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Enhancing cotton yield and profitability through high-density planting system in Adilabad, Telangana

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Abstract

Cotton is one of the most important cash crops in India, providing income to millions of farmers and supporting the country's textile industry. In recent years, challenges such as labor shortages, water scarcity, and climate variability have affected cotton production. To address these issues, the High-Density Planting System (HDPS) was introduced in the Adilabad district of Telangana. This method involves planting cotton at closer spacing using early-maturing, compact varieties along with canopy management using growth regulators like Mepiquat chloride. Trials were conducted at five locations covering 2.0 hectares each. Results from two consecutive years showed that HDPS significantly increased yield by 32.94% compared to traditional methods. The system also improved economic returns, with higher net income and benefit-cost ratio. These findings indicate that HDPS is a promising strategy to enhance cotton productivity and profitability in the region.

Keywords: High-density planting system (HDPS), cotton yield, canopy management, Mepiquat chloride, economic returns, Adilabad, Telangana, sustainable agriculture

Introduction

Cotton (*Gossypium hirsutum* L.) is one of the most important cash crops in India and supports the country's largest organized industry—the textile sector. Often called “White Gold,” it plays a vital role in foreign exchange earnings and employment generation (Smith, 1999) [13]. Globally, China leads in cotton production, followed by India, the USA, and Brazil. During 2011-2024, cotton production peaked in 2011-2012. In India, cotton is considered the “King of fibre crops” and is grown in rainfed (67%) and irrigated (33%) areas. It is cultivated across three agro-climatic zones between 8°-32°N latitude and 70°-80°E longitude, with variations in altitude (0-950 m), rainfall (250-1500 mm), and soil types. The majority of farmers in Adilabad district, Telangana, are marginal and small-scale, comprising 67.8% of the total land holdings. In terms of the district's total gross cropped area, cotton occupies 77%, followed by pulses at 18% and soybean at 12% (Poshadri *et al.*, 2019) [8].

Maharashtra leads the country in cotton cultivation area (4.18 million ha), followed by Gujarat. In the Southern zone, Telangana has the highest area (1.97 million ha), while Rajasthan leads in the Northern zone (0.81 million ha). In terms of production, Gujarat ranks first with 8.79 million bales, followed by Maharashtra. Telangana leads the Southern zone with 5.74 million bales, while Rajasthan records the highest output in the Northern zone with 2.77 million bales during 2022-2023.

Millions of farmers, traders, and labourers rely on cotton for their livelihood. However, the crop faces increasing challenges due to climate change, labor shortages, and the rising incidence of pests and diseases. To help farmers overcome these issues and earn a steady income, new technologies need to be adopted (Sekar *et al.*, 2024) [10].

One such approach is the High-Density Planting System (HDPS), where cotton is grown in narrow spacing using early-maturing, semi-compact varieties. Though each plant bears fewer bolls, the number of bolls per area increases, resulting in higher yields. HDPS encourages quick canopy coverage, reduces soil moisture loss, and limits excess vegetative growth. As the global demand for food and clothing increases (Khan *et al.*, 2019) [5], HDPS stands out as an effective

method for improving cotton productivity, profitability, and resource-use efficiency, and it also supports mechanized farming including machine harvesting (Nalayini *et al.*, 2018) ^[7].

Increasing plant population is especially beneficial on poor-quality soils (Dong *et al.*, 2010; Sankaranarayanan *et al.*, 2018) ^[2, 9], and managing plant density is a simple, low-cost technique to enhance cotton yields (Severino *et al.*, 2021; Li *et al.*, 2020) ^[11, 6]. Water scarcity, however, remains a major limitation. If irrigation is insufficient during flowering and fruit setting, it leads to boll drop and poor boll development (Aujla *et al.*, 2005) ^[1]. On the other hand, over-irrigation may cause excessive leafy growth and reduce yield (Karam *et al.*, 2006) ^[4]. Efficient irrigation improves both water productivity and nutrient uptake (Zonta *et al.*, 2016) ^[14].

Hybrid cotton varieties grow tall and take longer to mature, which increases cultivation costs, especially due to the need for manual harvesting (Gunasekaran *et al.*, 2020) ^[3]. HDPS provides a better solution by making the crop suitable for machine harvesting and enhancing yield and profit (Singh *et al.*, 2012). Therefore, HDPS under limited irrigation conditions offers a promising path for sustainable cotton farming. In spite of all the advantages of HDPS over traditional planting system in cotton, to increase production, productivity and sustainability in Adilabad district of Telangana introduced this system.

Materials and Methods

High-Density Planting System (HDPS) implemented in the Adilabad district of Telangana. The trials were carried out across five different locations, covering a total area of 2.0 hectares each location. The primary objectives behind this study were to increase yield levels, reduce the overall crop duration, and improve net returns for farmers.

In the traditional method of cultivation, cotton was planted with a spacing of 120 cm × 30 cm, resulting in a plant population of approximately 27,750 plants per hectare. This system did not

include any form of canopy management, which often leads to excessive vegetative growth under favorable conditions, ultimately reducing the crop's reproductive efficiency and yield potential.

On the other hand, the HDPS approach adopted a much closer spacing of 90 cm × 15 cm, significantly increasing the plant population to about 74,000 plants per hectare. To manage the dense canopy that results from such high planting density, foliar application of Mepiquat chloride (5% aqueous solution at the rate of 1.0 ml per litre of water) was used. Mepiquat chloride is a growth regulator that helps restrict excessive vegetative growth, making the plants shorter and more compact. This improves light penetration and air circulation within the crop canopy, promoting better boll development and retention.

Data collected (yield, cost of cultivation, gross returns, net returns and benefit cost ratio) from both the HDPS fields and traditional cultivation fields of cotton to compare both the systems regarding yield and economics.

Results and Discussion

The performance of High-Density Planting System (HDPS) in cotton was evaluated over two years to assess its impact on yield and economics. The results demonstrated a consistent advantage of HDPS over traditional cultivation methods (Table 1).

Over two consecutive years, cotton yield was consistently higher under HDPS. During the 2022-23 season, HDPS fields produced 2,625 kilograms per hectare, whereas traditional cultivation (check) yielded only 2,000 kilograms per hectare. The following year, the difference widened further, with HDPS fields recorded a yield of 3,025 kilograms per hectare compared to 2,250 kilograms per hectare from the check. On average, HDPS achieved a yield of 2,825 kilograms per hectare, significantly higher than the 2,125 kilograms per hectare from the conventional system, resulting in a yield increase of 32.94 percent.

Table 1: Yield and Economics of High Density Planting System (HDPS) in cotton over traditional cultivation

Year	Type	Yield (kg ha ⁻¹)	Cost of Cultivation (Rs. ha ⁻¹)	Gross Returns (Rs. ha ⁻¹)	Net Returns (Rs. ha ⁻¹)	B:C Ratio
2022-23	Demo (HDPS)	2625	72750	167475	94725	2.30:1
	Check (Traditional cultivation)	2000	64247	127600	63353	1.99:1
2023-24	Demo (HDPS)	3025	70600	214775	144175	3.04:1
	Check (Traditional cultivation)	2250	67600	159750	77950	2.15:1
Average	Demo (HDPS)	2825	71675	191125	119450	2.66:1
	Check (Traditional cultivation)	2125	65924	143675	70652	2.17:1

While the cost of cultivation was slightly higher under HDPS due to denser planting and the use of canopy management practices, the overall returns justified the investment. The average cost of cultivation under HDPS was ₹71,675 per hectare, in contrast to ₹65,924 per hectare in the traditional method. However, the gross returns were notably superior in HDPS. In 2022-23, HDPS recorded gross returns of ₹ 1,67,475 per hectare, and in 2023-24, this increased to ₹ 2,14,775 per hectare. In comparison, check reported gross returns of ₹ 1,27,600 and ₹ 1,59,750 per hectare, respectively. This trend shows that higher investment in HDPS translates to substantially increased revenue.

Net returns further emphasize the economic viability of HDPS. Through HDPS average net returns of ₹ 1,19,450 per hectare generated, compared to ₹ 70,652 per hectare from check (traditional cultivation). This difference in profitability is further reflected in the benefit-cost ratio. HDPS recorded an average B:C ratio of 2.66:1, while the traditional system showed a ratio of 2.17:1. These figures demonstrate that HDPS not only boosts

productivity but also enhances profitability, making it a sustainable and economically sound option for cotton farmers in the region. These results are in conformity with Prasad *et al.* (2023) ^[16], Saritha *et al.* (2024) ^[15] and Sekar *et al.* (2024) ^[10].

Conclusion

The study clearly shows that the High-Density Planting System (HDPS) is a better alternative to traditional cotton cultivation in Adilabad district. By increasing plant population and managing canopy growth, farmers were able to achieve higher yields and better boll retention. Although the cost of cultivation was slightly higher, the increase in gross and net returns proved the economic benefit of HDPS. The system also improved the benefit-cost ratio, making it a more profitable option. HDPS offers a practical solution to several issues faced by cotton farmers, including limited irrigation, labor shortage, and fluctuating weather. With its potential to support mechanized harvesting and efficient use of resources, HDPS can contribute to more sustainable and income-generating cotton farming in

Telangana and other cotton-growing regions of India.

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