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## Occurrence and distribution of cotton bacterial blight disease in Tamil Nadu

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### Abstract

Cotton is an important economic crop in India and across the world. It is affected by many diseases caused by fungi, bacteria and virus. Among these, bacterial blight incited by *Xanthomonas citri* pv. *malvacearum* is the most widespread and destructive disease inflicting yield losses ranging from 10% to 30%. Roving survey was conducted to assess the severity and the distribution of bacterial blight in eight major cotton growing districts of Tamil Nadu during two seasons viz., winter 2021 and summer 2022. The results revealed that the highest bacterial blight incidence of 18.5 PDI (Percent Disease Index) was recorded in Ramanathapuram village of Salem district followed by Kallipalayam village of Coimbatore district in which 15.7 PDI was registered. The least incidence of 2.9 PDI was found in Ramalingapuram village of Virudhunagar district. The mean district incidence of the bacterial blight during the winter and the summer seasons of 2021 and 2022 ranged from 3.5 to 16.0 PDI and 2.6 to 13.8 PDI respectively. The maximum PDI of 16.0 was found in Salem district and the minimum of 3.5 PDI was recorded in Virudhunagar district during winter season 2021. Pin prick inoculation method was proved to be the best method for artificial inoculation studies.

**Keywords:** Cotton, bacterial blight, incidence, assessment

### 1. Introduction

Cotton (*Gossypium* spp.) is a unique economically important fibre crop and it is widely cultivated throughout India. Cotton known as "White Gold" contributes to 35% of the global fabric needs and 60% of clothing in India (Jagtap *et al.*, 2012) [7]. Cotton is grown over 12.90 million hectares in India, accounting for 41% of the global area. Apart from hybrid cotton, India is the only country which cultivates all four cultivable *Gossypium* species: *Gossypium arboreum*, *Gossypium herbaceum* (Asian cotton), *Gossypium barbadense* (Egyptian cotton), and *Gossypium hirsutum* (Upland cotton) (Blaise and Kranthi 2019) [1]. Cotton crop is affected by more than 60 diseases, including root rot, wilt, boll rot, leaf spot complex, grey mildew, bacterial blight, and leaf curl (Chohan *et al.*, 2020) [4]. Among these bacterial blight incited by *Xanthomonas citri* pv. *malvacearum*, is a major disease prevailing in entire cotton growing regions of India. The disease was first reported in United States during 1891 and at present it is a wide spread devastating disease across the world (Kemerait *et al.*, 2017) [9]. The bacterium infects all parts of the cotton plant above ground, but the bolls are the most vulnerable for infection. Seedling blight, angular necrotic patches, vein blight and boll rot are the characteristic symptoms of bacterial blight. Depending on the cultivar and crop age, the yield loss due to bacterial blight ranges from 1% to 27% (Mishra and Ashok 2001) [12]. Boll yield loss up to 35% have been documented due to bacterial blight infection (Sheo Raj and Verma 1988) [14]. Due to the advent of development of new strains, the most effective surveillance for plant health is highly imperative. A periodic study of disease incidence paves the way for ascertaining the general health of the plant, identifying the hotspots locations, developing disease forewarning models and designing effective management strategies. With this view the present investigation was carried out with an objective of assessing the status of bacterial blight incidence in cotton in major growing districts of Tamil Nadu and to identify the endemic or hot spot area.

### 2. Materials and Methods

#### 2.1 Assessment of bacterial blight incidence in major cotton growing region of Tamil Nadu

Roving survey was undertaken in eight cotton growing districts of Tamil Nadu viz., Coimbatore, Dindugal, Virudhunagar, Tuticorin, Tirunelveli, Trichy, Salem and Perambalur

during two seasons *viz.*, winter 2021 and summer 2022 to assess the severity of bacterial blight in cotton. In each district minimum of three villages were selected and from each village, five fields were selected. From each field 50 plants were selected randomly the disease severity was assessed in 20 leaves in each plant by using the disease score chart (0- 4 grade) as furnished below. The expression of characteristic symptoms of bacterial blight *viz.*, angular leaf spot, vein blight and boll rot symptoms were recorded.

Disease grade	Description
0	Immune, completely free from bacterial blight
1	Highly resistant, infection 0 -10%
2	Moderately resistant, infection 11-20%
3	Moderately susceptible, infection 20-40%
4	Highly susceptible, infection more than 40%

The percent disease index was derived using the following formula, as given by Sheo Raj (Raj, 1988) <sup>[13]</sup>

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of individual ratings}}{\text{Total number of leaves observed}} \times \frac{100}{\text{Maximum grade}}$$

Cotton plants naturally infected with bacterial blight were obtained from different regions of Coimbatore. The infected samples were carefully placed in plastic bags, labelled, and taken to the laboratory. Sterilized distilled water was used to wash the samples completely.

## 2.2 Isolation of bacterial blight pathogen

Bacterial blight pathogen *Xanthomonas citri* pv. *malvacearum* was isolated from cotton leaf which showed typical angular leaf spot symptoms. The infected portions were cut into 2–3 mm pieces along with some healthy tissue and surface sterilized with 0.1% mercuric chloride (HgCl<sub>2</sub>) solution for 30s and washed thrice in a series of sterile distilled water. The leaf bits were crushed with a drop of sterile water using sterile glass rod and the resultant suspension was streaked on Petri plates containing nutrient agar (NA) medium (Verma and Jayaraman 2002) <sup>[16]</sup>. Petri plates were incubated at 28°C for 24 hours. Isolated cultures showing sparkling, dull to pale yellow, spherical, convex, and mucoid colonies (Kumar, A.S *et al.*, 2020) <sup>[11]</sup> was purified and maintained on Nutrient Agar (NA) medium.

## 2.3 Pathogenicity assay

### 2.3.1 Preparation of inoculum

The pathogen pellet of *Xanthomonas citri* pv. *malvacearum* was prepared by centrifugation of a 24-hours old culture multiplied in nutrient broth. The pathogen inoculum concentration was adjusted to 2x10<sup>9</sup> CFU/ml by using sterile distilled water (Kumar, A. S *et al.*, 2020) <sup>[11]</sup>.

The bacterial suspension was inoculated on 20-day-old LRA 5166 cotton seedlings grown in pots using coco pith as a growth medium by adopting three different inoculation methods as detailed below.

**Pin prick injury:** A sterilized needle was used to cause damage on the upper surface of cotton leaves and the bacterial suspension was applied on the leaves by using sterile cotton (Verma and Singh 1970) <sup>[17]</sup>.

**Syringe inoculation on lower surface of leaves without needle:** A needleless sterile hypodermic syringe was utilised. Pathogen inoculum were taken into the barrel through the needle hub and inoculated on the leaf lamina using mild pressure on the lower surface of leaves (Chakrabarty PK *et al.*, 1997) <sup>[2]</sup>.

**Syringe inoculation on lower surface of leaves with needle:** A sterile hypodermic syringe with needle was used for inoculation. Bacterial suspension drawn using a needle and injected into veins on the lower surface of leaves.

## 3. Results and Discussion

The bacterial pathogen *X. citri* pv. *malvacearum* infects cotton plants at all phases of development causing seedling blight, angular leaf spot, vein blight, black arm, and boll rot symptoms. Cotton bacterial blight can cause distinctive angular, water-soaked lesions on the leaves (Innes, N. L. 1983) <sup>[6]</sup>. A severe bacterial blight infection leads to early defoliation and boll shed, which cause severe reduction in yield. The disease causes significant losses by reducing photosynthetic activity by depleting chlorophyll concentration in leaves and stems.

Roving survey was conducted in eight cotton-growing districts of Tamil Nadu *viz.*, Coimbatore, Dindugal, Virudhunagar, Tuticorin, Tirunelveli, Trichy, Salem and Perambalur during two seasons *viz.*, winter 2021 and summer 2022. A total of 28 villages were surveyed from above eight districts. Among these, the maximum bacterial blight incidence of 18.5 PDI was recorded in Ramanathapuram village of Salem district followed by Kallipalayam village of Coimbatore district where in bacterial blight incidence of 15.7 PDI was observed. The lowest incidence of 2.9 PDI was found in Ramalingapuram village of Virudhunagar district. In Coimbatore, Dindigul and Virudhunagar districts the angular leaf spot and boll rot were the predominant symptoms observed. In Tuticorin, Tirunelveli and Trichy districts angular leaf spot was widely expressed in surveyed villages. The symptoms *viz.*, angular leaf spot, vein blight and boll rot were found to be severe in cotton growing villages of Perambalur and Salem districts (Table 1). Similar types of symptoms produced by bacterial blight of cotton was earlier reported by Essenberg *et al.* (2014) <sup>[5]</sup> and Kumar, A. S *et al.* (2019) <sup>[10]</sup> in the field grown crops.

The mean district incidence of bacterial blight during winter 2021 and summer 2022 ranged from 3.5 to 16.0 PDI and 2.5 to 13.8 PDI respectively. The district average was found to be high in Salem district during both the seasons where the PDI of 16.0 and 13.8 were recorded in winter and summer seasons respectively. In Coimbatore district the average incidence of 11.5 and 9.1 PDI was observed during winter and summer seasons respectively. The lowest mean district incidence of 3.5 PDI and 2.5 recorded in Virudhunagar district during these seasons (Fig 1& 2.). The prevalence of cotton bacterial blight in three major cotton growing regions of India comprising of six states *viz.*, Punjab (North zone), Maharashtra (Central zone), Tamil Nadu, Karnataka, Andhra Pradesh and Telangana (South zone, during the crop seasons 2015-2016 and 2016-2017 was documented by Kumar, A. S *et al.* (2019) <sup>[10]</sup>. They reported bacterial blight incidence of 3-12% in Tamil Nadu. Jagtapa *et al.* (2012) <sup>[8]</sup> carried out extensive survey on bacterial blight in Marathwada region of Maharashtra during 2012 and found the highest disease

incidence in Parbhani district (67%) and the lowest in Jalna district (36%). In Southern parts of Gujarat, the bacterial blight disease incidence of 15-30% was recorded in susceptible cultivars *viz.*, Surat dwarf and LRA 5166 (Sandipan *et al.*, 2016) [15]. The bacterial blight incidence of 21.98 PDI was found in Dharwad district of Karnataka (Chattannavar *et al.*, 2010) [3].

In this investigation three method of inoculation *viz.* pin prick method, syringe inoculation with needle and without needle were evaluated for standardizing the best method for artificial inoculation studies. Among these, pin prick method expressed

the symptoms earlier when compared to other methods. In this method of inoculation, the symptoms *viz.*, angular leaf spot and vein blight were observed within 10-15 Days After Inoculation (DAI) and showed the maximum PDI of 25.50. This was in corroboration with the findings of Kumar, A. S *et al.* (2020) [11] who observed maximum PDI of 64.25 in pin prick method within 20-24 days of inoculation. In the present study, syringe inoculation method with needle, symptom appears only after 15 DAI with the lowest disease incidence of 17.40 PDI (Table 2). Hence from this investigation it was inferred that, pinprick method was the best method for artificial inoculation studies.

**Table 1:** Incidence of bacterial blight disease in cotton growing regions of Tamil Nadu (Winter season 2021)

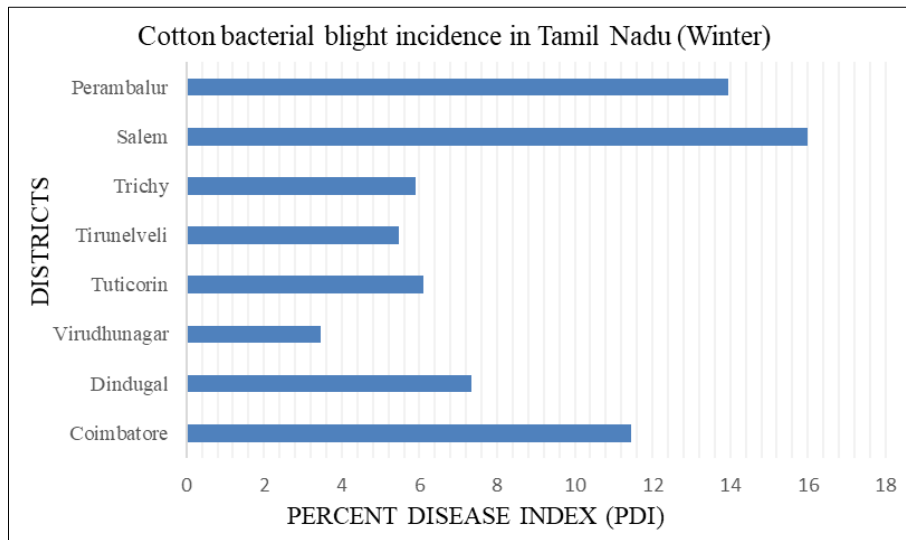
S. No	Villages	District	GPS Coordinates	Percent Disease Index (PDI)*	Symptoms
1	Kallipalayam	Coimbatore	11.1600°N,76.941°E	15.7 <sup>b</sup>	Angular leaf spot, Boll rot
2	Senthampalayam		11.8161°N,77.5356°E	12.3 <sup>d</sup>	
3	Kovilpalayam		11.9548°N,77.507°E	10.6 <sup>ef</sup>	
4	Vellamadai		11.9527°N,76.5914°E	8.7 <sup>g</sup>	
5	Thottipalayam		11.0439°N,76.5532°E	11.5 <sup>de</sup>	
6	Samanaickenpalayam		11.1653°N,76.9863°E	9.9 <sup>f</sup>	
7	Guvayanayakkanpatti	Dindugal	10.2144°N,77.5032°E	7.8 <sup>gh</sup>	Angular leaf spot, Boll rot
8	Karaiyagoundanpatti		10.2639°N,77.4830°E	6.5 <sup>i</sup>	
9	Boothipuram		10.1437°N,77.5267°E	7.7 <sup>gh</sup>	
10	Subramaniapuram	Virudhunagar	9.1550°N,78.5485°E	3.5 <sup>no</sup>	Angular leaf spot, Boll rot
11	Ramalingapuram		9.2614°N,78.4983°E	2.9 <sup>o</sup>	
12	Cholapuram		9.0521°N,78.0231°E	4.0 <sup>mn</sup>	
13	Villiseri	Tuticorin	9.2331°N,77.4865°E	7.6 <sup>h</sup>	Angular leaf spot
14	Nalattumuthur		9.3921°N,77.4920°E	5.9 <sup>ijk</sup>	
15	Shanmugapuram		9.1547°N,77.5226°E	4.8 <sup>lm</sup>	
16	Sankarankovil	Tirunelveli	9.1865°N,77.5834°E	6.9 <sup>hi</sup>	Angular leaf spot
17	Perumalpatti		9.3263°N,77.5785°E	5.3 <sup>ikl</sup>	
18	Manur		8.8550°N,77.6522°E	4.2 <sup>mn</sup>	
19	Muthuvathoor	Trichy	10.9772°N,78.9720°E	6.3 <sup>ij</sup>	Angular leaf spot
20	Kallakudi		10.9916°N,78.9424°E	6.5 <sup>i</sup>	
21	Varakkuppai		10.9982°N,78.9365°E	4.9 <sup>klm</sup>	
22	Thamukkupalayam	Salem	11.3064°N,78.4521°E	13.7 <sup>c</sup>	Angular leaf spot, Boll rot, Vein blight
23	Ramanathapuram		11.2930°N,78.4443°E	18.5 <sup>a</sup>	
24	Vazhapadi		11.3940°N,78.2240°E	14.3 <sup>b</sup>	
25	Veppamthattai	Perambalur	11.2151°N,78.4815°E	14.9 <sup>b</sup>	Angular leaf spot, Boll rot, Vein blight
26	Nerkunam		11.4323°N,78.8390°E	15.0 <sup>b</sup>	
27	Venbavur		11.3765°N,78.8285°E	13.5 <sup>c</sup>	
28	Krishnapuram		11.3878°N,78.7827°E	12.4 <sup>d</sup>	
	S.E <sub>(d)</sub>			0.371	-
	CD (P= 0.05)			0.744	-

\*Mean of three replications

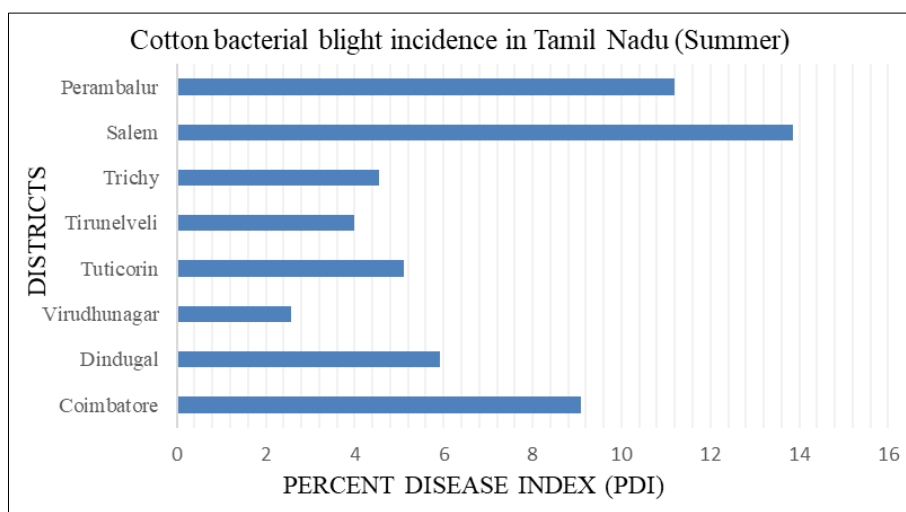
In a column any two means having common letter is not significantly different at 5% level of DMRT

**Table 2:** Efficacy of different methods of inoculation of *Xanthomonas citri* pv. *malvacearum* in the development of bacterial blight in cotton

S. No	Method of inoculation	Days taken for symptom development	Symptom expression	Percent Disease Index (PDI)
1	Pin prick injury	10-15	Angular leaf spot, vein blight	25.50
2	Syringe inoculation on lower surface of leaves without needle	12-16	Angular leaf spot, Vein blight	18.75
3	Syringe inoculation on lower surface of leaves with needle	15-17	Angular leaf spot	17.40



**Fig 1:** Bacterial blight incidence in different districts of Tamil Nadu during winter 2021



**Fig 2:** Bacterial blight incidence in different districts of Tamil Nadu in summer 2022

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