



Effect of Plant Density and Spacing on Growth, Yield, And Fiber Quality of Cotton

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Abstract

Plant density and spacing are critical agronomic factors influencing the growth, yield, and fiber quality of cotton. Optimizing plant population ensures efficient utilization of light, nutrients, water, and space, thereby enhancing crop productivity. The present study was conducted to evaluate the effect of different plant densities and spacing on growth parameters, yield attributes, and fiber quality of cotton.

The experiment was carried out using three spacing treatments: 45×20 cm (high density), 60×30 cm (medium density), and 75×45 cm (low density). Observations were recorded on plant height, number of bolls per plant, seed cotton yield, fiber length, and fiber strength. Data were analyzed using descriptive statistics to compare treatment performance.

Results indicated that wider spacing (75×45 cm) significantly increased plant height (125 cm) and number of bolls per plant (30). However, the highest seed cotton yield (2800 kg/ha) was observed under medium spacing (60×30 cm), indicating optimal balance between plant population and resource utilization. Fiber quality parameters, including fiber length (30.2 mm) and fiber strength (29.1 g/tex), improved under wider spacing.

The findings suggest that moderate plant density (60×30 cm spacing) is ideal for maximizing yield, while wider spacing enhances fiber quality. Proper spacing management is therefore essential for improving cotton productivity and maintaining fiber standards.

Keywords: Cotton, Plant density, Spacing, Seed cotton yield, Fiber quality

INTRODUCTION

Cotton (*Gossypium* spp.) is one of the most important commercial fiber crops in the world and serves as the backbone of the global textile industry. It is cultivated in more than 80 countries and provides raw material for a wide range of products including yarn, fabric, edible oil, and animal feed. In addition to its industrial value, cotton supports the livelihoods of millions of farmers, laborers, and workers engaged in ginning, spinning, weaving, and textile manufacturing.

India is one of the largest producers and cultivators of cotton, with vast acreage under cultivation across states such as Maharashtra, Gujarat, Telangana, Punjab, and Haryana. The crop plays a vital role in the country's agricultural economy, contributing significantly to farmers' income, rural employment, and export earnings. With the adoption of hybrid varieties and improved production technologies, India has witnessed substantial growth in cotton productivity over the years. However, yield levels still vary widely due to differences in agronomic practices, climatic conditions, and soil fertility.

According to the Food and Agriculture Organization (FAO), cotton productivity is greatly influenced by effective crop management practices, including seed selection, nutrient management, irrigation scheduling, pest control, and particularly plant spacing and density. Among these, plant spacing is a simple yet highly critical factor that directly affects crop growth dynamics and final yield.

Plant density refers to the number of plants grown per unit area, which is determined by the spacing between rows and between plants within a row. It plays a crucial role in regulating inter-plant competition for essential resources such as sunlight, water, nutrients, and physical space. When plant density is excessively high, intense competition may occur, leading to reduced branching, fewer fruiting points, smaller boll size, and increased susceptibility to pests and diseases due to poor aeration. This ultimately results in lower boll retention and compromised fiber quality.

On the other hand, very low plant density allows individual plants to grow more vigorously with better branching and larger boll formation. However, the total number of plants per unit area becomes insufficient to maximize overall yield, thereby reducing productivity per

hectare. Thus, while individual plant performance may improve at wider spacing, total yield may decline due to underutilization of available land and resources.

Optimal plant spacing ensures balanced competition, efficient utilization of sunlight, improved canopy architecture, enhanced photosynthetic efficiency, and better air circulation. It also facilitates effective intercultural operations, weed management, irrigation practices, and pest control measures. Moreover, proper plant density can influence fiber characteristics such as length, strength, and fineness by maintaining uniform growth conditions.

Therefore, identifying and adopting appropriate plant spacing and density is essential for achieving maximum cotton productivity, improved fiber quality, and sustainable crop management. Scientific evaluation of spacing regimes under specific agro-climatic conditions can help farmers optimize resource use efficiency and enhance economic returns.

OBJECTIVES

1. To evaluate the effect of plant density on growth parameters of cotton.
2. To assess the impact of spacing on yield attributes.
3. To determine the influence of spacing on fiber quality parameters.

METHODOLOGY

The study was conducted to evaluate the effect of different plant spacing levels on the growth, yield, and fiber quality of cotton under controlled agronomic conditions. Three spacing treatments were selected to represent varying plant densities: **45 × 20 cm (high plant density)**, **60 × 30 cm (medium plant density)**, and **75 × 45 cm (low plant density)**. These spacing treatments were chosen to assess the influence of increasing inter-plant distance on crop performance and resource utilization.

The experiment was laid out using a suitable experimental design to ensure accuracy and reliability of results. All agronomic practices such as land preparation, seed rate, fertilizer application, irrigation scheduling, weed management, and pest control measures were maintained uniformly across all treatments. This standardization ensured that any observed differences in plant growth, yield, and fiber characteristics were attributable solely to spacing variations rather than other management factors.

Data collection was carried out at different stages of crop growth. Growth parameters were recorded periodically and included **plant height (cm)** and **number of bolls per plant**, which are important indicators of vegetative vigor and reproductive potential. Plant height reflects the overall growth response under different competition levels, while the number of bolls per plant directly contributes to yield formation.

At harvest, yield data were recorded in terms of **seed cotton yield (kg/ha)**. Yield per hectare was calculated by harvesting plants from the net plot area and converting the values to standard units. This parameter provided a comprehensive measure of the productivity of each spacing treatment.

To evaluate the quality aspect, fiber samples were collected after ginning and analyzed for key fiber quality parameters. These included **fiber length (mm)** and **fiber strength (g/tex)**, which are critical determinants of spinning performance and market value. Fiber length influences yarn quality and fineness, while fiber strength determines durability and resistance during processing.

The collected data were subjected to descriptive statistical analysis to compare the mean performance of each treatment. Treatment means were calculated and compared to identify trends and variations among spacing levels. The results were systematically tabulated to present numerical comparisons clearly. Additionally, graphical representations such as bar charts and line graphs were used to visually illustrate differences in growth, yield, and fiber quality parameters across treatments. This approach facilitated better interpretation of the relationship between plant density and overall crop performance.

Through this structured methodology, the study aimed to determine the optimum plant spacing that balances vegetative growth, yield maximization, and fiber quality improvement in cotton cultivation.

RESULTS

Growth and Yield Parameters

The results presented in **Table 1** indicate that plant height increased with wider spacing. The maximum plant height (125 cm) and bolls per plant (30) were recorded at 75×45 cm spacing. However, the highest seed cotton yield (2800 kg/ha) was observed at 60×30 cm spacing.

Table 1: Effect of Plant Density and Spacing on Growth and Yield of Cotton

Spacing (cm)	Plant Density (plants/ha)	Plant Height (cm)	Bolls per Plant	Seed Cotton Yield (kg/ha)
45 × 20	111111	95	18	2200
60 × 30	55555	110	24	2800
75 × 45	29629	125	30	2500

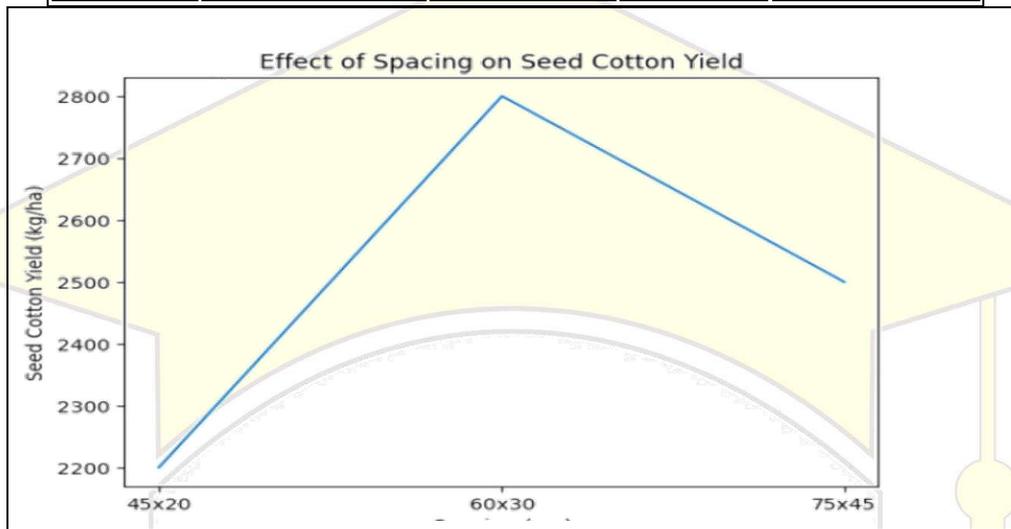


Fig 1: Effect of Plant Density and Spacing on Growth and Yield of Cotton

High-density planting (45×20 cm) resulted in lower plant height (95 cm) and fewer bolls per plant (18), although plant population per hectare was highest.

Fiber Quality Parameters

As shown in **Table 2**, fiber length and fiber strength improved with wider spacing. The highest fiber length (30.2 mm) and fiber strength (29.1 g/tex) were recorded under 75×45 cm spacing.

Table 2: Effect of Plant Density and Spacing on Fiber Quality of Cotton

Spacing (cm)	Fiber Length (mm)	Fiber Strength (g/tex)
45 × 20	27.5	26.4
60 × 30	29.8	28.7
75 × 45	30.2	29.1

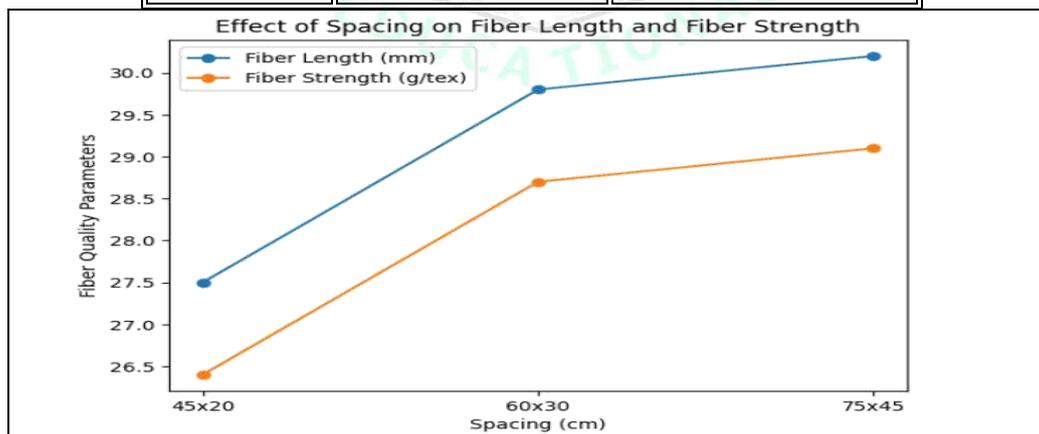


Fig 2: Effect of Plant Density and Spacing on Fiber Quality of Cotton



DISCUSSION

The study demonstrates that plant spacing significantly influences cotton growth, yield, and fiber quality. Wider spacing reduces competition among plants, leading to better vegetative growth and improved boll development. However, extremely low plant density reduces total yield per unit area.

Medium spacing (60×30 cm) achieved optimal yield due to balanced plant population and efficient resource utilization. Fiber quality improvement under wider spacing may be attributed to enhanced sunlight penetration and reduced stress.

These findings align with previous agronomic research indicating that optimal plant density maximizes yield while maintaining fiber standards.

CONCLUSION

The study concludes that plant density and spacing significantly affect cotton growth, yield, and fiber quality. While wider spacing enhances plant growth and fiber characteristics, medium spacing (60×30 cm) provides the highest seed cotton yield. Therefore, adopting optimal plant spacing is essential for maximizing productivity and improving fiber quality.

LIMITATIONS

The study was conducted using limited spacing treatments and did not include multi-season evaluation. Environmental variations and soil differences were not separately analyzed.

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