.2	62.9	6.0
2.	Rajendranagar	Rangareddy	17.326076	78.401312	TN-1	Tillering	Leaf	77.4	85.1	9.0
3.	Makulapet	Mancherial	19.040378	79.117635	MTU-1010	Hardening stage	Neck	18.5	22.2	2.0
4.	Polasa	Jagtial	18.832309	78.363170	BPT-5204	Panicle initiation	Leaf	32.0	40.7	5.0
5.	Dharmaram	Nizamabad	18.647096	78.172136	JGL-24423	Milky stage	Leaf	69.4	70.3	7.0
6.	Kanchanapalli	Nalgonda	17.738364	79.309172	MTU-1010	Flowering	Leaf	48.3	51.8	6.0
7.	Eligedu	Peddapalli	18.557719	79.263267	BPT-5204	Panicle initiation	Leaf	79.4	85.1	8.0
8.	Garla	Mahabubabad	17.483950	80.143614	BPT-5204	Milky stage	Neck	20.6	33.3	3.0
9.	Marlapadu	Khammam	17.108635	80.802222	MTU-1010	Hardening stage	Neck	46.6	48.1	5.0
10.	Makthal	Mahabubnagar	16.487408	77.503669	SRI RAMA GOLD	Milky stage	Leaf	41.1	37.0	4.0
11.	Peddashettipalli	Medak	18.041915	78.274453	BPT-5204	Flowering	Leaf	25.0	44.4	4.0
12.	Atmakur	Warangal	18.068901	79.739048	WGL-1368	Flowering	Leaf	34.4	40.0	4.0

Table 3. Mean Per cent disease incidence among the cultivars

Variety	Range of Per cent disease incidence	Mean Per cent disease incidence
MTU-1010	18.5 – 56.2	42.4
TN-1	77.4	77.4
BPT-5204	20.6- 79.4	39.25
JGL-24423	69.4	69.4
SRI RAMA GOLD	41.1	41.1
WGL-1368	34.4	34.4

Table 4. Pathogenicity test of *Pyricularia grisea* isolates on susceptible rice cultivar (TN1)

S. No.	Isolate	Severity scale (0 -9 scale)	Disease severity
1.	Pg1	7.0	85.1 (67.4)
2.	Pg2	8.0	88.8 (69.2)
3.	Pg3	6.0	70.3 (56.8)
4.	Pg4	4.0	48.1 (44.1)
5.	Pg5	6.0	70.3 (56.9)
6.	Pg6	6.0	74.0 (58.9)
7.	Pg7	7.0	77.7 (61.1)
8.	Pg8	6.0	66.7 (53.7)
9.	Pg9	7.0	81.5 (64.5)
10.	Pg10	6.0	66.6 (55.2)
11.	Pg11	6.0	74.0 (58.2)
12.	Pg12	8.0	88.8 (69.2)
Mean			**74.3 (59.6)**
SE (m) ±			**0.68**
CD at 5%			**2.00**

All the figures are means of three replications
Figures in parenthesis are angular transformed values

Highly significant differences were noticed among the test isolates of *P. grisea* using 0-9 Standard evaluation system scale [6]. The results indicated that the highest PDI of 88.8 per cent to lowest PDI of 48.1 per cent was recorded among different *P. grisea* isolates.

Pathogenicity test revealed that twelve isolates of *P. grisea* caused moderately susceptible (4.0 to 5.0) to highly susceptible (8.0 to 9.0) reaction on TN-1. Similarly, Srivastava et al. [10] categorised *P. grisea* isolates into three virulent groups based on their disease reaction on susceptible rice cultivar. Among the 12 *P. grisea* isolates, the highest Per cent disease index was recorded on TN-1 for Pg-2 and Pg-12 (88.8 %) which was followed by Pg-1 (85.1 %), Pg-9 (81.48 %), Pg-7 (77.7 %), Pg-6, Pg-11(74.07 %), Pg-3, Pg-5 (70.37 %), Pg-8 (66.7 %) and Pg-10 (66.6 %) and the least PDI was obtained in Pg-4 (48.1%) (Table 4.). These results of the present investigation are in accordance with the findings of Saifulla et al. [11], Prasad et al. [12] and Ghatak et al. [13].

4. CONCLUSION

In the present study, the rice blast disease incidence was highly varied in among all the surveyed areas in Telangana State due to variations in weather conditions, differences in varietal status, time of sowing, transplanting, soil type and high amount of nitrogen applications. Monocropping of the susceptible varieties continuously on the same field, prior application of fungicides, improper irrigation might have affected survival and spread of inoculum and that ultimately led to highly aggregated distribution in each cultivar among the rice fields. Among the various management practices available, use of resistant varieties are best method of fighting the blast disease in rice. However, these varieties were liable to blast infection within short period of release in farmer fields because of rapid change in pathogenicity and race specificity of the blast fungus. Therefore, understanding pathogenic and molecular diversity of *P. grisea* are essential for tracing out shift in pathogen population, overcoming constraints facing by many rice breeding programs and for implementation of efficient disease management strategies.

APPLICATION OF RESEARCH

This research is applicable to paddy farmers and researchers to know the status of rice blast diseases among the commonly cultivated varieties in rice in major rice growing areas of Telangana State.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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