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EFFECT OF DIFFERENT NITROGEN DOSES ON GROWTH AND YIELD OF COTTON (GOSSYPIUM HIRSUTUML)

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Abstract

The trial was set up in a three replicated randomized complete block design and was carried out at the Student's Experimental Farm, Department of Agronomy, Sindh Agriculture University Tandojam, during Kharif 2023. The trial included three different nitrogen doses: nitrogen at 120 kg ha^{-1} (20% < Recommended), nitrogen at 135 kg ha^{-1} (10% < Recommended), nitrogen at 150 kg ha^{-1} (Recommended), nitrogen at 165 kg ha^{-1} (10% > Recommended), and nitrogen at 180 kg ha^{-1} (20% > Recommended). The statistical analysis of the data showed that the growth and yield of cotton was significantly (P<0.05) impacted by the nitrogen doses in comparison to nitrogen at 150 kg ha^{-1} (Recommended). Nitrogen application at 180 kg ha^{-1} (20% > Recommended) resulted in the maximum plant height (143.36 cm), sympodial branches plant^{-1} (28.09), bolls plant^{-1} (43.36), seed cotton yield plant^{-1} (116.70g), seed cotton yield kg ha^{-1} (4463.2kg), and staple length (30.00mm), according to the experiment's findings. With 141.65 cm plant height, 42.89 bolls plant^{-1}, 27.70 sympodial branches plant^{-1}, 114.88g seed cotton yield plant^{-1}, 4426.7kg seed cotton yield kg ha^{-1}, and 29.58 mm staple length, nitrogen dose @ 165 kg ha^{-1} (10% > Recommended) achieved the second-place ranking. Nitrogen @ 120 kg ha^{-1} (20% < Recommended) showed the lowest performance, with 121.82 cm plant height, 28.24 bolls plant^{-1}, 14.92 sympodial branches plant^{-1}, 83.08g seed cotton yield plant^{-1}, 3384.6kg seed cotton yield kg ha^{-1}, and 26.26mm staple length. The experiment's findings revealed that a dose of nitrogen @ 165 kg ha^{-1} (10% > Recommended) was found to be suitable for achieving the highest cotton yield due to the lack of statistically significant differences with Nitrogen @ 180 kg ha^{-1} (20% > Recommended).

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INTRODUCTION

cotton (*Gossypium hirsutum* L.) is considered a major industrial plant in most nations, including Greece [1]. Higher nitrogen fertilizer rates have a more positive effect on cotton, particularly when it comes to enhanced production of vegetative growth, such as plant height and leaf count [2]. The competition among plants for nutrients highlights the importance of striking the right balance between nitrogen dosage and spacing because when the nitrogen supply is limited, fiber does not develop to its full potential, which can lead to poor quality and premature senescence, which could reduce yield [3]. The competition among plants for nutrients highlights the importance of striking the right balance between nitrogen dosage and spacing because when the nitrogen supply is limited, fiber does not develop to its full potential, which can lead to poor quality and premature senescence, which could reduce yield [4]. As the main nutrient that restricts cotton production, nitrogen is one of the soil components that cotton absorbs most often. It has a direct impact on the crop's height, fruiting, yield, and fiber quality [5]. Lack of nitrogen affects the number of leaves per plant,

which reduces the plant's ability to produce photosynthetic energy, the amounts of sugars that accumulate in the boll set, and ultimately the plant's height and maturity [6]. According to this study, plots treated with 150 N kg ha^{-1} under both protected and unprotected conditions produced the highest cotton seed yield, and it was also noted that a decrease in yield was seen as the nitrogen level rose. This suggests that applying 150 N kg ha^{-1} is the best way to increase cotton yield while lowering the impact of sucking pests in Jaadu BG-II cotton hybrids [7]. It is suggested that excessive nitrogen application can lead to boll shedding, lower harvest and ginning percentages, increased susceptibility to diseases and pests, and delayed maturity, among other problems. For these reasons, it is crucial to manage nitrogen application properly [8]. A sufficient supply of nitrogen is necessary to encourage cotton plants to develop strongly, have high photosynthesis, and have dark green leaves. Insufficient nitrogen may result in reduced leaf size, an enhanced root-to-shoot ratio, better earliness, and a higher shedding percentage [9]. The optimal density of cotton crops is influenced by the nitrogen concentration in addition to other agronomic practices [10].

According to reports, nitrogen is an essential component of cotton production, and applying the proper quantity of fertilizer can result in a high cotton yield, however this can be difficult [11]. According to current research on the effects of nitrogen fertilization on cotton, excessive usage delays ripening and increases environmental pollution, while insufficient use results in early senescence [12]. Although it has been noted that enhancing cotton's capacity to absorb nitrogen may rely in part on the phonological traits of the root system, examine whether nitrogen fertilizer encouraged root growth in most soil layers. Because they used irrigation with salty water, where nitrogen might have exacerbated salt stress, the 0–15 cm soil layer had the highest values of root length, surface area, volume, and biomass. These values are like the findings of a study on drip irrigation with saline water [13,14].

Nitrogen (N) is essential for the growth and development of cotton plants. Studies have indicated that urea is a common fertilizer that effectively transports nitrogen due to its high nitrogen content (46%) and rapid absorption, metabolism, and translocation following application, according to research, about 33% of the nitrogen fertilizer is absorbed; by the time the soil reaches maturity, 25% of it is still in the soil, while the remaining 42% is removed from the system. This suggests that split nitrogen application is one method to increase crop nitrogen utilization and reduce nutrient loss through leaching and volatilization [15]. Cotton is a special crop that provides people with oil and clothing, chaff for animal feed, organic matter for the land, and a variety of other goods for industry [16]. Although it is a perennial crop, cotton is grown indefinitely as an annual crop for economic purposes. While nitrogen increases photosynthesis, leaf development, and vegetative growth, a decrease in nitrogen results in early senescence, which impacts boll production [17]. 76 countries grow 32 million hectares of cotton, with China leading the world in cotton production for the past six years [18,19]. While nitrogen (N) is the primary factor limiting cotton growth and development, increased productivity in recent years has led to a significant increase in the use of synthetic nitrogen fertilizer [20].

Because of their unpredictable growth patterns, cotton plants need more nitrogen than other nutrients. As a result, a better understanding of cotton growth and development under nitrogen pickup at the sensible fertilizer regime is crucial to producers' ongoing efforts to produce lint and seed yield more successfully and profitably [21]. Nitrogen is an essential nutrient that needs to be supplied in the right amounts and at the right times to achieve improved production and quality in cotton crops. The top five countries that grow cotton are Brazil, China, India, Pakistan, and the United States [22]. The number of bolls can affect the number of sympodial branches. Superior sympodial branches were observed with two nitrogen splits, but significantly fewer sympodial branches were found with three and four equal splits of nitrogen fertilization. These findings further support the idea that nitrogen (N) is a critical component that restricts cotton output, as a lack of nitrogen from seedling emergence to the onset of flowering results in insufficient vegetative growth, which lowers fruiting [23].

MATERIALS AND METHODS

To ascertain the impact of varying nitrogen dosages on cotton development and yield, the experiment was carried out during Kharif 2023 at the Student's Experimental Farm, Department of Agronomy, Sindh Agriculture University Tandojam. In every treatment, the required dosage of potassium and phosphorus (60–60 kg ha^{-1}) was used.

Observations and Measurements

The following growth parameters were measured:

Plant height (cm) plant^{-1} Using a measuring tap, the height of each plant (cm) at crop maturity was measured from the bottom to the tip of the randomly chosen plants in each plot. The average was calculated in centimeters.

Sympodial branches plant^{-1} The average will be determined by counting the number of sympodial branches per plant.

Bolls plant^{-1} The total number of boll plants per plant was counted at crop maturity, and the average will be calculated.

Seed cotton yield plant^{-1} (g) Each randomly chosen plant's bolls were harvested at maturity; following cotton harvesting, the chosen plants were weighed individually, and the average was calculated in grams.

Seed cotton yield (kg ha^{-1}) Following the selection of bolls from each plot at maturity, the cotton seed yield (kg ha^{-1}) was computed using the formula below:

$$\frac{\text{Seed cotton yield plot}^{-1}\text{ (kg)} \times 10000\ \text{m}^2}{\text{Plot size (m}^2\text{)}}$$

Staple length (mm) Using a measuring scale, the staple length in millimeters was determined for the randomly chosen plants, and the average will be in millimeters.

Statistical Analysis

The computer program Statistix version 8.1 was used to apply the analysis of variance (ANOVA) approach to the acquired data (Statistix, 2006). When required, the LSD test was used to compare the variations in the treatment means.

RESULTS

The experiment was conducted in Kharif 2023 to ascertain the effects of nitrogen doses on cotton output and growth. The experiment was put up at Sindh Agriculture University Tandojam Student's Experimental Farm, Department of Agronomy, using three replicated randomized complete block designs. The nitrogen doses were T_1 = nitrogen 120 kg ha^{-1} (20% < Recommended), T_2 = nitrogen 135 kg ha^{-1} (10% < Recommended), T_3 = recommended nitrogen dosage (150 kg ha^{-1}), T_4 = nitrogen 165 kg ha^{-1} (10% > Recommended), and T_5 = nitrogen 180 kg ha^{-1} (20% > Recommended). Plant height (cm) plant^{-1}, sympodial branches plant^{-1}, bolls plant^{-1}, seed cotton.

production plant^{-1} (g), seed cotton yield (kg ha^{-1}), and staple length plant^{-1} (mm) were all noted.

Plant height (cm) Plant height mostly reflects the varietal influence or reaction of the plant to management conditions. The impact of different nitrogen dosages on cotton crops was examined, and Figure-1 presents the findings for plant height (cm) plant^{-1}.

The findings showed that when the cotton crop received a dosage of T_5 = Nitrogen 180 kg ha^{-1}

(20% > Recommended), the plant height at maturity reached its maximum (143.36 cm). Then came (141.65 cm and 138.51 cm) under nitrogen dosages of T_3 = Nitrogen 150 kg ha^{-1} (Recommended) and T_4 = Nitrogen 165 kg ha^{-1} (10% > Recommended). For T_2 = Nitrogen 135 kg ha^{-1} (10% < Recommended), the cotton crop's plant height at maturity was further reduced to 125.07 cm. Under T_1 = Nitrogen 120 kg ha^{-1} (20% < Recommended), the cotton crop's minimum plant height was 121.82 cm.

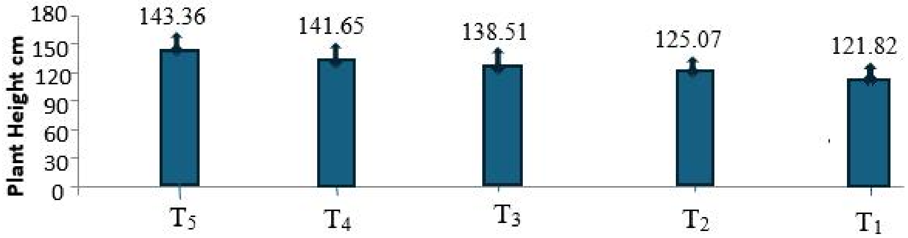

Figure 1: Effect of different nitrogen doses on plant height (cm) $plant^{-1}$

Statistical significance of plant height (cm) $plant^{-1}$

SE±	0.8945
LSD 0.05	2.306
C.V%	2.82

Sympodial branches $plant^{-1}$ Figure-2 presents the findings of an investigation into the effects of different nitrogen dosages on cotton crops, specifically regarding the number of sympodial branches $plant^{-1}$. The nitrogen doses of T_4 = Nitrogen 165 kg ha^{-1} (10% > Recommended) and T_3 = Nitrogen 150 kg ha^{-1} (Recommended) resulted in the highest number of sympodial branches $plant^{-1}$ at maturity (28.09), followed by T_5 = Nitrogen 180 kg ha^{-1} (20% > Recommended). When the cotton crop reached maturity, the number of sympodial branches $plant^{-1}$ decreased to 17.66 for T_2 = Nitrogen 135 kg ha^{-1} (10% < Recommended). Under T_1 = Nitrogen 120 kg ha^{-1} (20% < Recommended), the cotton crop showed the lowest (14.923) sympodial branches $plant^{-1}$

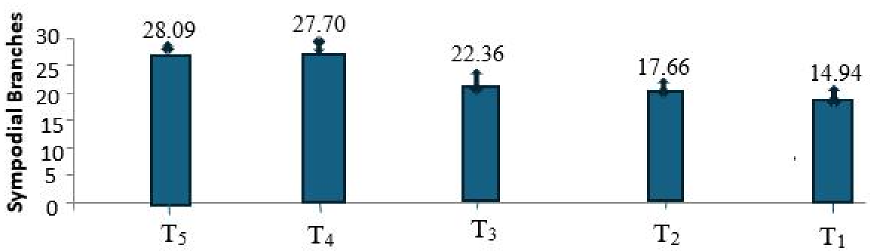

Figure 2: Effect of different nitrogen doses on sympodial branches $plant^{-1}$

Statistical significance of sympodial branches $plant^{-1}$

SE±	0.5966
LSD 0.05	2.306
C.V%	3.51

Bolls $plant^{-1}$ Figure-3 shows the findings of an investigation into the effects of different nitrogen dosages on cotton crops, specifically regarding bolls $plant^{-1}$ of cotton. According to the data, the crop receiving T_5 = Nitrogen 180 kg ha^{-1} (20% > Recommended) produced the most bolls $plant^{-1}$ at maturity (43.36). This was followed by T_4 = Nitrogen 165 kg ha^{-1} (10% > Recommended) and T_3

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= Nitrogen 150 kg ha^{-1} (Recommended), which produced 42.89 and 38.26 bolls $plant^{-1}$. By the time the cotton crop reached maturity, the bolls $plant^{-1}$ decreased to 33.77 for T_2 = Nitrogen 135 kg ha^{-1} (10% < Recommended). The cotton crop with the lowest bolls $plant^{-1}$ (28.24) was grown under T_1 = Nitrogen 120 kg ha^{-1} (20% < Recommended).

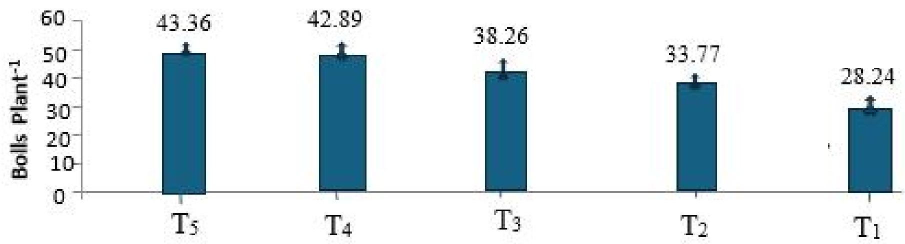

Figure 3: Effect of different nitrogen doses on bolls $plant^{-1}$.

Statistical significance of bolls $plant^{-1}$

SE±	0.6442
LSD 0.05	2.306
C.V%	3.11

Staple length (mm) The impact of different nitrogen dosages on cotton crops was examined, and Figure-4 presents the findings with respect to cotton staple length (mm). The results showed that the crop treated with T_5 = Nitrogen 180 kg ha^{-1} (20% > Recommended) had the longest staple length (mm) after ginning out (30.00), followed by T_4 = Nitrogen 165 kg ha^{-1} (10% > Recommended) and T_3 = Nitrogen 150 kg ha^{-1} (Recommended). After cotton was ginned out, the staple length (mm) decreased to (28.13) for T_2 = Nitrogen 135 kg ha^{-1} (10% < Recommended), respectively. Under T_1 = Nitrogen 120 kg ha^{-1} (20% < Recommended), the cotton crop's lowest staple length (mm) was measured at 26.26.

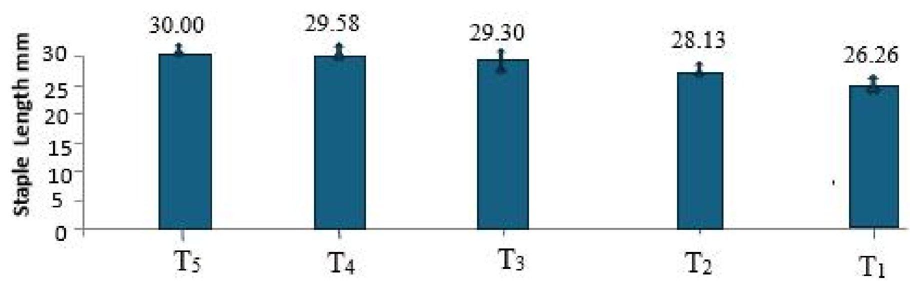

Figure 4: Effect of different nitrogen doses on staple length (mm).

Statistical significance of staple length (mm)

SE±	0.5222
LSD 0.05	2.306
C.V%	3.28

Seed cotton yield $plant^{-1}$ (g) The impact of different nitrogen dosages on cotton crops was examined, and Figure-5 presents the findings relating cotton seed yield $plant^{-1}$ (g) of cotton. Under nitrogen doses of T_4 = Nitrogen 165 kg ha^{-1} (10% > Recommended) and T_3 = Nitrogen 150 kg ha^{-1} (Recommended), the crop produced the highest seed cotton yield $plant^{-1}$ (g) at maturity (116.70) when treated with T_5 = Nitrogen 180 kg ha^{-1} (20% > Recommended). This was followed by 114.88 and 102.08 plants. For T_2 = Nitrogen 135 kg ha^{-1} (10% < Recommended), the cotton crop's seed yield $plant^{-1}$ (g) at maturity was decreased to 95.36. In the cotton crop, the lowest seed cotton yield $plant^{-1}$ (g) was recorded under T_1 = Nitrogen 120 kg ha^{-1} (20% < Recommended).

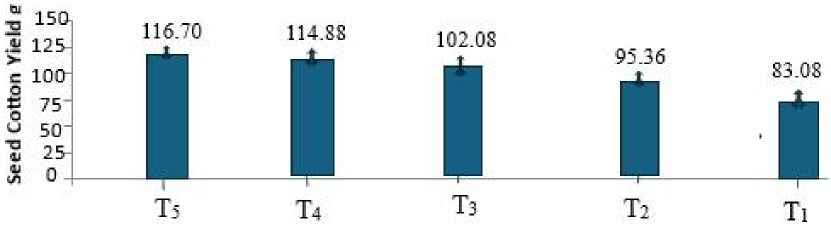

Figure 5: Effect of different nitrogen doses on seed cotton yield $plant^{-1}$ (g).

Statistical significance of seed cotton yield $plant^{-1}$ (g)

SE±	0.9551
LSD 0.05	2.306
C.V%	3.14

Seed cotton yield (kg ha^{-1}) The yield of seed cotton (kg ha^{-1}) is a dependent characteristic that is influenced by its many components. The soil condition for various nutrient components may also have an impact on this attribute in addition to the varietal influence on seed production (kg ha^{-1}). Under nitrogen doses of T_4 = Nitrogen 165 kg ha^{-1} (10% > Recommended) and T_3 = Nitrogen 150 kg ha^{-1} (Recommended), the crop produced the highest seed cotton yield (kg ha^{-1}) at maturity (4463.2), according to the results. After the cotton crop reached maturity; the seed cotton yield (kg ha^{-1}) decreased to (3702.7) for T_2 = Nitrogen 135 kg ha^{-1} (10% < Recommended). T_1 = Nitrogen 120 kg ha^{-1} (20% < Recommended) produced the lowest seed cotton yield (3384.6) of the cotton crop.

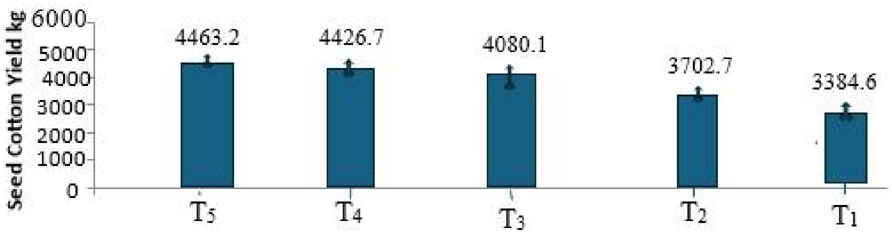

Figure 6: Effect of different nitrogen doses on seed cotton yield (kg ha^{-1})

Statistical significance of seed cotton yield (kg ha^{-1})

SE±	82.097
LSD 0.05	2.306
C.V%	3.23

DISCUSSION

Cotton (Gossypium hirsutum L.) is an important crop that contributes to the global agricultural economy by producing seed oil and fiber. However, it has been reported that the increased production of fiber has led to environmental problems, specifically the contamination of air, soil surface, and subsurface water. With the right management practices, it may be decreased. Cotton fields received extra nitrogen fertilizers totaling 50 to 60 kg N ha-1 and 15–25% nitrogen inputs [24,25].

The highest plant height (143.36 cm) with the nitrogen fertilizer dose of 180 kg ha-1 (20% > Recommended) was recorded, as were the highest sympodial branches plant-1 (28.09), bolls plant-1 (43.36), highest seed cotton yield plant-1 (116.70g), and highest seed cotton yield kg ha-1 (4463.2kg), according to the results of our study. The results of our study showed that declining nitrogen rates had a negative impact on cotton growth and yield. For example, the lowest plant height (121.82 cm) was recorded with a nitrogen dose of 120 kg ha-1 (20% < Recommended). Other parameters included the lowest sympodial branches plant-1 (14.92), the lowest bolls plant-1 (28.24), the lowest seed cotton yield plant-1 (83.08g), and the lowest seed cotton yield kg ha-1 (3384.6kg). The study examined how row spacing, and nitrogen rate can have a significant impact on earliness and seed cotton yield (*Gossypium hirsutum* L.). They also found that these two agrotechnical factors have a significant impact on plant height, quantity, weight, and seed production of each boll per unit area. In the end, the authors recommend that cotton be grown at the optimal temperature for the best seed production, with 75 cm row spacing, and fertilized with N 120 kg ha^{-1}. It is shown that emergence increases with lower nitrogen usual (60 kg ha^{-1}). Additionally, they found that applying N 180 kg ha^{-1} produces a high yield of cotton seeds, which lacks statistical support compared to N 120 kg ha^{-1} [26]. Cotton accumulates between 250 and 300 kg of nitrogen ha^{-1} to reach its optimum output, and it is believed that the bolls at the top fruit sites are later generated and late developed, which causes the earliness of production to decline at fertilization with high nitrogen levels [27].

CONCLUSION

According to the findings, cotton growth and output were positively and significantly impacted by varying nitrogen dosages. While T_5 = Nitrogen 180 kg ha^{-1} (20% > Recommended) produced superior cotton growth and production, T_4 = Nitrogen 165 kg ha^{-1} (10% > Recommended) produced the optimum nitrogen dosage for cotton growth and yield.

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