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# Nutrient Uptake, Fibre Quality and Productivity of High-Density Cotton as Influenced by Drip Irrigation and Crop Growth Stage Based Fertigation Levels

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## Abstract

*Cotton is one of the major crop in Telangana. Judicious use of irrigation water coupled with efficient nutrient management is more important to enhance the cotton production. An experiment was conducted at the College farm, College of Agriculture, PJTSAU, Hyderabad, during the 2019 and 2020 kharif seasons to examine the effects of various drip irrigation and fertigation levels on the growth and yield of high-density cotton. The experiment was put up in a three-fold Factorial randomised block design (FRBD). Four fertigation levels (application of 100 percent RDNK in differential dosage as per recommendation [F1], application of 100 percent RDNK in differential dosage as per crop coefficient curve [F2], application of 125 percent RDNK in differential dosage as per recommendation [F3], and application of 125 percent RDNK in differential dosage as per recommendation [F4]) and three irrigation levels (irrigation scheduled at 0.6 [I1], 0.8 [I2], and 1.0 [I3] Epan throughout the crop growth period). During the years 2020 and 2021, irrigation levels had no substantial impact on nutrient uptake, and yield. While the application of 125 percent RDNK in differential dosage as per the crop coefficient curve (F4) resulted in significantly higher nutrient uptake, stalk yield, and seed cotton yield among the fertigation levels. Quality parameters were not influenced by irrigation and fertigation levels.*

**Keywords:** *Drip irrigation, fertigation, High-density cotton, nutrient uptake, quality parameters, and yield*

## Introduction

With a total area of 13.47 million hectares and production and productivity of 36.06 million bales and 455 kilograms per hectare, respectively, India is the greatest cotton-growing nation in the world [6]. However, the fact that it is typically produced in rainfed conditions is one of the factors contributing to its poor productivity. In addition, nearly 80% of the cotton farmed in India is grown in low- to medium-fertile soils, necessitating closer planting to maximize variety potential and fit more plants per square foot. Bt Cotton hybrids considerably increased the output self-sufficiency of India and successfully stopped boll worm infestations. But in recent years, Bt cotton has begun to exhibit resistance to boll worms and is inefficient against sucking pests, leading to an increase in the need of pesticides and a higher seed cost compared to non-Bt cotton seeds. In this case, non-Bt cotton cultivars will take the place of Bt cotton hybrids and, if appropriate management practices are employed, will provide superior yields. The most crucial elements in raising cotton output are irrigation and fertilizer management. Modern technology, like the drip irrigation method with a high population, is required to get the most out of the resources that are currently available (water and

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nutrients) and to maximize net returns. This method enables irrigation water and fertilizers to be applied precisely and in a balanced manner to meet the needs of crop plants. To maximize output potential, the cotton fertilization schedule needs to be revalidated due to the increased planting density (55.5 to 77.7%) compared to standard planting density (i.e. 18517 and 37037 plants per hectare). The only research-based data on the timing of cotton fertigation based on crop growth phases and nutrient uptake is based on conjecture. Crop coefficient (Kc) measurements, which are based on scientific concepts, are not used to schedule water and nutrients precisely for cotton. Therefore, it is necessary to revalidate the fertigation schedule pattern in accordance with crop growth phases to maximize production potential and income. Keeping in view the importance of the precise use of two vital inputs irrigation and nutrients to cotton an experiment was formulated with the objective to study the effect of drip irrigation and fertigation on nutrient uptake, quality, and yield.

## Materials And Methods

College Farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana State was the site of the current experiment. The farm is located at an elevation of 542.3 meters above mean sea level in the Southern Telangana Agro-climatic zone of Telangana, at 17°19' N latitude and 78°23' E longitude, and is categorized as semi-arid tropics (SAT) by Troll's categorization. Between 26.8 and 34.0 °C with an average of 30.4 °C in 2019–20 and 25.9 to 33.8 °C with an average of 29.9 °C in 2020–21, respectively, were the mean weekly maximum temperatures for the cropping period. While the minimum weekly temperature ranged from 14.2 to 20.5 °C with an average of 17.4 °C in 2019–20 and 14.2 to 23.7 °C with an average of 19.0 °C in 2020–21. The crop study's total evaporation was 649.9 mm and 611.3 mm. Rainfall totaled 706.1 mm throughout the crop-growing period in 2019–20 and 1283.2 mm during 60 rainy days in 2020–21, respectively. The crop was primarily cultivated with moisture from rainfall during both experiment seasons. The soil in the experimental region has a sandy loam texture (75.24 % sand, 10.4% silt, and 14.06% clay), an average bulk density of 1.59 Mg $m^3$ for 0-60 cm depth, and a pH range of 7.4 to 7.5 in response. The experiment used a Factorial Randomized Block Design (FRBD) with twelve treatments that were reproduced three times. In this study, four fertigation levels (100% RDNK in differential dosage as per recommendation [F1], 100% RDNK in differential dosage as per crop coefficient curve [F2], and 125% RDNK in differential dosage as per crop coefficient curve [F4]) and three irrigation levels (irrigation at 0.6 [I1], 0.8 [I2], and 1.0 Epan [I3] throughout the crop growth period) were included as treatments. In the first season, the crop was sowed on July 15, 2019, and in the second season, on June 18, 2020. ADB-542 is the cotton composite variety that was employed in the investigation. The following spacing was 60 x 20 cm. The crop received the recommended fertilizer dose of 90 kg of nitrogen, 48 kg of phosphorus, and 48 kg of potassium for one hectare through urea, single super phosphate, and sulphate of potash, respectively according to the fertigation levels. Entire phosphorus was applied as basal to all the treatments before sowing. Nitrogen and potassium were applied through fertigation according to the treatments. Fertigation in 17 splits once in 6 days intervals in differential dosage as per crop growth was carried out from 10 DAS to 110 DAS. For the treatments, $F_1$ and $F_3$ fertigation was given in differential dosages as per recommendation in 100% and 125% RDF which was given in detail in table 1.

**Table. 1:** Differential dosage of fertilizer application based on growth stage of cotton crop as per recommendation by PJTSAU

| Crop stage | Nutrient dose (kg $ha^{-1}$ $day^{-1}$) | |
|---|---|---|
| | N | $K_2O$ |
| After sowing 35 days (10-45 DAS) | 0.56 | 0.29 |
| Squaring 20 days (45-65 DAS) | 1.50 | 0.58 |
| Flowering and boll formation stage 20 days (65-85 DAS) | 1.03 | 0.78 |
| Boll development 30 days (85-115 DAS) | 0.75 | 0.29 |

For the treatments F2 and F4, fertigation was administered in different dosages according to the crop coefficient curve at 100% and 125% RDF, respectively. The Kc values will be lower in the beginning stages as the crop's ground cover is less, gradually rise with the crop's growth stage as the crop approaches effective full cover, and in the late season, be high if the crop is frequently irrigated until fresh harvest or low if the crop is allowed to dry out in the field before harvest. This indicates that the crop evapotranspiration rates will increase as crop growth advances which shows that the water requirement of the crop also increases with the increase in crop growth. In the same way, the nutrient requirement will also follow a similar trend to water, and nutrient requirement increases as the crop growth increases. This principle was used and a fertigation pattern based on the crop coefficient curve was developed.

**Table. 2:** Differential dosage of fertilizer application based on growth stage of cotton crop as per crop coefficient curve

| Crop stage | Kc values | Nutrient dose (kg ha$^{-1}$ day$^{-1}$) | |
|---|---|---|---|
| | | N | $K_2O$ |
| 10-25 days | 0.45 | 0.54 | 0.29 |
| 26-31 | 0.49 | 0.59 | 0.31 |
| 32-37 | 0.53 | 0.64 | 0.34 |
| 38-43 | 0.57 | 0.69 | 0.36 |
| 44-49 | 0.61 | 0.74 | 0.39 |
| 50-55 | 0.65 | 0.79 | 0.42 |
| 56-61 | 0.69 | 0.83 | 0.44 |
| 62-67 | 0.73 | 0.94 | 0.47 |
| 68-73 | 0.78 | 1.00 | 0.50 |
| 74-79 | 0.83 | 1.07 | 0.53 |
| 80-85 | 0.88 | 1.11 | 0.57 |
| 86-91 | 0.92 | 1.17 | 0.59 |
| 92-97 | 0.97 | 1.17 | 0.62 |
| 98-103 | 1.02 | 1.24 | 0.66 |
| 104-110 | 1.06 | 1.28 | 0.68 |
| Average = | 0.74 | | |

It was planned to irrigate every three days. On the basis of pan evaporation replenishment in treatments, irrigation scheduling was made. A water metre was used to measure the amount of water applied to each treatment. On days when it rained, the amount of water used for each treatment was modified according to the actual amount of rain that fell. Each lateral line of 16.mm spaced at 0.6 m on the sub-main and is equipped with build-in emitters of a 2 l h$^{-1}$ discharge rate spaced at 0.2 m on the lateral lines. The application rate in drip irrigated treatments was calculated using the following formula.

$$\text{Application rate (mmhr}^{-1}) = \frac{Q}{DL \times DE}$$

Whereas

Q = Dripper discharge (liters h$^{-1}$),$D_L$ = Distance between lateral spacing (m)

$D_E$ = Distance between dripper (emitters) spacing (m)

Irrigation time for each treatment was calculated using following formulae.

$$\text{Irrigation time (minutes)} = \frac{E_{pan}\text{ (mm)} \times 60}{\text{Application rate (mmhr}^{-1})}$$

**Chemical Analysis Of Plants**

Cotton plant samples at 30, 60, 90, 120 DAS and at harvest were collected, shade dried, and then kept in labelled brown paper bags. These samples were oven dried for 36-48 hours at 60-65$^{o}$C till constant weight is obtained. The oven-dried plant samples were grinded and finely ground samples were kept in labelled butter paper bags. Samples were analysed for N, P & K content by adapting standard procedures at the laboratory of the Central Instrumentation Cell (CIC). The values of N, P & K contents for plant samples were recorded treatment wise and then N, P & K uptakes were determined for plant samples of each treatment.

**Table 3:** Method employed for plant analysis

| Nutrient content in sample | Methods employed |
|---|---|
| Total Nitrogen | Modified Kjeldhal"s method [9] |
| Total Phosphorus | Di-acid digestion method and colorimetric estimation [14] |
| Total Potassium | Di-acid digestion method followed by Flame photometer method [9] |

Nutrient uptake = Percentage of nutrient x Total dry matter production (kg ha$^{-1}$)/100

## Results And Discussion

**N, P, And K Uptake**

Nitrogen, phosphorus and potassium uptake by cotton were not significantly influenced by irrigation levels. However, higher nitrogen, phosphorus and potassium uptake were recorded with the application of 125 % RDNK in differential dosage as per crop coefficient curve ($F_4$) over the application of 100 % RDNK in differential dosage as per recommendation ($F_1$) and the application of 100 % RDNK in differential dosage as per crop coefficient curve ($F_2$) and were on par with 125 % RDNK in differential dosage as per recommendation ($F_3$). Nutrient uptake by $F_3$ was also on par with $F_2$. On the whole, higher nitrogen and potassium uptake with $F_3$ and $F_4$ might be due to the application of higher doses of N, and K through fertigation in the many numbers of

**Table 4:** Nitrogen uptake (kg ha$^{-1}$) bycotton as influenced by drip irrigation and fertigation levels

| Treatments | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | At harvest | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Irrigation levels** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** |
| $I_1$ | 3.4 | 3.9 | 40.8 | 44.2 | 93.5 | 86.4 | 102.1 | 95.1 | 113.4 | 108.5 |
| $I_2$ | 3.4 | 4.0 | 40.7 | 46.8 | 92.8 | 88.8 | 101.2 | 95.5 | 119.5 | 114.5 |
| $I_3$ | 3.6 | 3.9 | 41.8 | 45.6 | 98.1 | 93.2 | 106.9 | 101.3 | 116.3 | 119.1 |
| SEm± | 0.12 | 0.12 | 1.1 | 2.1 | 1.9 | 3.2 | 3.7 | 3.9 | 3.9 | 5.1 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Fertigation levels** | | | | | | | | | | |
| $F_1$ | 3.3 | 3.8 | 39.1 | 42.4 | 90.0 | 81.0 | 94.9 | 89.8 | 103.1 | 101.2 |
| $F_2$ | 3.5 | 3.9 | 38.0 | 38.9 | 91.7 | 85.6 | 98.9 | 91.0 | 111.2 | 107.2 |
| $F_3$ | 3.4 | 4.0 | 44.7 | 51.9 | 97.6 | 94.9 | 108.3 | 103.1 | 123.1 | 122.2 |
| $F_4$ | 3.5 | 4.1 | 42.6 | 49.0 | 99.7 | 96.3 | 111.6 | 105.3 | 128.1 | 125.7 |
| SEm± | 0.14 | 0.12 | 1.3 | 2.4 | 2.3 | 3.7 | 4.3 | 4.5 | 4.5 | 5.9 |
| CD (P=0.05%) | NS | NS | 3.8 | 7.1 | 6.7 | 10.9 | 12.5 | 13.2 | 13.2 | 17.2 |
| **Interaction** | | | | | | | | | | |
| SEm± | 0.24 | 0.21 | 2.3 | 4.1 | 3.9 | 4.2 | 7.4 | 7.8 | 7.8 | 10.2 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 5:** Phosphorus uptake (kg ha$^{-1}$) bycotton as influenced by drip irrigation and fertigation levels

| Treatments | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | At harvest | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Irrigation levels** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** |
| $I_1$ | 0.76 | 0.90 | 12.1 | 13.1 | 25.2 | 24.4 | 31.0 | 30.9 | 33.8 | 30.0 |
| $I_2$ | 0.77 | 0.92 | 12.4 | 13.6 | 25.9 | 25.0 | 30.9 | 33.3 | 35.1 | 32.0 |
| $I_3$ | 0.81 | 0.94 | 12.5 | 14.1 | 26.5 | 25.7 | 31.8 | 33.5 | 33.8 | 31.7 |
| SEm± | 0.02 | 0.03 | 0.3 | 0.7 | 0.5 | 0.8 | 1.1 | 1.5 | 1.2 | 1.3 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Fertigation levels** | | | | | | | | | | |
| $F_1$ | 0.74 | 0.87 | 11.8 | 12.5 | 24.8 | 23.1 | 28.8 | 28.8 | 30.8 | 28.0 |
| $F_2$ | 0.77 | 0.89 | 11.7 | 11.2 | 25.1 | 23.8 | 29.4 | 30.0 | 32.7 | 28.8 |
| $F_3$ | 0.79 | 0.94 | 13.2 | 15.7 | 26.6 | 26.2 | 32.8 | 34.9 | 36.0 | 32.6 |
| $F_4$ | 0.82 | 0.97 | 12.6 | 15.0 | 26.9 | 27.0 | 33.9 | 36.5 | 37.5 | 35.5 |
| SEm± | 0.02 | 0.03 | 0.4 | 0.8 | 0.6 | 0.9 | 1.3 | 1.8 | 1.4 | 1.5 |
| CD (P=0.05%) | NS | NS | 1.0 | 1.4 | 1.7 | 2.6 | 3.8 | 5.2 | 4.0 | 4.2 |
| **Interaction** | | | | | | | | | | |
| SEm± | 0.03 | 0.05 | 0.6 | 1.3 | 0.9 | 1.5 | 2.3 | 3.1 | 2.4 | 2.5 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

splits has made more nutrients available in the root zone of the soil which encouraged the absorption and translocation of more nutrients resulting in higher biomass production and uptake by the crop. Reducing the fertilizer dose resulted in a reduced availability of nutrients which might be the reason for the lower uptake of nutrients by crops at lower doses of fertilizers ($F_1$ and $F_2$) as indicated in the present study. These findings are in agreement with the results reported by [2] and [10]. Further, the uptake recorded with $F_3$ was also on par with $F_2$ but was significantly superior over $F_1$ during both years. This indicates that the application of fertilisers as per the crop coefficient curve coincided with the nutrient demand of the crop more effectively and 25% of the fertiliser can also be saved when fertilizers are applied according to crop growth needs. While the higher uptake of P in the higher fertigation level treatments was the result of significantly higher dry matter production of the crop throughout the crop growth period.

 

**Table 6:** Potassium uptake (kg ha$^{-1}$) bycotton as influenced by drip irrigation and fertigation levels

| Treatments | 30 DAS | | 60 DAS | | 90 DAS | | 120 DAS | | At harvest | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Irrigation levels** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** |
| $I_1$ | 4.8 | 5.7 | 61.9 | 70.6 | 150.8 | 148.8 | 214.2 | 206.1 | 245.4 | 218.9 |
| $I_2$ | 4.9 | 6.0 | 64.6 | 76.0 | 154.3 | 151.5 | 217.9 | 210.6 | 250.8 | 222.6 |
| $I_3$ | 5.2 | 6.0 | 67.3 | 75.1 | 154.8 | 151.9 | 223.4 | 216.1 | 251.6 | 228.3 |
| SEm± | 0.1 | 0.2 | 1.6 | 3.7 | 2.6 | 3.8 | 7.1 | 7.4 | 6.3 | 7.1 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Fertigation levels** | | | | | | | | | | |
| $F_1$ | 4.7 | 5.6 | 61.7 | 67.9 | 146.1 | 139.7 | 201.9 | 196.2 | 225.0 | 206.1 |
| $F_2$ | 5.0 | 5.8 | 60.7 | 64.8 | 149.5 | 146.8 | 208.4 | 199.2 | 241.7 | 212.3 |
| $F_3$ | 5.0 | 6.1 | 69.3 | 84.1 | 157.8 | 155.9 | 229.8 | 221.7 | 260.8 | 232.6 |
| $F_4$ | 5.2 | 6.0 | 66.7 | 79.8 | 160.0 | 160.7 | 233.9 | 226.6 | 269.6 | 241.9 |
| SEm± | 0.2 | 0.2 | 1.8 | 4.3 | 3.0 | 4.4 | 8.2 | 8.5 | 7.2 | 8.2 |
| CD (P=0.05%) | NS | NS | 5.3 | 12.6 | 8.9 | 12.8 | 24.1 | 25.0 | 21.2 | 24.1 |
| **Interaction** | | | | | | | | | | |
| SEm± | 0.3 | 0.4 | 3.1 | 7.4 | 5.3 | 7.6 | 14.2 | 14.8 | 12.5 | 14.2 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 7:** Quality parameters in cotton as influenced by drip irrigation and fertigation levels

| Treatments | Ginning percentage (%) | | Lint index | | Fineness(µg inch$^{-1}$) | | Bundle strength (g tex$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|
| **Irrigation levels** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** |
| $I_1$ | 33.6 | 34.3 | 4.6 | 4.7 | 3.3 | 3.7 | 23.9 | 24.1 |
| $I_2$ | 33.7 | 34.3 | 4.6 | 4.8 | 3.4 | 3.6 | 23.6 | 23.7 |
| $I_3$ | 33.6 | 34.4 | 4.6 | 4.8 | 3.5 | 3.5 | 23.8 | 24.0 |
| SEm± | 0.8 | 0.8 | 0.11 | 0.11 | 0.09 | 0.07 | 0.5 | 0.8 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS |
| **Fertigation levels** | | | | | | | | |
| $F_1$ | 33.7 | 34.1 | 4.6 | 4.7 | 3.3 | 3.5 | 23.4 | 23.8 |
| $F_2$ | 33.6 | 34.3 | 4.6 | 4.7 | 3.4 | 3.6 | 23.9 | 24.1 |
| $F_3$ | 33.7 | 34.4 | 4.6 | 4.8 | 3.4 | 3.6 | 24.0 | 23.9 |
| $F_4$ | 33.6 | 34.5 | 4.7 | 4.8 | 3.5 | 3.7 | 23.7 | 24.0 |
| SEm± | 1.0 | 0.9 | 0.13 | 0.12 | 0.10 | 0.08 | 0.70 | 0.96 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS |
| **Interaction** | | | | | | | | |
| SEm± | 1.7 | 1.6 | 0.2 | 0.2 | 0.18 | 0.15 | 0.99 | 1.66 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS |

## Quality Parameters

Data reveals that the irrigation levels did not influence the quality parameters of cotton, The quality of the lint will decrease with the increase in the water stress during flowering and boll development stages, as none of the treatments experienced water deficit conditions due to continuous rains throughout the crop growth period during both the years of study there was no significant effect of irrigation on the quality parameters. [3] also stated that there was no significant difference among quality parameters due to irrigation levels.

Fertigation levels also had no significant levels on quality parameters. The levels of fertilisers tested might not be sufficient to produce significant changes in the quality characters of cotton. Similarly, also reported the same. [5] reported that the quality characters were not influenced by the narrow range of variations in irrigation water and nutrient supply.

**Table 8:** Yield of cotton as influenced by drip irrigation and fertigation levels

| Treatments | Seed cotton yield (kg $ha^{-1}$) | | Stalk yield (kg $ha^{-1}$) | | Lint Yield (kg $ha^{-1}$) | | Harvest index (%) | |
|---|---|---|---|---|---|---|---|---|
| **Irrigation levels** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** | **2019** | **2020** |
| $I_1$ | 2237 | 2046 | 5897 | 5788 | 745 | 679 | 27.9 | 25.6 |
| $I_2$ | 2248 | 2060 | 5917 | 5831 | 749 | 684 | 27.8 | 25.8 |
| $I_3$ | 2252 | 2090 | 5935 | 5857 | 750 | 694 | 27.8 | 25.9 |
| SEm± | 81 | 50 | 166 | 187 | 27 | 16 | 0.8 | 0.5 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS |
| **Fertigation levels** | | | | | | | | |
| $F_1$ | 2040 | 1953 | 5551 | 5419 | 679 | 650 | 27.4 | 26.2 |
| $F_2$ | 2113 | 2000 | 5666 | 5586 | 704 | 665 | 27.1 | 26.2 |
| $F_3$ | 2384 | 2129 | 6241 | 6007 | 794 | 706 | 28.4 | 25.1 |
| $F_4$ | 2446 | 2178 | 6287 | 6210 | 814 | 721 | 28.4 | 25.6 |
| SEm± | 94 | 58 | 192 | 216 | 32 | 19 | 1.0 | 0.6 |
| CD (P=0.05%) | 275 | 170 | 562 | 634 | 93 | 56 | NS | NS |
| **Interaction** | | | | | | | | |
| SEm± | 163 | 100 | 332 | 374 | 55 | 33 | 1.7 | 1.0 |
| CD (P=0.05%) | NS | NS | NS | NS | NS | NS | NS | NS |

**Yield**

Seed cotton, stalk yield, and lint yield were not significantly influenced by the drip irrigation levels during 2020, 2021 and in the mean (Table 8). Due to continuous rains during July, august, September and October, there was equal distribution of soil moisture in the root zone and the crop did not experience moisture stress during moisture-sensitive periods. Crop was grown during both of the years of study with an adequate amount of moisture from rainfall. This could be the cause of the lack of a discernible impact of irrigation regimes on seed cotton output.

While the application of 125 % RDNK in differential dosage as per crop coefficient curve ($F_4$) has recorded higher seed cotton, stalk yield, and lint yield and was at par with the application of 125 % RDNK in differential dosage as per recommendation ($F_3$) during 2020 and 2021. While the lowest seed cotton, stalk yield, and lint yield was observed with the application of 100 % RDNK in differential dosage as per recommendation ($F_1$) and was at par with the application of 100 % RDNK in differential dosage as per crop coefficient curve ($F_1$) during 2020, 2021 and in mean. The seed cotton yield, stalk yield, and lint yield produced under $F_3$ was also comparable with $F_2$ during both the years of study. Higher yield with the application of 125 % RDNK over 100 % RDNK in both the fertigation patterns was due to higher availability of both the two major nutrients (N and k) in the soil solution which led to higher uptake and better crop growth ultimately producing a higher yield. These results are in accordance with the findings of [12], [11], [5], [10], [1] and [8]. Fertigation in differential dosage as per crop coefficient curve ($F_2$, $F_4$) has met the crop growth needs without much loss, when compared to other fertigation in differential dosage as per recommendation ($F_1$, $F_3$) which produced higher dry matter production thus resulting in higher yield. The harvest index was not significantly influenced by drip irrigation and fertigation levels.

Interaction effect of irrigation and fertigation levels on nutrient uptake, quality parameters and yield was found non-significant during 2019 and 2020.

## Conclusion

From the above study, it is concluded that, irrigation levels had no substantial impact on nutrient uptake, seed cotton, and stalk yield. While the application of 125 percent RDNK in differential dosage as per the crop coefficient curve (F4) resulted in significantly higher nutrient uptake, stalk yield, and seed cotton yield among the fertigation levels. Quality parameters were not influenced by irrigation and fertigation levels.

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**Future Scope of Study:** Water and nutrients are the two important factors effecting the yield. Cotton is one of the most important commercial crop of our country. Recently non Bt and high density cotton is also gaining much importance. In this study we have examined the performance of high-density cotton under different irrigation and fertigation patterns. Fertigation pattern was also designed according to scientific approach that is based on crop coefficient. Hence water and fertilisers which are limiting resources can be efficiently used and maximum potential of the crop can be realised.

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