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Scenario of Bacterial Leaf Blight of Rice Caused by *Xanthomonas oryzae* pv. *oryzae* in Major Rice Growing Areas of Andhra Pradesh, 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

Rice is among the oldest crops of the world which feeds more than half of the world's population. Bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae*, is a most devastating disease which results in yield losses upto 70-90%.
Aim: The current research study was aimed to investigate the occurrence of disease and distribution of pathotypes.

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Methodology: A roving survey was conducted over twelve major rice growing districts of Andhra Pradesh *viz.*, East Godavari, West Godavari, Eluru, Kakinada, NTR district, Krishna, Nellore, Chittoor, Tirupati, Kadapa, Kurnool, Nandyal.
Place and Duration of Study: Department of Plant Pathology, S. V. Agricultural College, Tirupati, between November 2023 and Febraury 2024.
Results: The highest disease incidence was found in Putrela village (72.34%) of Krishna district and lowest disease incidence was recorded in the fields of Burugupudi village (21.06%) of Kakinada District.
Conclusion: The results indicate that the disease is prevalent in all rice-growing areas, ranging with varying levels of disease incidence of 20 to 72 per cent.

Keywords: Bacterial leaf blight; disease incidence; survey; symptomatology; Xanthomonas oryzae pv. oryzae.

1. INTRODUCTION

"Rice is the staple food of Asia where, about 90% of the world's rice is produced and consumed. It was reported that rice production in the world was 503.27 million tonnes and in India, was to be around 124 million tonnes in 2022-2023. The major constraints in the rice production and productivity of rice were irregular rainfall, pests and diseases" [1].

Among various diseases, the bacterial blight disease caused by *Xanthomonas oryzae* pv. *oryzae* is the most devastating disease due to its high epidemic potential. Yield loss due to bacterial blight can reach up to 70% when susceptible varieties are cultivated and can be as high as 100% under severe conditions in environments conducive to the disease.

"The disease was first time reported by farmers of Fukuoka area of Japan in 1884-1885" [2,3]. In India, it was first reported during the 1950s by Srinivasan et al. [4]. Earlier the disease occurred in an endemic form in Maharashtra. Later it broke out in epidemic form in the Shahabad district of Bihar in 1963 [5] since then, it has become one of the important diseases of rice plants.

"Bacterial leaf blight can affect rice crops both in the highlands and lowlands, but particularly in lowland rice, and often appears during the rainy season" [6]. "*Xanthomonas oryzae* pv. *oryzae* enters through hydathodes at the leaf tip and leaf margin, multiplies in the intercellular spaces, migrates to the xylem vessels and causes systemic infection" [7]. "The infection chain begins by entering the plant through the hydathodes and continues to the xylem vessels, where it spreads throughout the entire plant and become systemic" [8].

Surveying the disease over time reveals how severely it impacts production and quality, in addition to revealing the presence of different races in various agro climatic zones. Therefore, this is an effort to know the disease status of bacterial leaf blight in major rice growing areas.

The current study aims to obtain a more detailed and accurate estimate of bacterial leaf blight occurrence and to know the prevalence and distribution of *Xanthomonas oryzae* pv. *oryzae* pathotypes in Andhra Pradesh. As the new pathotypes continue to emerge, majority of them varied in their virulence depending upon areas and fields within the area. Continuous monitoring of the virulence structure of pathogen in an area is a pre-requisite to make resistance breeding more durable and sustainable.

2. MATERIALS AND METHODS

A roving survey was conducted during *late kharif,* 2023-2024 to determine the prevalence of bacterial leaf blight disease in twelve major rice growing districts of Andhra Pradesh *viz.,* West Godavari, East Godavari, NTR district, Krishna, Kakinada, Eluru, Nellore, Tirupati, Chittoor, Kurnool, Nandyal, Kadapa. Survey is depended on the field diagnosis of the disease based on the plant symptoms and further confirmation in the laboratory by pathogenicity tests.

Diseased samples showing characteristic symptoms of bacterial leaf blight were collected, properly labelled with date of collection, variety name, place along with GPS location etc. and sealed in polythene bags [9] Additional information on the parameters like variety name, place, crop growth stage, crops in neighbouring fields and plant parts affected were recorded. Random sampling was conducted from each field

and per cent disease incidence was calculated using the following formula [10].

$$Disease\ Incidence = \frac{No.of\ diseased\ plants}{Total\ no.of\ plants\ observed} X\ 100$$

Pathogenicity test was performed to confirm the presence of bacterial leaf blight infection from randomly collected diseased samples. For this, 72hr old isolates collected from each district and multiplied on nutrient broth is clip inoculated onto 40day old seedlings of susceptible cultivar TN_1 using sterilized scissors [11].

3. RESULTS AND DISCUSSION

The present survey results revealed that incidence of bacterial leaf blight occurred in all the twelve districts surveyed, but its incidence is not uniform across the surveyed districts of Andhra Pradesh. The disease incidence observed during the field survey was presented in Table 1 and the collection sites are represented in Fig. 1.

This study revealed that the average disease incidence ranged from 20 -72%. The lowest disease incidence was recorded in Burugupudi village of Kakinada district (21.02%), Kalaparru village of Eluru district (25.6%) and Chinnadandluru village (28.6%) of Kadapa district. Highest incidence was observed in the fields Putrela village (72.34%) of Krishna district, Research plots of ARS, Nellore (59.25%), Davuluru village (54.5%) of NTR district, Perumalapalli village (49.12%) of Tirupati district (Table 1 and Fig. 1) as there were optimum environmental conditions for the disease development. District wise disease incidence was graphically represented in Fig. 5.

The incidence of *Xanthomonas oryzae* pv. *oryzae* was observed on all growth stages of rice crop. Infected plants displayed symptoms like greyish leaf tip discoloration, dried leaves, water-soaked lesions that enlarge with wavy margins, and straw-yellow colour across the entire leaf. In susceptible varieties such as TN1 and BPT-5204, symptoms became systemic, resembling burnt appearance Infection during the flowering stage in the NLR 3228 variety, observed in Tirupati district, lead to partial or incomplete grain filling. Water-soaked lesions and leaf blight symptoms are found across Andhra Pradesh, regardless of growth stage.

Younger plants exhibited Kresek (seedling blight or wilt phase) which was prevalent in Putrela village of Krishna district, which was also seen in West Godavari. Older plants commonly showed water-soaked, translucent lesions turning straw yellow with wavy margins. Severe incidence caused leaf blight and seedling wilt in Yerlampalli village of Chittoor district, and Burugupudi village of Kakinada district. Bacterial ooze on young lesions was noted in Nellore and Tirupati districts in the early morning. Kresek was the most damaging symptom of BLB, while blight symptoms are the most common.

The above variation in the symptomology may be because of variable temperature and rainfall, as these two factors play important role in survival, disease development and spread. Similar information was reported by Garret et al. [12] who suggested that climate change affects the level of disease through genomic, cellular, physiological levels of plant and pathogen.

As there is irregular increase in the temperatures and uneven rainfall over past ten years there is a sporadic outbreak of the disease. The data analysis on BB incidence with the weather parameters of rice growing seasons from 2015 to 2017 revealed that the rainfall distribution varied greatly within rice growing seasons over the years [13].

Local climatic conditions, variability of the strain, rice variety, cultural practices adopted by the farmer can also be attributed for variation in symptomology and disease incidence which are in accordance with the results presented by Lubis et al. [14]. Climatic conditions play a vital role in the infection cycle, influencing the dispersal of the pathogen and its transmission between host plants [15].

Kresek symptoms in rice caused by *Xanthomonas oryzae* pv. *oryzae* occurs at 25-30°C which is optimum temperature for disease development. According to Ahsan et al. [16] delayed sowings and unseasonal rainfall were responsible for creating favourable conditions for BLB disease. Amin et al. [17] also highlighted the significant impact of epidemiological factors like temperature, relative humidity, rainfall and sunshine hours etc. on the occurrence and spread of bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae*

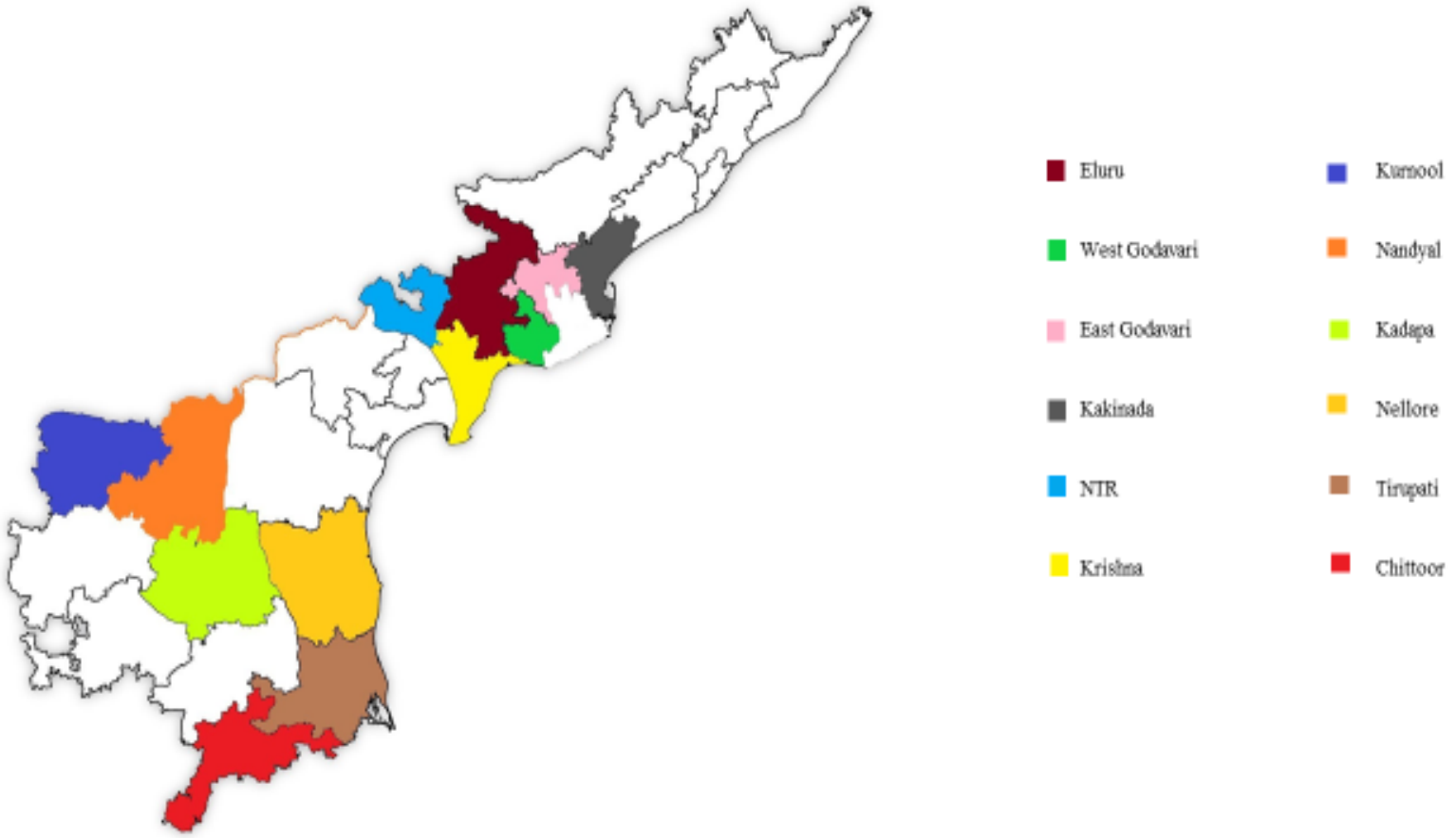

Fig. 1. Map showing survey locations of bacterial leaf blight from major rice growing areas of Andhra Pradesh

Table 1. Disease incidence of bacterial leaf blight in major rice growing districts of Andhra Pradesh.

S. No.	District	Village	Variety name	Crop stage	Surrounding crop	Disease incidence	Pathogenicity test	Symptoms in field
1	West Godavari	Maruteru	MTU 2077	Kresek	Rice	40.84%	+ve	Kresek
2	East Godavari	Peravali	MTU 1318	Tillering stage	Rice	44.9%	+ve	Wavy margins
3	Eluru	Kalaparru	MTU 1121	Reproductive stage	Coconut orchad	25.6%	+ve	Yellowish wavy margins
4	Kakinada	Burugupudi	MTU 1064	Panicle initiation	Black gram	21.02%	+ve	Water soaked lesions
5	NTR district	Davuluru	MTU 1061	Vegetative stage	Banana orchad	54.5%	+ve	Wilted seedlings with straw coloured leaves
6	Krishna	Putrela	MTU 1010	Kresek	Rice	72.34%	+ve	Kresek stage
7	Nellore	ARS, Nellore	Bpt 5204	Tillering stage	Rice	59.25%	+ve	Ooze on leaf tips
8	Tirupati	Perumalapalli	NLR 3228	Panicle initiation	Maize	49.12%	+ve	Straw coloured wilted leaves
9	Chittoor	Yerlampalli	RNR 15048	Vegetative stage	Guava orchad	39.7%	+ve	Water soaked lesions
10	Kadapa	Chinnadandluru	IR 93	Vegetative stage	Tomato	28.6%	+ve	Water soaked lesions with yellow wavy margins
11	Nandyal	Bukkapuram	Nandyal sona	Vegetative stage	Rice	44.4%	+ve	Yellowish wavy margins
12	Kurnool	Veldurthi	Jilakara sona	Tillering stage	Groundnut	40.8%	+ve	Water soaked yellow stripes

which is in accordance with Islam [18]. it is important to understand these epidemiological parameters to manage the disease efficiently.

Adhikari et al. [19] found a strong correlation between the progression of bacterial leaf blight and environmental factors like rainfall and relative humidity. Additionally, Kapoor et al. [20] equally suggested significant variations in rainfall and its distribution within growing seasons from 1979 to 1999. Understanding these parameters is crucial for effective disease management [21,22].

Fig. 2. Blighted appearance of the field infected with BLB

3a. Kresek phase

3b. yellowish stripes at the margins

3c. straw yellow wavy margins

Fig. 3. Symptoms at different growth stages of rice crop

Fig. 4. Leaf inoculation of bacteria by leaf clipping method for pathogenicity test

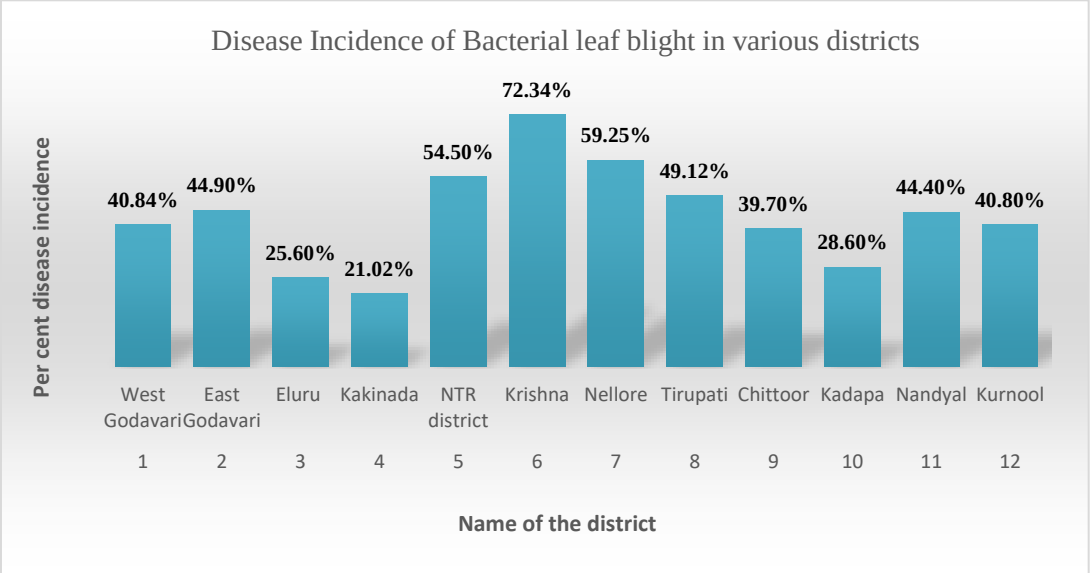

Fig. 5. Prevalence of BLB disease incidence across twelve districts of Andhra Pradesh

Fig. 6. Rice bacterial blight disease scoring on 0–9 scale based on lesion length on the clip inoculated leaves

4. CONCLUSION

The findings indicated that the disease is prevalent in all rice-growing areas, with varying levels of disease incidence ranged from 20 to 72 per cent and diverse pathogenic variations existed in the *Xanthomonas oryzae* pv. *oryzae* population. Further studies on pathotype identification and its distribution in these districts will solve the problems encountered in developing rice cultivars with specific and broad-spectrum resistance against *Xanthomonas oryzae* pv. *oryzae* population. This would aid in deploying better strategies for planning and incorporation of different *Xa* gene combinations for effective management against this pathogen.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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