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Growth and productivity of *Bt* cotton (*Gossypium hirsutum*) in various agro-climatic conditions

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Abstract
This study investigates the growth and productivity of *Bt* cotton (*Gossypium hirsutum*) across three distinct agro-climatic zones in India: tropical, subtropical, and arid regions. By analyzing key growth parameters and productivity indicators such as plant height, number of branches, boll weight, boll count per plant, fiber length, and fiber strength, the research aims to determine the optimal conditions for maximizing yield and improving cotton quality. Field trials were conducted from June 2022 to March 2023 using a randomized complete block design with three replications in each zone. The results showed significant differences in growth and productivity across the zones, with the tropical zone demonstrating the most favorable conditions. These findings provide valuable insights into the adaptability and performance of *Bt* cotton, informing agricultural practices and policy decisions to enhance productivity and economic benefits for farmers.

Keywords: Agro-climatic conditions, *Bt* cotton, *Gossypium hirsutum*

Introduction
Cotton is a crucial cash crop globally, providing raw materials for the textile industry and livelihoods for millions of farmers. The introduction of *Bt* cotton (*Gossypium hirsutum*), genetically modified to express the *Bacillus thuringiensis* (Bt) toxin, has significantly increased cotton productivity and reduced pesticide use. *Bt* cotton has been widely adopted in various parts of the world due to its resistance to pests, particularly the bollworm complex, which has historically caused substantial yield losses in conventional cotton farming. Despite the benefits of *Bt* cotton, its growth and productivity are highly influenced by agro-climatic conditions. Agro-climatic zones are geographical areas characterized by specific climate conditions, including temperature, rainfall, and soil type, which can significantly affect agricultural practices and crop performance. Understanding the impact of these environmental factors on *Bt* cotton is essential for optimizing its cultivation and maximizing yield and fiber quality. India, with its diverse geography and climate, offers a unique opportunity to study the influence of different agro-climatic zones on *Bt* cotton. The tropical zone, represented by Maharashtra, experiences high temperatures and significant rainfall, providing a warm and humid environment conducive to cotton growth. The subtropical zone, represented by Gujarat, features moderate temperatures and rainfall, offering a balanced climate that supports cotton cultivation. The arid zone, represented by Rajasthan, presents a challenging environment with high temperatures and limited rainfall, posing stress conditions for cotton plants. Previous studies have highlighted the importance of environmental factors in determining cotton growth and productivity. Research by Kumar *et al*. (2014) [1] and Sharma *et al*. (2016) [26] emphasized the critical role of temperature and rainfall in influencing cotton yield and fiber quality. Additionally, studies by Patil *et al*. (2018) [3] and Singh and Kaur (2017) [4] demonstrated how different climatic conditions impact the growth parameters of *Bt* cotton. Given the significant influence of agro-climatic conditions on *Bt* cotton, this study aims to evaluate its growth and productivity across tropical, subtropical, and arid zones in India. By assessing key growth parameters, including plant height, number of branches, boll weight, boll count per plant, fiber length, and fiber strength, this research seeks to identify the optimal conditions for *Bt* cotton cultivation. The findings will provide valuable insights for farmers, agricultural practitioners, and policymakers to enhance *Bt* cotton productivity and economic returns.

Objective

To assess the growth and productivity of *Bt* cotton in different agro-climatic conditions and identify optimal conditions for maximizing yield and fiber quality.

Methodology

The study was conducted in three distinct agro-climatic zones in India: the tropical zone of Maharashtra, the subtropical zone of Gujarat, and the arid zone of Rajasthan. These zones were selected to represent a range of environmental conditions that influence the growth and productivity of *Bt* cotton (*Gossypium hirsutum*). The tropical zone of Maharashtra is located at an altitude of 300-600 meters above sea level, with coordinates ranging from 18 °N to 22 °N latitude and 72 °E to 80 °E longitude. The temperature in this zone ranges from 25-35 °C, and the annual rainfall is between 700-1200 mm. The subtropical zone of Gujarat is situated at an altitude of 100-300 meters above sea level, with coordinates from 20 °N to 24 °N latitude and 68 °E to 74 °E longitude. The temperature here ranges from 20-30 °C, with annual rainfall between 500-800 mm. The arid zone of Rajasthan is at an altitude of 100-300 meters above sea level, with coordinates from 23 °N to 29 °N latitude and 69 °E to 75 °E longitude. The temperature ranges from 20-40 °C, and the annual rainfall is between 200-500 mm.

Field trials were conducted from June 2022 to March 2023 using a randomized complete block design (RCBD) with three replications in each zone. *Bt* cotton seeds were sown at the onset of the monsoon season, with recommended agronomic practices followed uniformly across all sites to ensure consistency. Growth parameters, including plant height, number of branches, and leaf area, were measured at various growth stages. Boll formation, boll weight, and boll count per plant were recorded to assess productivity. Fiber quality parameters, including fiber length, strength, and micronaire, were analyzed using standard laboratory techniques. Data on plant growth, yield, and fiber quality were collected and subjected to analysis of variance (ANOVA) to determine the significance of differences between zones. Mean values and standard deviations were calculated for each parameter. Correlation analysis was performed to identify relationships between environmental factors and cotton productivity. The experimental data provided insights into the adaptability and performance of *Bt* cotton under different agro-climatic conditions, informing agricultural practices and policy decisions.

Results and Discussion

ANOVA: *Bt* cotton Growth and Productivity Parameters

Parameter	F-Value	P-Value
Number of Branches	38.600	0.000375
Boll Weight (g)	48.538	0.000197
Boll Count per Plant	18.750	0.002624
Fiber Length (mm)	52.615	0.000157
Fiber Strength (g/tex)	52.615	0.000157

The results of the ANOVA indicate significant differences in several growth and productivity parameters of *Bt* cotton across the three agro-climatic zones. The number of branches per plant showed a highly significant difference (F-Value = 38.600, P-Value = 0.000375) among the zones. This suggests that environmental factors, such as temperature and rainfall, significantly influence the branching of *Bt* cotton. Tropical zone plants exhibited the highest number of branches, likely due to the favorable warm temperatures and adequate rainfall supporting vegetative growth. Boll weight also varied significantly (F-Value = 48.538, P-Value = 0.000197) across the zones. Tropical zones recorded the highest boll weights, followed by subtropical and arid zones. The consistent warmth and sufficient rainfall in tropical regions likely contributed to the higher boll weights, as these conditions are conducive to the development and maturation of bolls. The boll count per plant showed significant variation (F-Value = 18.750, P-Value = 0.002624). Tropical and subtropical zones had higher boll counts compared to the arid zone. The reduced boll count in the arid zone can be attributed to the high temperatures and limited rainfall, which stress the plants and reduce boll formation. Fiber length displayed significant differences (F-Value = 52.615, P-Value = 0.000157), with tropical zone fibers being the longest, followed by subtropical and arid zones. The optimal growth conditions in tropical regions, including adequate moisture and favorable temperatures, likely promoted the development of longer fibers. Fiber strength also varied significantly (F-Value = 52.615, P-Value = 0.000157) among the zones, with the strongest fibers observed in the tropical zone. The environmental conditions in tropical areas likely enhance the synthesis of cellulose and other structural components, resulting in stronger fibers. These findings highlight the substantial impact of agro-climatic conditions on the growth and productivity of *Bt* cotton. The tropical zone of Maharashtra provided the most favorable conditions, resulting in superior growth and higher yields. Subtropical zones also supported good growth and productivity, while the arid zone posed challenges due to higher temperatures and limited rainfall. This study underscores the importance of selecting suitable cultivation zones for *Bt* cotton to maximize yield and improve fiber quality. Future research should focus on developing climate-resilient *Bt* cotton varieties and optimizing agronomic practices to enhance productivity across diverse environmental conditions.

Conclusion

This study investigated the growth and productivity of *Bt* cotton (*Gossypium hirsutum*) across three distinct agro-climatic zones in India: tropical, subtropical, and arid regions. The findings reveal significant differences in key growth parameters, including the number of branches, boll weight, boll count per plant, fiber length, and fiber strength. These differences underscore the profound impact of environmental factors such as temperature, rainfall, and soil type on the performance of *Bt* cotton. The tropical zone of Maharashtra demonstrated the most favorable conditions for *Bt* cotton cultivation, with the highest growth rates, boll formation, and superior fiber quality. The subtropical zone of Gujarat also supported good growth and productivity, although to a lesser extent than the tropical zone. Conversely, the arid zone of Rajasthan posed significant challenges due to higher temperatures and limited rainfall, resulting in reduced growth and yield. The ANOVA results confirmed the significant influence of agro-climatic conditions on the growth and productivity of *Bt* cotton. The tropical zone consistently showed the best performance in all measured parameters, suggesting that warm temperatures and adequate rainfall are crucial for optimizing *Bt* cotton

yield and quality. The findings also indicate that while *Bt* cotton can be cultivated in diverse environmental conditions, its growth and productivity are maximized under specific optimal conditions. This study highlights the need for strategic selection of cultivation zones to enhance *Bt* cotton productivity and improve fiber quality. The insights gained from this research can inform agricultural practices and policy decisions, promoting the efficient use of resources and maximizing the economic benefits for farmers. Future research should focus on developing climate-resilient *Bt* cotton varieties and optimizing agronomic practices to further improve yield and fiber quality across diverse environmental conditions. By leveraging these findings, policymakers and agricultural practitioners can make informed decisions to support sustainable and productive *Bt* cotton cultivation, addressing the challenges of food security and agricultural sustainability.

References

1. Kumar R, Singh S, Reddy PR. Impact of agro-climatic conditions on growth and yield of *Bt* cotton. J Cotton Res Dev. 2014;28(3):215-222.
2. Sharma P, Verma S, Tripathi S. Influence of environmental factors on cotton productivity: A review. Int J Agric Sci. 2016;12(2):145-154.
3. Patil VP, Patil SR. Comparative performance of *Bt* cotton under different climatic conditions. J Agric Res. 2018;54(1):67-74.
4. Singh K, Kaur G. Growth and yield response of *Bt* cotton to varying environmental conditions. Indian J Plant Sci. 2017;5(4):29-34.
5. Rao MJ, Krishna R. Assessing the performance of *Bt* cotton in different agro-ecological zones. Agric Rev. 2015;36(2):125-132.
6. Johnson L, Singh R. Effect of climate on cotton growth and productivity. J Clim Change Agric. 2013;5(1):89-97.
7. Kumar A, Singh P. Nutrient uptake and soil health in cotton-based cropping systems. Soil Sci. 2019;48(4):321-329.
8. Nair RB, George S. Agronomic performance of *Bt* cotton in varied climatic conditions. J Crop Improv. 2018;32(3):281-295.
9. Rao PP, Reddy GM. Nutrient management in *Bt* cotton for enhancing productivity and nutrient use efficiency. Indian J Fertilisers. 2016;12(4):100-109.
10. Sharma N, Bhatt R. Performance of *Bt* cotton under different rainfall regimes. J Agron. 2020;56(2):203-211.
11. Singh V, Jain S. Influence of temperature on growth and yield of *Bt* cotton. J Agric Meteorol. 2015;71(1):112-119.
12. Patil SL, Raj PK, Chittapur BM. Impact of climate variability on *Bt* cotton production. Res J Agric Sci. 2016;8(2):110-117.
13. Johnson AM, Singh K. Evaluating the growth of *Bt* cotton in different agro-climatic zones. Int J Plant Res. 2017;30(3):145-153.
14. Verma RP, Shukla A. Climate resilience in *Bt* cotton cultivation: An overview. J Environ Biol. 2019;40(2):229-236.
15. Singh RB, Kaur S. Role of climatic factors in determining the yield of *Bt* cotton. J Agric Sci. 2018;15(3):85-94.
16. Kumar P, Reddy M. Analysis of growth performance of *Bt* cotton in diverse climates. J Crop Sci. 2015;50(4):230-240.
17. Amadou I, Le GW, Shi YH, Jin S. Red and white millet grains: nutritional quality and health benefits. Food Rev Int. 2013;29(3):256-264.