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Status of Bacterial Leaf Blight in Major Rice Growing Districts of Gujarat

Ajay Chaudhary[1*], Gangwar RK[2] and Thorat SS[2]

[1]Department of Plant Pathology, BACA, AAU, Anand (Gujarat) 388 110

[2]Main Rice Research Station, AAU, Nawagam, Kheda (Gujarat) 387 540

*Corresponding author Email: ajchaudhary02@gmail.com

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Abstract

Rice **(***Oryza sativa* L.), a staple food for over half of the global population, plays a crucial role in meeting nutritional needs, particularly in Asia, often referred to as the world's "Rice Bowl." Bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* pv. *oryzae* poses a significant threat to rice production. In response to the destructive nature of the pathogen, a survey was conducted during the *kharif* 2023 in Ahmedabad, Tapi, Anand, Kheda and Navsari districts of Gujarat. The survey aimed to assess the incidence of bacterial leaf blight, providing crucial insights into the current status of the disease. Among all the surveyed districts highest per centage incidence (49.54%) of bacterial leaf blight was observed in Kheda followed by Tapi (48.73%), Ahmedabad (46.53%), Navsari (12.74%) and the lowest incidence per centage was recorded in Anand (22.57%).

Keywords: Bacterial leaf blight, rice, survey, *Xanthomonas oryzae pv. oryzae*

Introduction

Rice **(***Oryza sativa* L.) belonging to the *Poaceae* family, is the world's most widely grown food crop (Ezuka and Kaku, 2000). In terms of its nutritional content, rice is becoming of paramount importance to more than half of the world's population. Asia is considered as the world's "Rice Bowl". It is a nourishing food because it has 6.89 g of protein, 78.2 g of carbohydrates, 0.5 g of fat, 0.2 g of crude fibre, 0.6 g of mineral matter, 10 mg of calcium and 160 mg of phosphorus per 100 g (Mangalarai and Mauria, 1999). In tropical and subtropical rural and urban settings, people get between 40 to 70 per cent of their calories from rice (Hossain and Fischer, 1995). The cultivation of rice is a significant source of income and employment in the rural areas of Asian countries (Hossain, 1997). Rice is a tropical plant and cultivated in hot and humid climate. It is primarily grown in the regions which are rain-fed and get good rain every year during *kharif* season. In India, rice occupies an area of 46.5 m ha with the production of 130.84 million tonnes and productivity of 2809 kg per ha (Anonymous, 2023). Whereas in Gujarat rice crop is cultivated on 0.89 million hectares with the production of 2.10 million tonnes and productivity of 2356 kg per ha (Anonymous, 2023). Rice is mainly grown in central and southern districts of Gujarat, which include Valsad, Dang, Kheda, Ahmedabad, Anand, Mahisagar, Panchmahal, Vadodara, Tapi and Navsari. The crop is cultivated in both irrigated as well as rainfed conditions during *Kharif* as well as summer season in Gujarat state. The productivity of rice in Gujarat is quite low due to several abiotic and biotic factors, which includes bad weather, diseases and insect-pests infestation.

Among the diseases bacterial leaf blight (BLB) or bacterial blight (BB) caused by *Xanthomonas oryzae* pv. *oryzae (Xoo)* is a serious problem and threat to rice production in both tropical and temperate rice growing regions due to its high epidemic potential (Mew,1987). The disease broke out in the epiphytotic form in Shahabad district of Bihar (Srivastava and Rao, 1966). The disease has become endemic on rice due to intensive and repeated cultivation in many Asian countries, (Mew *et al*., 1993). BLB has spread to many non-traditional areas in India, in addition to recurring incidence in the traditional areas under irrigated and rainfed shallow lands. The pathogen is highly variable in nature (Kumar *et al.,* 2016).

The disease causes up to 20 per cent of the yield losses when appear at the tillering stage (Thind and Bala 2002; Liu *et al*., 2006). The disease has the potential to cause 10-12 per cent yield losses under mild infection (Mew *et al*., 1993). Under severe conditions, bacterial blight of rice can cause significant yield losses. In Japan, yield losses have ranged from 25-35%, sometimes reaching up to 60% (Ou, 1985). In the Philippines and Indonesia, losses were also very high, with the Philippines recording losses of 24.50% in the moist season and 7.21% in the dry season for vulnerable crops (Exconde, 1973). In India and Bangladesh, heavy yield losses of 12-32% have been reported (Shah Jahan, 1992). Similarly, in East India, yield losses have ranged from 7- 62% and even up to 82% for the same genetic resources (Srivastava *et al.*, 1967; Singh *et al*., 1980; Srivastava and Kapoor, 1982).

Laha *et al*., (2016) reported in production-oriented survey 9-52% intensity of bacterial leaf blight during 2001 to 2014 in different rice growing districts of Gujarat. Laha *et al*., (2020) reported that a production-oriented survey conducted in 2020 found the incidence of bacterial leaf blight to be low to moderate in different rice growing districts of Gujarat. The disease occurs at the seedling, vegetative and reproductive stages but at the tillering stage it causes severe blighting of leaves resulting in yield loss. The pathogen, is seed-borne, residing in glumes and occasionally within the endosperm. Seeds collected from heavily diseased fields carry the pathogen and seedlings grown from such seeds typically exhibit disease symptoms and succumb at an early stage (Srivastava and Rao, 1966). The ability of the bacteria to persist in seeds contributes to the perpetuation and dissemination of the disease, further emphasizing the need for effective management strategies to safeguard rice crops from this destructive threat (Mondal *et al*., 2019).

The most effective approach to control these this disease is using resistant varieties. Development of disease resistant rice is one of the most important achievements rice breeders attempt to accomplish (Tejaswini *et al.,* 2016).

In view of the destructive nature of the pathogen, a roving survey on the incidence of bacterial leaf blight was carried out during *Kharif*, 2023 in major rice-growing districts of Gujarat.

Symptomatology

Bacterial leaf blight is a typical vascular disease that can be divided in three distinct phases of symptoms i) Leaf blight phase, ii) Kresek phase and iii) Pale yellow leaf phase. The leaf blight phase is characterized by water-soaked lesions starting at the leaf tips, which then extend downward. Initially, these lesions are pale green but later turn yellow to straw-colored with wavy margins. Water soaking can be observed where the lesions meet healthy tissue. Lesions can begin at one or both edges of the leaves and sometimes appear along the midrib or elsewhere on the leaf blade. As the disease progresses, the lesions can cover the entire leaf blade, turning white and eventually gray or black due to saprophytic fungi growth. In humid areas, yellowish, turbid drops of bacterial ooze may be seen on young lesions in the early morning, which dry into

small, yellowish beads. The most destructive phase, known as the 'kresek' or wilt phase, occurs in the tropics due to early systemic infection in the nursery or from seed infection. This phase causes leaves to roll, droop, turn yellow or gray and ultimately wither. In severe cases, the entire affected plant may die. And the last is pale yellow leaf phase, which was reported from the Philippines, this phase causes some of the youngest leaves in a clump to turn pale yellow or whitish. These diseased leaves then wither, turn yellowish-brown and dry up. This phase has not been reported in other countries (Laha *et al.,* 2009).

Materials and Methods

The roving survey was conducted during the *kharif* season of 2023 to estimate the incidence of bacterial leaf blight in rice in five major rice growing districts of Gujarat *viz.,* Anand, Kheda, Navsari, Ahmedabad and Tapi. To conduct this survey two talukas were selected from each district and two villages were chosen from each taluka, whereas total five fields were selected randomly from each village to ensure a broad and representative sample of the rice crops in these regions. The survey was conducted between panicle initiation to booting stage of the crop.

During the field surveys, positive sampling was conducted and infected leaves of rice plants exhibiting typical bacterial blight symptoms **(Figure 1)** were collected.

Figure 1: Bacterial leaf blight infected plants

For accurately record observations of the Per centage Disease Index (PDI) and Disease Incidence (DI) for (BLB) of rice, several key parameters were recorded.

For calculating the actual incidence of disease in a field, plants were observed at ten points along a diagonal transect (IRRI, 1996). Five quadrates were randomly selected from each field and ten plants were then observed for the disease symptoms.

$$DI\ (\%) = \frac{\text{Number of bacterial blight infected plants}}{\text{Total number of plants examined}} \times 100$$

Total number of plants examined within each quadrate, as well as the number of plants showing symptoms of BLB were counted and recorded. The per cent disease index (PDI) was assessed by evaluating the severity of the disease on individual plants, using a standardized scale (e.g., 1-9, where 1 indicates mild symptom and 9 indicates severe disease).

The PDI is calculated with the formula:

$$PDI\ (\%) = \frac{\text{Sum of all the disease rating}}{\text{Total no. of leaves examined}} \times 100 \frac{100}{\text{Max. disease grade}}$$

Observations recorded

Per centage disease index (PDI)

Disease incidence (DI)

Results and Discussions

A roving survey was conducted during September-October of *kharif* 2023 in major rice growing districts of Gujarat *i.e.,* Anand, Ahmedabad, Tapi, Kheda and Navsari which are known for their rice cultivation to assess the incidence of bacterial leaf blight of rice.

The data in **Table 1** revealed that the highest incidence (49.54%) of bacterial leaf blight was observed in Kheda followed by Tapi (48.73%), Ahmedabad (46.53%), Navsari (12.74%) and the lowest incidence per centage was recorded in Anand (10.56%).

Table 1: Per cent disease incidence and per cent disease index of bacterial leaf blight of rice in different rice growing districts of Gujarat

Sl. No.	District	Taluka	Village	Per cent Incidence			Per cent Disease index		GPS coordinates	Cultivar/ Varieties
				Village	Taluka	District	Village	District		
1.	Kheda	Kheda	Nawagam	87.30	84.4	49.54	47.30	31.31	22.797505° 72.573497°	GR11, Surya Moti,
2.			Lali	81.50			38.50		22.861302° 72.633431°	Punjab S, Moti Gold
3.		Matar	Radhvanaj	13.17	14.69		20.17		22.70970° 72.72390°	GAR13
4.			Ratanpur	16.21			19.27		22.73660° 72.71477°	GAR13
5.	Ahmed-abad	Daskroi	Devdi	71.92	74.65	46.53	35.92	28.56	22.901808° 72.660803°	GR11, Punjab S
6.			Nandej	77.38			37.55		22.908878° 72.673322°	Moti Gold, GR11, Gurjari
7.		Bavla	Kathwada	29.50	18.41		22.45		23.80799° 72.55299°	GAR 13, Moti Gold
8.			Bavla	7.33			18.33		22.842144° 72.363074°	Surya Moti, GAR13
9.	Anand	Anand	Lambhvel	21.45	15.06	10.56	22.50	17.50	22.577175° 72.924656°	GR21, Sonam, Moti gold
10.			Chikhodra	8.67			16.67		22.559579° 73.00783°	Masuri, Sonam
11.		Petlad	Morad	6.97	6.07		19.97		22.543975° 72.873618	Moti Gold, GAR13
12.			Ravipura	5.18			11.18		22.549936° 72.847512°	Sriram125, GAR13, Mahisagar
13.	Tapi	Vyara	Magarkui	79.31	81.43	48.73	39.31	26.44	21.070414° 73.394043°	Versha, US-312
14.			Panvadi	83.55			40.38		21.094584° 73.400135°	US-312, MC-13, Annapurna
15.		Valod	Borakhadi	15.55	16.03		12.55		21.094584° 73.400135°	US 2171, Masuri, GAR13
16.			Bajipura	16.52			13.50		21.10013° 73.291831°	Bayer 6444, GAR 13, US-312
17.	Navsari	Chikhli	Chikhli	9.18	18.17	12.74	11.18	16.63	20.76388° 73.06012°	GNR7, GAR13
18.			Rethvania	27.17			30.70		20.81083° 73.12391°	Nath Pawan, MC-13, US 312
19.		Navsari	Dhantej	7.13	7.32		14.13		20.92247 ° 72.93124 °	US 2111, Gurjari
20.			Sisodra	5.51			10.51		20.93445 ° 72.98385	US 2111, GR15, GAR13

The incidence of bacterial blight varied across talukas in different districts. In Kheda district, the highest incidence was observed in Kheda taluka (84.4%), followed by Matar taluka (14.69%). In Tapi district, Vyra taluka recorded 81.43%, while Valod taluka had 16.03%. Ahmadabad district reported 74.65% in Daskroi taluka and 18.41% in Bavla taluka. In Navsari district, the incidence rates were 7.32% in

Navsari taluka, 18.17% in Chikhli taluka and 16.03% in Valod taluka. Meanwhile, Anand district showed 15.06% in Anand taluka and 6.07% in Petlad taluka, reflecting considerable variation in disease incidence across these regions.

The data on village wise incidence of bacterial leaf blight showed that the highest incidence (87.30%) was recorded in Nawagam of Kheda district followed by Panvadi (83.55%) of Tapi district, Lali (81.50%) of Kheda district, Mangarkui (79.31%) of Tapi district, Nandej (77.38%), Devdi (71.92) of Ahmedabad district and Kathwada (29.50%) of Ahmedabad district, Rethvania (27.17%) of Navsari district, Lambhvel (21.45%) of Anand district, Bajipura (16.52%) of Tapi district, Ratanpur (16.21%) of Kheda district, Borkhadi (15.55%) of Tapi district, Radvanaj (13.17%) of Kheda district, Chikhli (9.18%) of Navsari district, Chikhodra (8.67%) of Anand district, Bavla (7.33%) of Ahmedabad district, Dhantej (7.13%) of Navsari district, Morad (6.97%) of Anand district and Sisodra (5.51%) of Navsari district whereas the village with the lowest incidence was Ravipura of Anand district with a disease incidence of (5.18%) **(Table 1).**

As for the Per cent Disease Index (PDI) the highest PDI (31.31%) of bacterial leaf blight was recorded in Kheda followed by Ahmedabad (28.56%), Tapi (26.44%), Anand (17.50%) and the lowest PDI was recorded in Navsari (16.63%).

The PDI of BLB was also recorded during the survey in major rice growing districts of Gujarat. The highest PDI was observed in village Nawagam of Kheda district with a PDI of 47.30%, followed by Panvadi in Tapi district with 40.38% and Magarkui in Tapi district with 39.31%. Nandej and Devdi in Ahmedabad district also exhibited a high PDI (37.55 and 35.92%, respectively). Other significant observations in PDI were from Lali (38.50%) in Kheda district and Lambhvel (22.50%) in Anand district. Kathwada in Ahmedabad showed a PDI of 22.45% and Ratanpur in Kheda had a PDI of 19.27%. Whereas in Radhvanaj village of Kheda, the PDI was 20.17% and in Bavla of Ahmedabad it was 18.33%, showed moderate PDI. While the lower PDI was recorded from the village Chikhodra in Anand (16.67%), Borakhadi in Tapi (12.55%) and Morad in Anand (19.97%). The minimum PDI was recorded from the Ravipura village (11.18%) and Chikli village (11.18%) while the lowest PDI was recorded in village Sisodra (10.51%) of Navsari district. This comprehensive data highlights the varying severity of BLB across different regions and varieties in Gujarat.

The result found were in accordance to that recorded by Laha *et al*., (2016) who reported during production-oriented survey 09-52 *per cent* incidence of bacterial leaf blight during 2001 to 2014 in different rice growing districts of Gujarat. Laha *et al*., (2020) also reported that during production-oriented survey conducted of *kharif* 2020 that the incidence of bacterial leaf blight to be low to moderate in different rice growing districts of Gujarat. The results of this study align with the findings of Thimmegowda (2006), who observed during the *kharif* season of 2005 that Raichur had the highest disease incidence rate of 61.7 per cent, while Siruguppa had the lowest incidence 46.78 per cent. In the summer of 2006, the highest disease incidence was recorded in Sindhanur at 74.69 per cent, with Siruguppa again having the lowest at 46.78 per cent.

Our present study identified the hotspots of bacterial leaf blight (BLB) of rice in different ecosystems of Gujarat. This disease, caused by a dynamic pathogen that rapidly evolves new races, can be effectively managed through several strategies.

The widespread presence of bacterial leaf blight (BLB) across various regions of Gujarat suggests the critical need for improved management practices. In particular, high incidences in specific areas point to potential hot spots where targeted interventions could be most effective. The variability in disease incidence across different districts, talukas and villages suggests that local environmental conditions, agricultural practices and the choice of rice cultivars play significant roles in disease dynamics.

High incidence rates in districts such as Kheda (49.54%), Tapi (48.73%) and Ahmedabad (46.53%) indicate the urgent need for focused disease management strategies in these regions. Similarly, talukas with exceptionally high incidences, such as Kheda (84.4%), Vyara (81.43%) and Daskroi (74.65%), represent critical areas where targeted control measures could substantially reduce the disease burden. Village-level data, revealed the highest incidence in Nawagam (87.30%) and Panvadi (83.55%), further emphasize the importance of localized interventions.

Several factors contribute to the observed variability in BLB incidence, including climatic conditions, soil health, water management and the susceptibility of rice cultivars. For instance, areas with high humidity and frequent rainfall provide conducive environments for the spread of BLB. Poor soil health and improper water management practices can exacerbate disease conditions. Additionally, the use of susceptible rice cultivars in certain regions can lead to higher disease incidences. Research by Mew *et al*. (1993) and Gnanamanickam *et al*. (1999) highlights that high-yielding varieties and excessive nitrogen use are key factors in bacterial blight outbreaks.

To mitigate the impact of BLB and improve rice yields in Gujarat, region-specific integrated disease management strategies are essential. These strategies should combine both chemical and cultural practices. Chemical management could include the use of effective bactericides and antibiotics, while cultural practices might involve crop rotation, proper water management and the use of resistant rice varieties.

Studies have shown that integrated disease management, which combines various control methods, is more effective in managing BLB than relying on a single approach. For instance, Krishnakumar and Kumaravadivel (2018) reported that the incidence of BLB could be reduced through the adoption of integrated management practices that include timely application of bactericides, use of resistant cultivars and implementation of good agricultural practices.

Conclusion

Bacterial leaf blight (BLB) is a major issue in Gujarat's traditional rice-growing areas, with disease incidence ranging from 10.56% to 49.54% and PDI from 16.63% to 31.31%. It is severe in moderate rainfall areas with high humidity, driven by factors like strong winds, rain splashes and heavy monsoon rains. The widespread cultivation of susceptible varieties such as GR11 and Moti Gold, monocropping and excessive nitrogen fertilization have further increased its prevalence.

The significant variability in BLB incidence across Gujarat highlights the need for targeted, region-specific management strategies. By addressing the unique conditions and practices in each region, it is possible to effectively control BLB, thereby safeguarding rice production and enhancing food security in the state. Effective control can be achieved through proper cultural practices, resistant cultivars and timely antibiotic applications. Identifying high-risk areas is essential for implementing targeted interventions to reduce disease impact and improve yield.

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