



## **Effect of Chemical Manipulation on Growth, Yield and Fiber Traits of Compact Cotton**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors PJ and MK designed the study. Authors BR, CNC and DV performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors LA and NMB managed the analyses and literature searches. All authors read and approved the final manuscript*

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### **ABSTRACT**

Crop management is one of the most important factors in modern agricultural activity. Studying the balance of growth stages and supplying optimal quantities of mineral nutrients and hormones to growing plants is essential to improve yield in short duration cotton varieties. In recent years, several approaches have been tried to break this yield plateau. The present investigation was intended to study and improve the yield of newly released variety Co 17 (compact cotton) by foliar application of nutrients, growth hormones, growth retardants and nutrient consortium. The treatments are mepiquat chloride (0.015%), potassium silicate (0.5%), Potassium schoenite (0.5%), borax (0.3%), salicylic acid (0.01%), calcium silicate (0.5%) and TNAU cotton plus (1.25%). Foliar application of different treatments at peak vegetative and flowering stage significantly influenced the leaf traits, root traits, and yield. Nutrient consortium (TNAU cotton plus – 53% over control) and growth retardant (mepiquat chloride- 42% over control) increased the seed cotton yield.

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## 1. INTRODUCTION

Cotton is a crop of global significance, playing a significant role in the agricultural and industrial economy. Cotton is one of the most important economic crops and the fiber produced is the raw material for the textile industry worldwide. Around 60% of fiber in Indian textiles is from cotton; Cotton is commonly known as “White gold” and “King of natural fiber” owing to its higher economic value amid the cash crops. India is the second - largest consumer and exporter, representing 5.4 and 5.9 million bales, respectively, in 2018/19. Tamil Nadu requires 100 lakh bales per annum, but production is only 6 lakh bales. Hence, it is essential to produce more cotton to meet the demand [1]. The perennial and indeterminate habit of cotton makes it difficult for farmers to cultivate it, and researchers were attempting to study the growth stages for management practices.

The management of plant density in cotton plants, for achieving higher yield has been attempted by physiologists for several decades. Cotton crop is sensitive for sudden management operations and reacts to any distresses in its surroundings with a dynamic growth response that is often erratic. Physiological efficiency holds the key for ideal performance of the crop in terms of growth stages, yield, and fiber quality. Balancing the vegetative and reproductive growth by using nutrients, hormones and retardants is essential [2]. Researches in these areas are driven by the need to intensify production to obtain greater yields. In countries such as the USA, Australia and, Brazil, cotton is grown on larger, modernized farms using more mechanized technology. In India, it is small-scale with labor - intensive production like hand weeding and picking. Nowadays along with chemical manipulation, the practice of high - density planting system (HDPS) is currently being conceived as an alternative production system having a potential for improving productivity, profitability, increasing input use efficiency, reducing input costs, and minimizing the risks associated with the current cotton production system in India for short duration varieties [3].

Plant growth hormones, growth regulators, nutrients, and nutrient consortiums can promote physiological growth, square formation, boll retention, higher nutrient uptake, keeping

vegetative and reproductive development in balance to improve lint yield and quality. Nutrients are very important compounds that are essential for growth and development of cotton crop. Nutrients promote the growth in many ways by improving physiological efficiency of plants to increase the yield. The use of growth retardants under a high-density planting system promotes synchronized maturity [4]. Most decisions regarding production inputs depend upon plant growth stage and yield potential. There is a need to optimize the nutrient, hormones, growth retardant and nutrient consortium requirement for compact cotton types before liberating to farmers. Therefore, the present investigation was designed and conducted to know the yield potential of cotton variety Co 17 under different chemical treatments.

## 2. MATERIALS AND METHODS

The field experiment was conducted at Department of Cotton, Tamil Nadu Agricultural University, Coimbatore, located in the Western Agro-climatic zone of Tamil Nadu (11° 02' N latitude, 76° 93' E longitude and at an altitude of 428.5 meters above mean sea level) during the winter season (August-February) of 2018/2019 and 2019/2020. The soil was sandy clay loam. Compact cotton Co 17 was taken as a test crop. The crop was supplied with fertilizers and other cultivation operations were performed in a timely manner. There were eight treatments viz., T<sub>1</sub>-Control, T<sub>2</sub>-Mepiquat chloride (0.015%), T<sub>3</sub>-Potassium silicate (0.5%), T<sub>4</sub>-Potassium schoenite (0.5%), T<sub>5</sub>-Borax (0.3%), T<sub>6</sub>-Salicylic acid (0.01%), T<sub>7</sub>-Calcium silicate (0.5%), T<sub>8</sub>-TNAU Cotton Plus (1.25%). Foliar spray of treatments were given at peak vegetative (45 Days after sowing-DAS) and flowering (60 DAS) stage of the crop. The observations on growth, physiology were recorded, and yield attributes were taken at the time of harvest of a crop. The cotton crop was raised in raised beds, and the major cultivation practices were carried out from sowing to harvest in a timely manner. The weather that prevailed during the cropping period is recorded from the meteorological observatory of Tamil Nadu Agricultural University, Coimbatore. Harvesting was done manually. Root parameters were taken at the maturity stage of the crop. The observations on yield attributes like the number of sympodia, seed cotton yield were taken at the time of harvest of crop.

## 2.1 Growth Traits

### 2.1.1 Number of leaves per plant

Number of leaves was recorded by counting the leaves from top to bottom of the plant, and the mean value of the five tagged plants selected at random in each treatment was expressed as number per plant.

### 2.1.2 Number of sympodia per plant

The reproductive sympodia arising from extra axillary buds were counted from the tagged plants at the maturity stage and expressed in number per plant.

## 2.2 Root Parameters

Root parameters like root length, root volume, and root dry weight were taken at the maturity stage of the crop.

## 2.3 Seed Cotton Yield

The Seed cotton yield obtained from the net plot area was recorded and expressed in kg/ha.

## 2.4 Quality Traits

Quality parameters such as ginning out turn, lint index, seed index, fiber span length (mm), fiber fineness ( $\mu\text{g}/\text{inch}$ ), fiber strength (g/tex), uniformity ratio were analyzed. The detailed procedures for fiber quality analyses are given below.

### 2.4.1 Sample preparation

Seed cotton was randomly selected and picked from each treatment during the first harvest. The collected seed cotton was hand cleaned from contaminants like trash and dried leaves, insects damaged bolls and subjected for ginning. Cleaned and ginned lint samples of about 100 g were packed and labeled for quality testing.

### 2.4.2 High volume instrument system (HVI)

Various conventional instruments were integrated into a single compact operating system by using a state of art technology in optics, machines and electronics. The high volume instrument system provides the measurement of fiber span length (mm), fiber fineness ( $\mu\text{g}/\text{inch}$ ), fiber strength (g/tex) and uniformity ratio. Cotton samples were tested for

fiber quality parameters at the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore with HVI instrument (in ICC mode) by the method adopted from ASTM D-5867 given by Sundaram [5].

### 2.4.3 Ginning outturn

The ratio of weight of lint to that of seed Cotton was worked out and expressed in percentage using the formula given by Santhanam [6].

$$\text{Ginning outturn} = \frac{\text{Weight of lint (g)}}{\text{Weight of seed Cotton (g)}} \times 100$$

### 2.4.4 Lint index

The quantity of lint obtained from 100 seeds after ginning was expressed as lint index [6].

### 2.4.5 Seed index

Hundred seeds selected at random after ginning was weighed and expressed as seed index [6].

### 2.4.6 2.5 per cent span length

It is the distance spanned by a specific percent of the fiber in the test board. The 2.5 per cent span length is the distance from the clamp of fiber board to a point up to which only 2.5 per cent of the fiber extends and expressed in mm [5].

### 2.4.7 Micronaire

It is the measure of fiber weight in microgram per inch length of fiber ( $\mu\text{g}/\text{inch}$ ). The fiber fineness was another important quality character, which plays a prominent role in determining spinning performance of cotton. The fiber fineness denoted the size of the cross-sectional dimension of fiber [5].

### 2.4.8 Fiber strength

It denotes the maximum tension at which the fiber is able to sustain before it breaks. It could be defined as the ratio of breaking strength of a bundle of fibers to its weight and expressed in gram/tex [5].

## 2.5 Statistical Analysis

Observations were recorded as per the standard procedure laid out for cotton crop and the data

were subjected to statistical analysis by using SPSS software. Wherever the treatment differences were found significant (\*\*) (F test), critical difference was worked out at 0.05 probability level. Treatment differences that were non-significant were denoted by "NS".

### 3. RESULTS AND DISCUSSION

#### 3.1 Weather Parameters

Weather parameters play an important role in the manifestation of the growth and yield potential of any crop. Weather variability was considered as one of the major factors of inter-annual variability of crop growth and yield in all environments. The weather parameters like temperature and rainfall prevailed during the cropping period are recorded (Figs.1a, b).

#### 3.2 Growth Traits

The data on the number of leaves per plant recorded at the maturity stage are presented in Table 1. There were significant differences in the number of leaves per plant registered under the

treatments. Foliar treated plants were recorded with increased number of leaves per plant. Among the treatments T<sub>2</sub>: Mepiquat chloride (0.015%) recorded the highest numbers of leaves per plant (91) followed by T<sub>8</sub>: TNAU Cotton Plus (1.25%) (85 numbers of leaves per plant), respectively, during 2018-2019 and a similar trend was followed in 2019-2020. Reduced number of leaves per plant (79, 80) was recorded in control plants (T<sub>1</sub>) in both the years. Similar findings were in accordance with Jitendra et al., [7]. Foliar application of 300 ppm of cycocel (growth retardant) increased the number of leaves in cotton [8]. Roopa [9] observed the nutrient consortium applied through foliar spray increased the number of leaves in cotton.

In cotton, the sympodia form the principal superstructures on which the fruiting bodies develop. The data on number of sympodia per plant as influenced by various treatments are presented in Table 1. There was a significant difference in number of sympodia per plant recorded under the treatments. Among the treatments T<sub>8</sub>: TNAU Cotton Plus (1.25%)

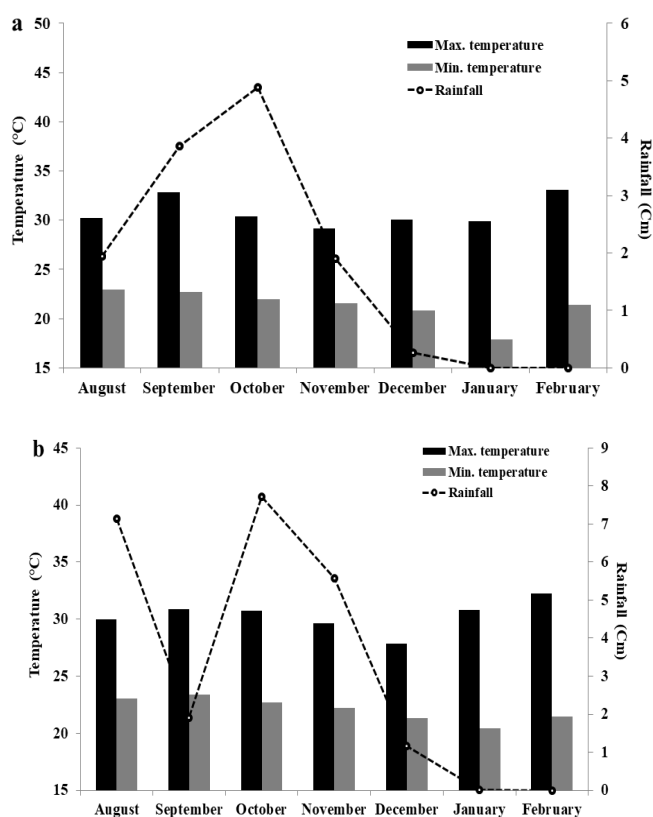


Fig.1a. Details of weather data prevailed during the experimental period from August -February (2018/2019); Fig.1b. Details of weather data prevailed from August - February (2019/2020)

produced 14.53 sympodia per plant during 2018/2019 and 14.86 sympodia per plant during 2019/2020, significantly more than the other treatments. Reduced number of sympodia per plant (11.81) during 2018/19 and 2019/2020 (11.91) sympodia per plant), respectively, was recorded in T<sub>2</sub>: Mepiquat chloride (0.015%). However, control (T<sub>1</sub>) recorded (13.15 in 2018 to 2019 and 13.62 in 2019 to 2020) less sympodia per plant. Next to T<sub>8</sub>: TNAU Cotton Plus (1.25%), T<sub>4</sub>: Pottasium schoenite (0.5%) recorded 13.78 and 14.03 sympodia per plant in both the years. Other treatments including nutrients and hormones showed a moderate range of increase in sympodial branch production. Increased number of sympodia signified the formation of more fruiting points [10]. The increase in number of sympodia per plant under foliar treated plants was except retardants was mainly due to availability of adequate amount of nutrients, moisture and an increased light interception, which resulted in optimum growth and development. The observations were in conformity with Bhalerao et al., [11] and Kalaichelvi, [12]. Similar results were also observed by Reddy and Gopinath, [13] and Narayana et al., [14] by using nutrients and growth hormones in cotton. A reduced number of sympodia per plant was found to be under Mepiquat chloride (0.015%) than other treatments. It might be due to the reduction in plant height and main stem nodes and the main stem nodes are the points where the sympodial branch arise. Similar results were also observed by Kholer Prakash, [15] in cotton, which was also in confirmation with the findings in cotton by Baskar, [16] and Bhalerao et al., [17].

### 3.3 Root Traits

Chemical treatments had a significant influence on root characters, viz root length, root volume, and root dry weight. The data on root length was influenced by foliar application of chemical treatments during both the years of study (Table 2). Among the treatments, T<sub>8</sub>: TNAU Cotton Plus (1.25%) recorded longer root length of 28.75 cm (2018/2019) and 29.96 cm (2019/ 2020), when compared to shorter root length of 24.60 cm (2018/2019) and 25.68 cm (2019/2020) recorded in control plots (T<sub>1</sub>). The data on root volume in cc under the foliar application of treatments are presented in Table 2. Among the treatments, a significant increase in root volume of 33.53 cc and 35.68 cc during 2018/19 and 2019/20, respectively, were registered under T<sub>8</sub>: TNAU Cotton Plus (1.25%) followed by T<sub>2</sub>: Mepiquat chloride (0.015%), which correspondingly

recorded root volume of 32.74 cc and 33.83 cc. Reduced root volume of 28.81 cc and 29.53 cc during 2018/19 and 2019/2020, respectively, was recorded in control (T<sub>1</sub>) plots. A similar trend was followed in root dry weight during both the years. Higher root length at closer spacing might be due to higher competition laterally by the nearest plant, which pushed them vertically down [16]. These results are in agreement with the findings of Arunvenkatesh, [18] and Bhanudas, [19] in cotton.

### 3.4 Seed Cotton Yield and Quality Traits

Foliar application of nutrients, growth hormones, growth retardants, and the nutrient consortium had affected on the outcome of compact cotton Co 17. Among treatments, T<sub>8</sub>: TNAU Cotton Plus (1.25%) recorded an increased seed cotton yield (2469 kg ha<sup>-1</sup> during 2018-19 and 2632 kg ha<sup>-1</sup> during 2019-20), followed by T<sub>2</sub>: Mepiquat chloride (0.015%) (2245 and 2474 kg ha<sup>-1</sup> during 2018-19 and 2019-20) and T<sub>4</sub>: Potassium schoenite (0.5%) which recorded 2189 and 2336 kg ha<sup>-1</sup> during 2018-19 and 2019-20 when compared to control plots (T<sub>1</sub> - 1582 and 1653 kg ha<sup>-1</sup> during 2018-19 and 2019-20). Foliar application of treatments has increased the yield percentage of T<sub>8</sub>: TNAU Cotton Plus (1.25%) (53%) and T<sub>2</sub>: Mepiquat chloride (0.015%) (42%) of Co17 over control (Fig. 2). This depends on the accumulation and partitioning of photoassimilates in reproductive parts of the plant resulting in increased yield [20]. The same trend was observed by Muhammad and Hayat, [21], who reported that high seed cotton yield could be achieved at closer plant spacing with mepiquat chloride to manage the excessive plant growth. Joel, [22] and Zakaria et al., [23] reported a positive effect of nutrient consortium and growth regulators in increasing the yield of cotton.

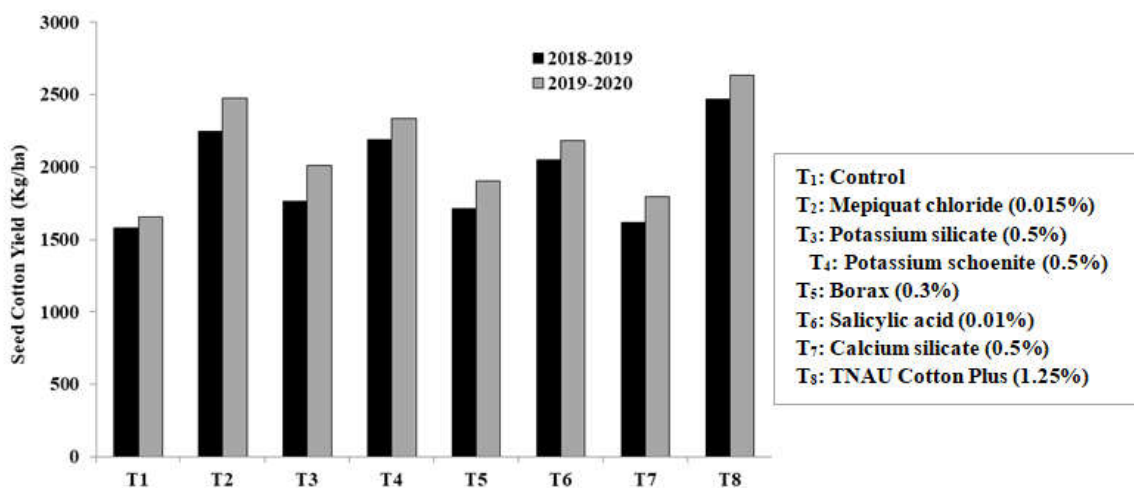
The quality parameters like ginning percent, seed index, lint index were not significantly influenced by foliar application of chemical treatments during both the year of study (Tables 3a and 3b). Though there was a small range of differences in quality traits, there was no significant interaction between treatments and features statistically. Similar results were said by Dhillon et al., [24] and Gu et al., [25]. Several researchers had reported that the effect of foliar application of nutrient and growth retardants with closer spacing on fiber quality traits was less effective in Cotton [26,27]. These findings were also under Bhanudas, [19]; Gacche and Gokhale, [28].

**Table 1. Effect of chemical manipulation on growth traits of compact cotton (2018/2019 and 2019/2020)**

Treatments	No. of leaves per plant		No. of sympodial branches per plant	
	2018/19	2019/20	2018/19	2019/20
T <sub>1</sub> : Control	79	80	13.15	13.62
T <sub>2</sub> : Mepiquat chloride (0.015%)	91	93	11.81	11.99
T <sub>3</sub> : Potassium silicate (0.5%)	82	83	13.47	13.84
T <sub>4</sub> : Potassium schoenite (0.5%)	84	85	13.78	14.03
T <sub>5</sub> : Borax (0.3%)	80	82	13.28	13.79
T <sub>6</sub> : Salicylic acid (0.01%)	83	84	13.54	13.93
T <sub>7</sub> : Calcium silicate (0.5%)	79	81	13.21	13.71
T <sub>8</sub> : TNAU Cotton Plus (1.25%)	85	88	14.53	14.86
Mean	83	85	13.35	13.72
SEd	1.457	1.483	0.243	0.250
CD (P<0.05)	3.125**	3.181**	0.521**	0.536**

**Table 2. Effect of chemical manipulation on root traits of compact cotton (2018/2019 and 2019/2020)**

Treatments	Root length (cm)		Root volume (cc)		Root dry weight (g)	
	2018/19	2019/20	2018/19	2019/20	2018/19	2019/20
T <sub>1</sub> : Control	24.60	25.68	28.81	29.53	18.58	20.12
T <sub>2</sub> : Mepiquat chloride (0.015%)	27.12	28.67	32.74	33.83	23.18	24.57
T <sub>3</sub> : Potassium silicate (0.5%)	25.67	26.23	30.13	30.69	20.64	22.86
T <sub>4</sub> : Potassium schoenite (0.5%)	26.71	27.03	31.84	32.98	22.06	23.61
T <sub>5</sub> : Borax (0.3%)	25.18	25.91	29.58	30.17	19.55	21.73
T <sub>6</sub> : Salicylic acid (0.01%)	26.83	26.79	31.39	31.63	21.68	22.98
T <sub>7</sub> : Calcium silicate (0.5%)	24.98	25.82	28.97	29.88	18.75	20.68
T <sub>8</sub> : TNAU Cotton Plus (1.25%)	28.75	29.96	33.53	35.68	24.23	25.05
Mean	26.23	27.01	30.87	31.80	21.08	22.70
SEd	0.463	0.474	0.542	0.559	0.370	0.404
CD (P<0.05)	0.993**	1.018**	1.163**	1.200**	0.795**	0.866**



**Fig. 2. Effect of chemical manipulation on seed cotton yield of compact cotton during the year 2018/2019 and 2019/2020**

**Table 3a. Effect of chemical manipulation on quality traits of compact cotton (2018/2019)**

Treatment	Ginning outturn (%)	Lint index (g)	Seed index (g)	2.5 % Span length (mm)	Fiber strength (g/tex)	Micronaire (10 <sup>-6</sup> g/inch)	Uniformity ratio
T <sub>1</sub> : Control	37.05	6.37	10.52	27.35	19.41	4.37	44.25
T <sub>2</sub> : Mepiquat chloride (0.015%)	37.51	6.71	11.32	27.55	19.65	4.62	44.67
T <sub>3</sub> : Potassium silicate (0.5%)	37.21	6.53	11.20	27.48	19.53	4.48	44.38
T <sub>4</sub> : Potassium schoenite (0.5%)	37.39	6.65	11.28	27.53	19.60	4.58	44.59
T <sub>5</sub> : Borax (0.3%)	37.14	6.49	11.09	27.42	19.49	4.42	44.34
T <sub>6</sub> : Salicylic acid (0.01%)	37.32	6.59	11.26	27.50	19.59	4.51	44.45
T <sub>7</sub> : Calcium silicate (0.5%)	37.09	6.43	10.83	27.39	19.47	4.39	44.29
T <sub>8</sub> : TNAU Cotton Plus (1.25%)	37.57	6.79	11.37	27.58	19.73	4.78	44.75
Mean	37.29	6.57	11.11	27.48	19.56	4.52	44.47
SEd	0.664	0.116	0.198	0.490	0.349	0.080	0.793
CD (P<0.05)	1.426 <sup>NS</sup>	0.250 <sup>NS</sup>	0.425 <sup>NS</sup>	1.052 <sup>NS</sup>	0.748 <sup>NS</sup>	0.172 <sup>NS</sup>	1.701 <sup>NS</sup>

**Table 3b. Effect of chemical manipulation on quality traits of compact cotton (2019/2020)**

Treatment	Ginning outturn (%)	Lint index (g)	Seed index (g)	2.5 % Span length (mm)	Fiber strength (g/tex)	Micronaire (10 <sup>-6</sup> g/inch)	Uniformity ratio
T <sub>1</sub> : Control	37.22	6.41	10.57	27.39	19.62	4.46	44.36
T <sub>2</sub> : Mepiquat chloride (0.015%)	37.59	6.71	11.33	27.59	19.82	4.72	44.71
T <sub>3</sub> : Potassium silicate (0.5%)	37.40	6.58	11.14	27.49	19.70	4.60	44.55
T <sub>4</sub> : Potassium schoenite (0.5%)	37.51	6.64	11.28	27.57	19.77	4.69	44.64
T <sub>5</sub> : Borax (0.3%)	37.35	6.53	11.05	27.46	19.69	4.54	44.49
T <sub>6</sub> : Salicylic acid (0.01%)	37.46	6.61	11.21	27.53	19.74	4.64	44.58
T <sub>7</sub> : Calcium silicate (0.5%)	37.28	6.48	10.68	27.42	19.65	4.49	44.43
T <sub>8</sub> : TNAU Cotton Plus (1.25%)	37.72	6.80	11.42	27.61	19.85	4.80	44.79
Mean	37.44	6.60	11.09	27.51	19.73	4.62	44.57
SEd	0.668	0.117	0.197	0.491	0.351	0.082	0.795
CD (P<0.05)	1.433 <sup>NS</sup>	0.251 <sup>NS</sup>	0.422 <sup>NS</sup>	1.053 <sup>NS</sup>	0.751 <sup>NS</sup>	0.176 <sup>NS</sup>	1.706 <sup>NS</sup>

#### 4. CONCLUSION

Chemical manipulation in compact cotton Co 17 by nutrients, hormones, growth retardants, and nutrient consortium influenced the number of leaves, number of sympodial branches, root traits, and yield components. From the results, it

could be concluded that foliar application of TNAU Cotton Plus (1.25%) and mepiquat chloride (0.015%) recorded the highest seed cotton yield than other treatments. Though, nutrient consortium (TNAU Cotton Plus) application to zero monopodial and short sympodial compact cotton Co 17, increased the

partitioning efficiency of assimilates from source to sink parts and lead to an increase in yield over control, it did not reduce the foliage size. But the foliar application of mepiquat chloride decreased the height and the length of fruit branches, resulting in thicker leaves, bigger boll size with higher yield, and also resulted in synchronized maturity for easy management. Hence, foliar application of mepiquat chloride (0.015%) will be a promising practice for the farmers to get desirable yield in the newly released compact cotton Co 17.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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