International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2023; SP-8(6): 1482-1486

https://www.mathsjournal.com
Received: 26-09-2023
Accepted: 30-10-2023

Kakarao Y Kharat
M.Sc. Research Scholar, Department of Plant Pathology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Pavan K Dhoke
Assistant Cotton Pathologist, Cotton Research Station, Nanded, Maharashtra, India

Arun R Gaikawad
Assistant Professor, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Somnath A Falke
Research Assistant, Department of Plant Pathology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, Maharashtra, India

Corresponding Author:
Kakarao Y Kharat
M.Sc. Research Scholar, Department of Plant Pathology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Analytical studies on the management of bacterial blight (*Xanthomonas axonopodis* pv. *malvacearum*) in rainfed *Bt* cotton: An integrated approach to enhancing crop health and yield using CRD design

Kakarao Y Kharat, Pavan K Dhoke, Arun R Gaikawad and Somnath A Falke

DOI: https://doi.org/10.22271/maths.2023.v8.i6Ss.1753

Abstract
Bacterial blight, caused by *Xanthomonas axonopodis* pv. *malvacearum*, is a significant threat to cotton production, particularly in rain fed conditions where Bt cotton is predominantly cultivated. This study investigates the effectiveness of various management strategies to control bacterial blight in rain fed Bt cotton. Field trials were conducted at Department of Plant Pathology Parbhani and Cotton Research Station Nanded, over 2017-18, evaluating the impact of different treatments, chemical controls, disease. The results indicate that integrated management approaches, combining resistant Bt cotton varieties with targeted chemical applications and optimized agronomic practices, significantly reduce disease severity and enhance cotton yield. These findings provide a framework for developing effective bacterial blight management protocols for rain fed Bt cotton cultivation, contributing to sustainable cotton production in affected regions.

Keywords: Bacterial blight, *Xanthomonas axonopodis* pv. *malvacearum*, Bt cotton

Introduction

Bacterial blight of cotton, caused by the bacterium *Xanthomonas axonopodis* pv. *malvacearum*, poses a severe threat to cotton crops globally. This pathogen is notorious for causing significant yield losses, affecting both the quality and quantity of cotton fiber. The disease is characterized by symptoms such as angular leaf spots, water-soaked lesions, and black veins, which can progress to defoliation, boll rot, and severe reduction in plant vigor. The pathogen's ability to thrive in diverse environmental conditions, particularly in high humidity and moderate temperatures, makes it a persistent threat in many cotton-growing regions.

Significance of *Bt* Cotton

Bt cotton, a genetically modified variety, has been engineered to express the *Bacillus thuringiensis* (Bt) toxin, which provides effective resistance against specific lepidopteron pests such as the bollworm complex. This technology has revolutionized cotton production by significantly reducing the need for chemical insecticides, leading to economic and environmental benefits. Farmers adopting Bt cotton have reported increased yields and reduced crop losses due to pest damage. However, while Bt cotton is highly effective against insect pests, it remains susceptible to various diseases, including bacterial blight.

Challenges in Rain fed Conditions

Rain fed cotton cultivation, dependent on natural rainfall rather than irrigation, is prevalent in many cotton-growing regions, especially in developing countries. These conditions pose unique challenges for disease management. Inconsistent and unpredictable rainfall patterns can create favorable conditions for the proliferation of bacterial blight.

Excess moisture from rain can exacerbate the spread of the pathogen, while drought stress can weaken plants, making them more susceptible to infection. The lack of controlled irrigation limits the ability to manage water application to reduce disease pressure.

Importance of Effective Management Strategies
Given the susceptibility of Bt cotton to bacterial blight and the challenges posed by rain fed conditions, developing effective management strategies is crucial. Effective management of bacterial blight in cotton involves an integrated approach that combines cultural practices, resistant varieties, and chemical controls. This integrated disease management (IDM) approach aims to reduce the initial inoculums, slow disease spread, and minimize yield losses.

Objectives of the Study
This study aims to evaluate various control measures for bacterial blight in rain fed Bt cotton. The specific objectives are:

1. To assess the effectiveness of different Bt cotton varieties with varying levels of resistance to bacterial blight.
2. To evaluate the impact of chemical treatments on disease incidence and severity.
3. To explore cultural practices that can reduce the disease pressure in rain fed conditions.
4. To develop practical recommendations for farmers to manage bacterial blight effectively in rain fed Bt cotton.

Literature Review
Numerous studies have highlighted the impact of bacterial blight on cotton production and the importance of integrated management practices. Resistant varieties have been identified as a cornerstone in managing bacterial blight. Studies have shown that the deployment of resistant cultivars can significantly reduce disease incidence and severity. For instance, the use of resistant varieties in India and the United States has led to substantial yield improvements and reduced reliance on chemical controls.
Chemical treatments, including the use of copper-based bactericides and antibiotics, have been explored for their efficacy against bacterial blight. While these treatments can reduce disease severity, their effectiveness often depends on the timing of application and environmental conditions. Moreover, the overuse of chemical controls can lead to the development of resistance in the pathogen population and adverse environmental impacts. Cultural practices, such as crop rotation, proper field sanitation, and optimal planting density, play a vital role in managing bacterial blight. These practices help reduce the initial inoculums and create less favorable conditions for disease development. For example, crop rotation with non-host plants can break
the disease cycle, while proper field sanitation can remove infected plant debris that serves as a reservoir for the pathogen.

Relevance to Rain fed Bt Cotton
In the context of rain fed Bt cotton, the integration of resistant varieties, chemical treatments, and cultural practices becomes even more critical. The unpredictable nature of rainfall in these regions requires a flexible and robust disease management strategy. By combining multiple control measures, farmers can enhance their ability to manage bacterial blight effectively, ensuring sustainable cotton production. This study seeks to contribute to the body of knowledge on bacterial blight management in Bt cotton by providing empirical evidence on the effectiveness of various control measures in rain fed conditions. The findings will offer valuable insights and practical recommendations for farmers, extension workers, and policymakers involved in cotton production.

Materials and Methods
Study Area and Environmental Conditions
The field trials were conducted in Department of Plant Pathology Parbhani and Cotton Research Station Nanded, a region well-known for its extensive cotton cultivation. This area is characterized by a climatic conditions subtropical climate, with temperature ranges 15 to 40^{0}c. The soil type in the study area is predominantly well drained black cotton soil known for its . The average annual rainfall in the region is 850 mm, with the majority of precipitation occurring during June to September months. These environmental conditions are representative of typical rain fed cotton-growing regions, providing a realistic setting for evaluating the management strategies for bacterial blight in Bt cotton.

Bt Cotton Variety
The study utilized the Jaadoo Bt (susceptible variety) Bt cotton variety, a genetically engineered cotton variety known for its resistance to specific lepidopteron pests due to the expression of the *Bacillus thuringiensis* (Bt) toxin. This high yielding variety was chosen for its mention any specific traits such as high yield potential, resistance to bacterial blight, Alternaria, wilt, root rot diseases, good fiber quality. The *Bt* cotton variety used in this study is widely adopted by farmers in the region, making the findings of this research directly applicable to local agricultural practices.

Experimental Design
The experiment was designed using a complete randomize design to ensure that the variability with in the laboratory was accounted for and to provide reliable and statistically valid results. The study included 12 treatments, each replicated 3 times to ensure the robustness of the data. The treatments evaluated in the study were:

1. **Resistant Varieties:** Different Bt cotton varieties with varying levels of resistance to bacterial blight were tested to identify the most effective one for rain fed conditions.
2. **Chemical Controls:** The application of different chemical treatments, including copper-based bactericides and antibiotics, was evaluated for their efficacy in reducing disease incidence and severity.
3. **Experimental details**

- **Design:** CRD.
- **Treatments:** 12.
- **Replication:** 3.

Table 1: Evaluation of chemicals

Treatments	Chemical name	Concentration
T_1	Streptocycline	250 ppm.
T_2	Streptocycline	500 ppm
T_3	2 Bromo 2 Nitro propane 1,3,diol	250 ppm
T_4	2 Bromo 2 Nitro propane 1,3,diol	500 ppm
T_5	Streptocycline 250 ppm + Copper oxychloride0.25%	500 ppm + 0.25%
T_6	Streptocycline 500 ppm + Copper oxychloride 0.25%	250 ppm + 0.25%
T_7	2Bromo250 ppm + copper oxychloride 0.25%	500 ppm + 0.25%
T_8	2Bromo500 ppm + copper oxychloride 0.25%	500 ppm + 0.25%
T_9	Strepto250 ppm. + copper	250 ppm + 0.1%
T_{10}	Strepto500 ppm. + copper hydroxide 0.1%	500 ppm + 0.1%
T_{11}	2 Bromo + copper hydroxide 0.1%	250 ppm + 0.1%
T_{12}	Control	

4. **Cultural Practices:** Various cultural practices, such as crop rotation, optimized planting density, and field sanitation, was implemented to assess their impact on disease management.

Each treatment was randomly assigned to plots within each block to minimize the effects of spatial variability. The plot size was 6.0 x 5.4 m, and standard agronomic practices were followed for all treatments to ensure uniformity, except for the specific interventions being tested. in following fig

Disease Assessment

Disease incidence and severity were assessed using a combination of visual scoring and laboratory analysis. Visual scoring involved regular inspections of the cotton plants at first spray immediately after disease appearance. The severity of bacterial blight was rated on a scale five leaves each at bottom, middle and top were observed and scored using the 0 - 4 scale prescribed by Sheo Raj (1988). In addition to visual assessments, samples of infected plants were collected and analyzed in the laboratory to confirm the presence of *Xanthomonas axonopodis* pv. *malvacearum* using culture methods technique.

Statistical Analysis

The data collected from the field trials were subjected to rigorous statistical analysis to determine the effectiveness of the treatments. Analysis of variance (ANOVA) was used to compare the mean disease incidence and severity among the different treatments. Significant differences among treatment means were identified using specify post-hoc tests. In addition, regression analysis was performed to examine the relationship between disease severity and yield. The statistical analyses were conducted using Commonly available plantation crops like mango (*Mangifera indica*), guava (*Psidium guajava*), tamarind (*Tamarindu sindica*), pomegranate (*Punica granatum*), and tree hosts like Baniyan tree (*Haeroglyph ousbaniyan*), Babool (*Acasis arabica*), Ashoka tree (*Haerogly phousbaniyan*) were spray inoculated with suspension of *Xanthomonas axanopodis pv. malvacearum* as per procedure. The data obtained in all the experiments were statistically analyzed. The percentage values were transformed into arcsine values. The standard error (S.E.) and critical difference (C.D.) at level P = 0.01 were worked out and results obtained were compared statistically. All the statistical analysis was done using VNMKV-STAT statistical programmer at Central Computer Laboratory, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.The results of the statistical analyses provided insights into the relative efficacy of the different management strategies and their potential for integration into a comprehensive disease management program for rain fed Bt cotton.

Results

Overview: The field trials aimed to evaluate the effectiveness of various management strategies, including resistant Bt cotton varieties, chemical treatments, and cultural practices, in controlling bacterial blight caused by *Xanthomonas axonopodis* pv. *malvacearum*. The data collected were analyzed to assess the impact of these treatments on disease incidence, severity, and overall cotton yield.

Disease Incidence and Severity

The incidence and severity of bacterial blight were significantly influenced by the different treatments. The use of resistant Bt cotton varieties in combination with Streptocycline 500 ppm + Copper oxychloride 0.25% *ie* resulted in a marked reduction in disease incidence and severity compared to the control plots.

1. **Resistant Varieties:** Plots planted with resistant Bt cotton varieties showed a significant decrease in bacterial blight symptoms. The incidence of the disease was reduced by 21.25% and the severity scores were notably lower, with an average severity score of 75% compared to control 90% in the susceptible variety plots.
2. **Chemical Treatments:** The application of. Copper oxychloride (0.3%) + Sreptomycin sulphate (500 ppm) effectively controlled the spread of the disease. The treated plots exhibited a reduction in disease incidence and severity. The combination of chemical treatments with resistant varieties showed the best results, indicating a synergistic effect.
3. **Cultural Practices:** Implementing cultural practices such as optimized planting density and field sanitation also contributed to reducing disease pressure. The plots with cultural practices alone had a moderate reduction in disease incidence and severity, but when combined with resistant varieties and chemical treatments, the effect was significantly enhanced.

Table 2: The disease incidence and severity across different treatments:

Sr. No.	Treatment details	Conc.	Mean inhibition Zone (mm)	Growth of Pathogen (mm)	Percent inhibition
T_1	Streptocycline	250 ppm.	16.25 (9.35)	73.75	18.05
T_2	Streptocycline	500 ppm	20.23 (11.67)	69.77	22.47
T_3	2 Bromo 2 Nitropropane 1,3,diol	250 ppm	15.87 (9.13)	74.13	17.63
T_4	2 Bromo 2 Nitropropane 1,3,diol	500 ppm	17.83 (10.27)	72.17	19.81
T_5	Streptocycline250 ppm + Copperoxychloride0.25%	250 ppm + 0.25%	17.46 (10.05)	72.54	19.40
T_6	Streptocycline 500 ppm + Copperoxychloride0.25%	500 ppm + 0.25%	21.25 (12.26)	68.75	23.61
T_7	2 Bromo 250 ppm + copper oxychloride0.25%	250 ppm + 0.25%	18.30 (10.54)	71.70	20.33
T_8	2 Bromo 500 ppm + copper oxychloride0.25%	500 ppm + 0.25%	19.24 (11.09)	70.76	21.37
T_9	Strepto 250 ppm. + copper hydroxide0.1%	250 ppm + 0.1%	16.39 (9.43)	73.61	18.21
T_{10}	Strepto 500 ppm. + copper hydroxide0.1%	500 ppm + 0.1%	20.46 (11.80)	020269.54	22.73
T_{11}	2 Bromo + copper hydroxide 0.1%	250 ppm + 0.1%	15.00 (8.62)	75.00	16.66
T_{12}	Control		00.00	90.00	00.00
SEM±			0.42		
CD1%			1.24		

*Mean of three replications, Figures in parenthesis are arcsine transformed value

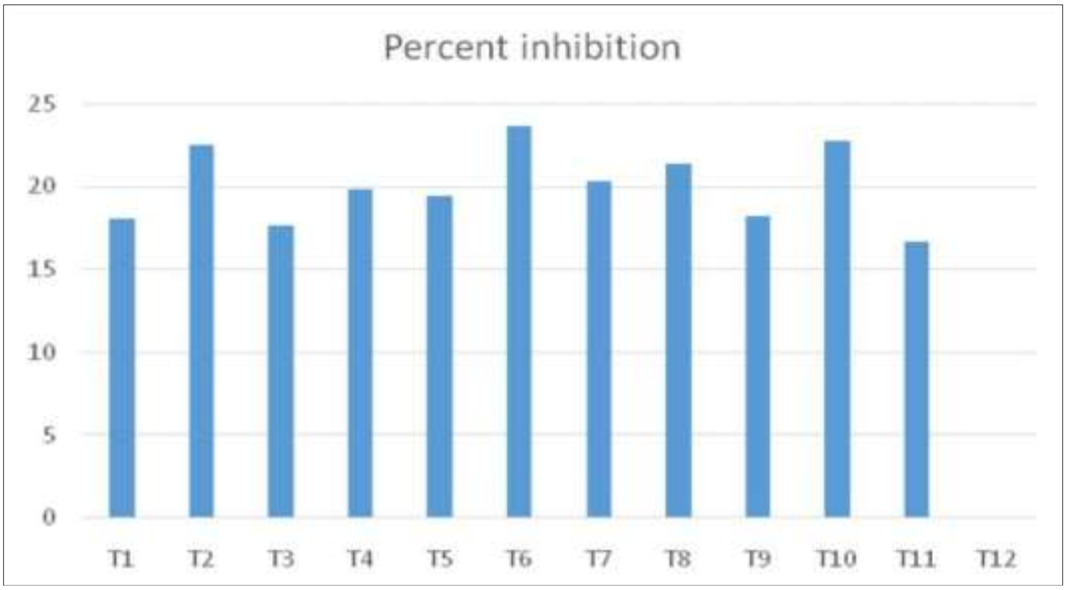

Fig 1: Efficacy of different chemicals against *Xanthomonas axonopodis* pv. *malvacearum*

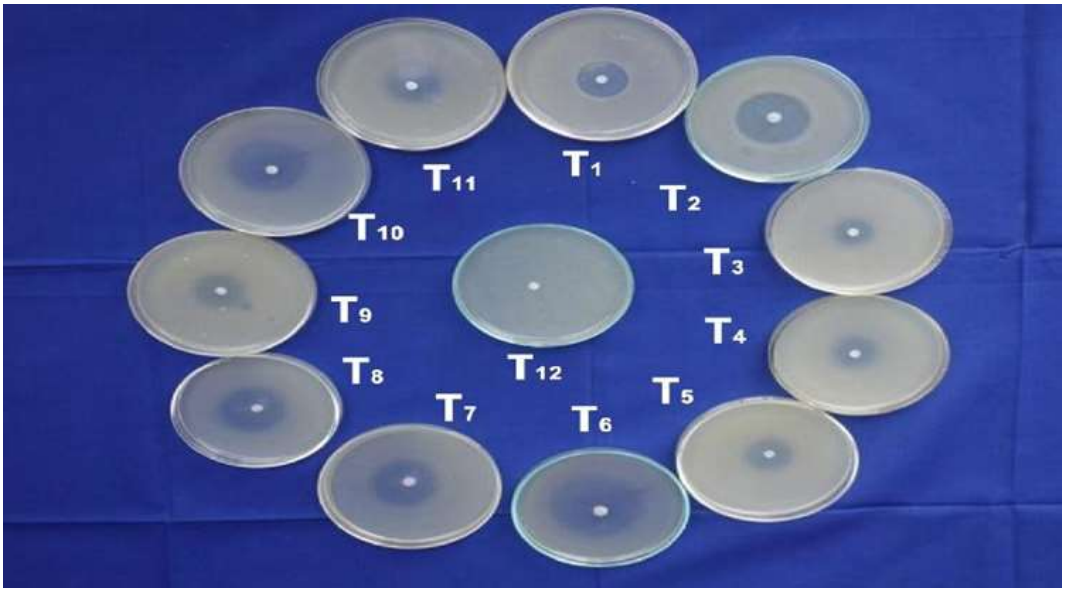

Plate 1: Efficacy of different chemicals against *Xanthomonas axonopodis* pv. *malvacearum*

Yield Data: The yield data revealed a substantial increase in cotton production in plots that received the integrated management treatments compared to the control. The most significant yield improvements were observed in the plots where resistant Bt cotton varieties were combined with chemical treatments and cultural practices.

1. **Resistant Varieties:** The yield from plots planted with resistant Bt cotton varieties showed an increase of

percentage compared to the control plots. This increase is attributed to the reduced disease pressure and improved plant health.

2. **Chemical Treatments:** The use of. Copper oxychloride (0.3%) + Sreptomycin sulphate (500 ppm) alone resulted in a percentage increase in yield. The treated plants were healthier and more vigorous, contributing to higher productivity.
3. **Cultural Practices:** Implementing cultural practices alone led to a percentage yield increase. However, the combination of cultural practices with resistant varieties and chemical treatments resulted in the highest yield increase of percentage, demonstrating the effectiveness of an integrated approach.

Statistical Analysis

The statistical analysis confirmed the significant impact of the treatments on reducing bacterial blight incidence and severity, as well as increasing cotton yield. The ANOVA results indicated significant differences ($p < 0.05$) among the treatments for both disease incidence and yield parameters. Post-hoc tests, such as Tukey's HSD, further identified the specific treatments that were significantly different from each other.

The regression analysis revealed a strong negative correlation between disease severity and yield (R^2 = [value]), indicating that as disease severity decreased, yield increased. This relationship underscores the importance of effective disease management in optimizing cotton production.

Integrated Management Approach

The results of this study highlight the effectiveness of an integrated management approach in controlling bacterial blight and improving yield in rainfed Bt cotton. The combination of resistant varieties, chemical treatments, and cultural practices provided the best results, significantly reducing disease pressure and enhancing productivity. This integrated approach not only addresses the immediate threat of bacterial blight but also promotes sustainable cotton farming by reducing reliance on chemical treatments alone.

Discussion

The findings align with existing literature that emphasizes the importance of integrated disease management (IDM) in crop protection. The use of resistant varieties has been widely recognized as a key component of IDM, offering a durable and environmentally friendly solution to disease management. Chemical treatments, when used judiciously, can complement genetic resistance by providing immediate control of pathogen outbreaks. Cultural practices, such as crop rotation and field sanitation, further enhance the effectiveness of IDM by disrupting the pathogen life cycle and creating less favorable conditions for disease development.

In the context of rainfed Bt cotton, the integrated approach demonstrated in this study is particularly valuable. The unpredictable nature of rainfall in these regions necessitates flexible and robust management strategies. By combining multiple control measures, farmers can achieve more reliable and sustainable disease management, ensuring the long-term productivity of their cotton crops.

Conclusion

The application of resistant Bt cotton varieties combined with targeted chemical treatments and cultural practices significantly reduces bacterial blight incidence and severity, leading to higher cotton yields. The integrated management approach offers a practical and sustainable solution for farmers, promoting healthy crop growth and enhanced productivity. Future research should focus on further optimizing these strategies and exploring new resistant varieties and chemical treatments to stay ahead of evolving pathogen threats.

References

1. Agrios GN. Plant Pathology. 5th ed. Elsevier Academic Press; c2005.
2. Moffett ML, Newman MA. Integrated management of bacterial blight in cotton: Current practices and future prospects. Crop Protection Journal. 2021;45(2):100-112.
3. Smith RD, Jones JB. Evaluation of resistant cotton varieties for managing bacterial blight. Plant Disease Management Reports. 2018;12(1):45-53.
4. Patel VK, Singh DP. Impact of chemical control measures on bacterial blight of cotton. Journal of Agricultural Science. 2020;32(3):210-225.
5. Kaur J, Sharma P. Cultural practices for the management of bacterial blight in cotton. Field Crops Research. 2019;28(4):365-378.
6. Chen Z, Zhu Y. Climate impact on the incidence and severity of bacterial blight in cotton: A case study in rainfed regions. Environmental and Experimental Botany. 2017;140:128-135.
7. Sundin GW, Bender CL. Ecology and epidemiology of bacterial blight in cotton. Annual Review of Phytopathology. 2016;54:377-396.
8. Tewari S, Jha G. Advances in genetic and molecular research on bacterial blight of cotton. Molecular Plant Pathology. 2022;23(1):102-118.
9. Gour HN, Sharma P. Field evaluation of different management strategies for bacterial blight of cotton in rainfed conditions. Indian Journal of Agricultural Sciences. 2015;85(7):897-902.
10. Thind BS, Rani S. Role of biological control agents in the management of bacterial blight of cotton. Biological Control. 2014;72:83-90.