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CONTENT

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ICRA
INTERNATIONAL COTTON RESEARCHERS ASSOCIATION

News

ICAC Announces Eric Trachtenberg as Its 8th Executive Director

Eric Trachtenberg

Mr Eric Trachtenberg has been selected by the Members of the International Cotton Advisory Committee (ICAC) to serve as the 8th Executive Director since the organisation was founded in 1939.

The ICAC's current Executive Director ad interim, Ms. Caroline Taco, who is also the Business Development Manager, will serve until 16 August, when Mr Trachtenberg will assume the duties of Executive Director on a full-time basis.

Mr Trachtenberg has a wealth of impressive credentials that earned him the position:

- Mr Trachtenberg has more than 25 years' experience working in international agricultural development and trade.
- In his current position at the U.S. Millennium Challenge Corporation, he leads design and implementation of programs worth more than 900$ million to improve food security and strengthen land productivity.
- At McLarty Associates, he counselled corporations, investors, and non-profits in the food and agriculture sector globally and served as a Private Sector Mechanism delegate to the UN Committee on World Food Security.
- For most of his career, Mr Trachtenberg served as a Foreign Service Officer at USDA's Foreign Agricultural Service (FAS) both in Washington and abroad.
- He has a Master's of Public Administration from the University of Southern California, a Master's of Science in Agricultural Economics from Michigan State University, and a Bachelor's degree from Cornell University in Government and Economics.

For more information, please visit www.icac.org, Twitter or LinkedIn.

Dr. Michael P. Bange Winner of the ICAC Researcher of The Year Award 2023.

Dr. Michael Bange

It is with great admiration and respect that we honor Dr. Mike Bange, a cotton systems agronomist of exceptional international reputation, with over three decades of innovative work, and a significant contributor to sustainable management practices. His illustrious tenure as a chief scientist at CSIRO Australia stands testament to his exceptional capability and dedication in the field of science.

Dr. Bange's innovative approach has consistently enabled him to meld comprehensive understanding of farm-scale requirements with an in-depth analysis of key biological processes. His profound insights into productivity under varied and shifting climates have distinguished his career. He is known for addressing challenges throughout the entire value chain, from seed to shirts, with an innate ability to engage farmers, advisors, and stakeholders in his research.

In addition to his extensive collaborations with universities and international cotton industry stakeholders, Dr. Bange has attracted and managed complex projects, leading teams of up to 50 people. As a Fulbright Scholar with active collaborations in the USA and China, his influence extends far beyond Australian borders.

Dr. Bange's pioneering work in sustainable crop management, water use efficiency, cotton agronomy, harvest and postharvest management, and climate change impacts and adaptation are notable. His impactful development of computerized decision support systems for cotton management further highlights his contribution to the field.

Dr. Bange has been acknowledged with an impressive tally of awards for his contributions to the field. His recognitions include four prestigious international accolades and a substantial seventeen national awards from esteemed institutions such as the CSIRO, CRC Association of Australia, Australian Museum, Cotton Australia, and the Australian Cotton Cooperative Research Centre, among others. The prestigious USA Beltwide cotton award in 2017 recognized Dr. Bange's significant contributions to physiology and agronomy. In 2016, he graced the World Cotton Research Conference as a keynote speaker, discussing 'Cotton Physiology as the Cornerstone of Cotton Science', further affirming his esteemed standing in the cotton science community.

Dr. Bange's leadership extends beyond his research. He has held executive roles within the Association of the Australian Cotton Scientists (AACS) and with ICRA. In 2019, the AACS acknowledged his remarkable contribution to cotton science with the prestigious service to cotton science award.

Currently serving as the commercial research manager for Cotton Seed Distributors in Australia, Dr. Bange continues to guide industry-facing research programs.

We wholeheartedly congratulate Dr. Bange, whose stellar career and exceptional achievements make him a deserving recipient of this award.

AMMI analysis for GE interaction in cotton (*Gossypium hirsutum*)

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Abstract

Background: *AMMI analysis has evolved into an important statistical tool in plant breeding to test the adaptability of cotton genotypes in multi-environment. The objective of this study was to determine the genotype × environment interaction of four introduced and two local genotypes across the five environments in Bangladesh. The experiment was conducted in a randomized complete block design with three replications during the Kharif 2020-2021 growing season.*

Results: *The AMMI analysis revealed that the seed cotton yields of the studied genotypes were significantly influenced by the genotype × environment interaction.*

Keywords: *AMMI, Cotton, genotype, environment*

Introduction

Multi-environment trials are usually conducted to evaluate the genotype-environment interaction to release new genotypes in targeted environments (Ceccarelli, 1996; Kaya *et al*., 2006; Karimizadeh*et al*., 2012; andMitrovic*et al*., 2012;).The differential response of a genotype or cultivar for a given trait across environments is defined as the genotype × environment interaction (G × E) that helps in the selection process to recommend a genotype for a target environment (Gauch, 2006). Genotype X environment (GE) interactions are of major concern to plant breeders for developing improved cultivars. A genotype is considered as promising if it performs well across a range of environments. GE interaction can be exploited by selecting location-specific superior genotypes or by choosing widely adapted and stable genotypes over different locations (Lakew*et al.,* 2017). There are two widely used approaches of grain yield stability analysis for multi-location trial data such as AMMI (Gauch*et al.,* 2008) and GGE-Biplot (Yan, 2002).

The AMMI model is a popular approach to studying GE interaction. The main effects of the environment and genotype with principal components analysis of GE interactions are combined through AMMI ANOVA (Sharifi*et al*., 2017). The present study was conducted to compare the performance and stability of 4 introduced cotton genotypes with 2 cotton varieties in Bangladesh for recommending the farmers' wider or specific cultivation in different cotton growing areas.

Materials and methods

The experiments were conducted at five cotton research centers across Bangladesh viz., Sreepur, Gazipur (E1); Jagdishpur, Jashore (E2); Mahigonj, Rangpur (E3); Sadarpur, Dinajpur (E4); and Balaghata, Bandarban (E5). The biophysical characteristics of the test environment is given in Table 1.Four cotton genotypes viz. Turkish-1 (G1), Turkish-2 (G2), Turkish-3 (G3), Turkish-4 (G4), introduced from the Cotton Research Institute of Turkey, and two local varieties viz. CDB-Tula-M1 and CB-15 were used as test materials. The experiments in all locations were designed in a Complete Randomized Block Design (CRBD) with three replications per environment under rain feed conditions. Sowing was done manually in rows. The experimental plot consisted of four ridges, 12 m long and 70cm apart. The other agriculturalpractices were applied as recommended by the Cotton Development Board, Bangladesh. Seed cotton yield was determined by harvesting the busted boll of the two middle lines. The seed cotton yield data were subjected to AMMI analysis by PBTools, version 1.4. 2014. Biometrics and Breeding Informatics, PBGB Division,International Rice Research Institute, Los Baños, Laguna.

Table 1. The biophysical characteristics of the test environments

Environ ment	Month	Longitude	Latitude	Attitude (m)	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)	Humidity (%)
	Jul				33.68	27.53	130.05	82.57
	Aug				33.88	27.44	98.66	81.74
E1	Sep	90.4202724	23.9999405	14	33.57	27.01	115.46	81.15
	Nov				32.43	24.82	74.53	77.36
	Oct				30.21	21.04	17.44	67.15
	Dec				27.28	17.7	5.29	60.76
	Jul				32.58	26.86	142.52	77.15
	Aug				32.23	26.3	154.44	79.76
E2	Sep	89.1801225	23.1777682	10.89	31.79	25.6	109.1	80.74
	Nov				30.71	23.22	75.51	75.06
	Oct				29.2	19.53	38.57	60.08
	Dec				26.8	16.45	3.23	49.6
	Jul				32.55	26.45	387.58	81.29
	Aug				33.22	26.77	286.41	78.54
E3	Sep	89.275227	25.7438916	33.66	32.25	25.42	330.85	80.77
	Nov				30.92	22.22	77.06	76.44
	Oct				28.55	18.47	4.85	66.39
	Dec				25.92	15.96	2.94	59.06
	Jul				34.92	28.38	415.83	87.22
	Aug				35.64	28.72	307.29	84.27
E4	Sep	88.6437649	25.6221009	40.09	34.6	27.27	354.97	86.66
	Nov				33.17	23.84	82.68	82.01
	Oct				30.63	19.82	5.2	71.23
	Dec				27.81	17.12	3.15	63.37
	Jul				30.29	26.55	449.38	86.47
	Aug				30.27	26.4	321.64	86.62
E5	Sep	92.2187476	22.1935628	22.08	30.5	26.32	219.66	85.5
	Nov				29.87	24.87	171.11	83.21
	Oct				28	21.02	28.77	77.45
	Dec				25.41	17.81	2.03	72.16

Results and discussion

Combined analysis of variance

Table 2 presents the combined analysis of variance. Genotype (G), environment (E) and genotype × environment interaction (GEI) were highly significant ($P<0.001$) for seed cotton yield. The factors explained showed that seed cotton yield was affected by genotype (10.07%), environment (64.26%) and their interaction (19.47%).

Table 2. Combined analysis of variance of seed cotton yield for 6 cotton genotypes evaluated at five environments

Source	DF	SS	MS	F	P	SS%
Genotype (G)	5	5870181	1174036	19.5	0.0000	10.07
Environment (E)	4	3.75E+07	9362052	155.48	0.0000	64.26
G x E interaction (GEI)	20	1.14E+07	567514	9.42	0.0000	19.47
Error	60	3612926	60215			
Total	89	5.83E+07				

AMMI analysis of variance

The AMMI analysis of variance for seed cotton yield is presented in Table 3. IPCs 1 to 3 jointly accounted for 95.8% of the entire variation among the genotypes.

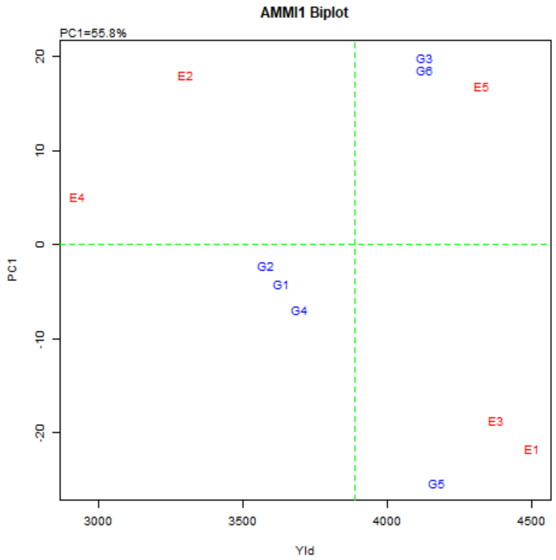
Table 3. AMMI analysis for seed cotton yield

	Variance (%)	Acum. Variance (%)	Df	SS	MS	F	P
PC1	55.8	55.8	8	4219561	527445	9.62E+18	0
PC2	33.9	89.7	6	2561790	426965	7.79E+18	0
PC3	6.1	95.8	4	462425	115606	2.11E+18	0
PC4	4.3	100.1	2	323074	161537	2.95E+18	0

AMMI biplot display

The AMMI biplots are graphs where aspects of both genotypes and environments are plotted on the same axes so that interrelationships can be visualized. There are two basic AMMI biplot, the AMMI 1 biplot, where the main effects of seed cotton yield (genotype mean and environment mean) and IPCA1scores for both genotypes and environments are plotted against each other. On the other hand, the second biplot is AMMI 2 where scores for IPCA1 and IPCA2 are plotted. In the AMMI 1 biplot, the usual interpretation of biplot is that the displacements along the abscissa indicate differences in main (additive) effects, whereas displacements along the ordinate indicate differences in interaction effects. Genotypes that group together have similar adaptation while environments that group together influences the genotypes in the same way (Kempton, 1984). The AMMI 1 biplot gave a model fit 55.8% (Fig. 1). Among the genotypes, G3 and G6 exhibited high yield with a positive IPCA1 score. These two genotypes (G3 and G6) were adapted to the environment E5. Genotype G5 showed a negative IPCA1 score with over average yield and was adapted to E1 and E3. Other genotypes showed below-average yield and negative IPCA1 score.

In AMMI 2 biplot (Figure 2), the environmental scores are joined to the origin by side lines called vectors. Environments with short vectors did not exert strong interaction effects while those environments that have long vectors located away from the origin exert strong interaction effects. The vector length in the AMMI model can be used to determine the discriminative ability of environments for genotypes (Li *et al,* 2003). The environments E1, E2, E3, E4 and E5 had longer vectors. Thus, they were the best discriminative environments for investigated genotypes (Yan and Hunt, 2001). The acute angle between vectors of E1 and E3 environments indicated that these two environments were similar for yield determination. Yet, environments with obtuse angles were different, i.e., E2 and E4.



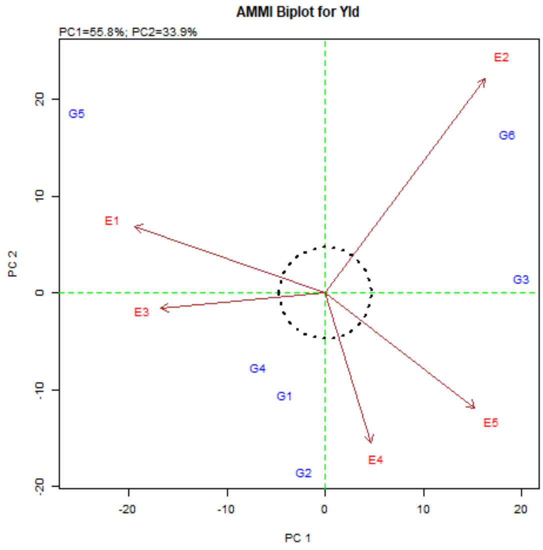


Figure 1. AMMI 1 Biplot for seed cotton yield of six cotton genotypes (G) and five environments (E)

Figure 2. AMMI II biplot for cotton yield showing the interaction of PC1 and PC2 scores of six cotton genotypes (G) and five environments (E)

Conclusion

Our study revealed that none of the studied genotype is suitable for all environments. All of the studied genotypes are highly influenced by the Genotype × Environment interaction. The G3 and G6 genotypes were adapted to E5 environment while the G5 genotype were adapted to E1 and E3 environments.

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Effect of Nitrogen Rate on Cotton Crop Growth, Yield and Fibre Quality

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Abstract

Background: *Nitrogen application rate is an important practice for optimizing cotton production. CB-15 is a newly released cotton variety for which N rate is not determined.*

Results: *Experiments were conducted at three Cotton Research Centers located at Sreepur, Gazipur; Jagadishpur, Jashore and Sadarpur, Dinajpur in 2018-2019 growing season to determine the effects of variable doses of nitrogen on yield and fiber quality of cotton variety CB-15. The influence of seven nitrogen rates (0, 40, 80, 120, 160, 200, 240 kg/ha) were compared in RCB Design with three replications. Cotton growth, yield and fiber quality data were collected. Nitrogen rate had a positive effect on seedcotton yield. Nitrogen rates at all levels significantly (p< 0.05) increased the cotton yield when compared with control. At Sreepur, Gazipur and Sadarpur, Dinajpur the highest seedcotton yield (3187 and 2736 kg/ha respectively) were obtained from 160 kg N/ha while at Jagadishpur, Jashore the highest seedcotton yield (2963 kg/ha) was obtained from 200 kg N/ha. The estimated regression equations of cotton yield in response to N rates for Sreepur was y = -0.075x2 + 27.03x + 725.1 (R2=0.898), for Sadarpur was y = -0.044x2 + 17.61x + 1013 (R2=0.9489) and for Jagadishpur was y = -0.041x2 + 18.24x + 913.1 (R2=0.9473). The higher value of R-square revealed that the yield was predictable. N had significant positive association with fiber strength.*

Key Words:

Nitrogen fertilizer, cotton growth, cotton yield, cotton fiber quality, regression equations of cotton yield

Background

Cotton in an important cash crop and main raw material for the textile industries in Bangladesh. Sustainability of textile value chain in Bangladesh largely depends on the steady supply of lint. In 2019, Bangladesh has imported 17.52 lac tons of lint from India (25%), USA (10%), Australia (9%), Mali (9%), Burkina Faso (8%), Benin (8%), Brazil (7%), Uzbekistan (6%), Turkmenistan (4%), Cameroon (3%), Ivory Coast (2%), Chad (2%) and others (7%) while the local production was 31207 tons that met 1.78 per cent of national requirement. To ensure uninterrupted cotton supply and avoiding market vulnerability, increasing cotton production in Bangladesh is one of one best alternative solution to achieve sustainable textile sector. For increasing cotton production in Bangladesh, Cotton Development Board released CB-15, an open pollinated high yielding variety for growing all over the Bangladesh. However, for optimizing the yield of CB-15 its N fertilizer rate was not determined.

All over the cotton growing countries, nitrogen (N) is a major nutrient element limiting cotton production (Bondada and Oosterhuis, 2001; Rochester, 2011; Devkota et al., 2013; Iren and Aminu, 2017a & b; Sattaret al., 2017,). Nitrogen deficiency can reduce leaf size, number of fruiting nodes, boll retention, yield and fibre quality (Hallikeri et al., 2010; Tang et al., 2012; Bhati and Manpreet, 2015; Iren and Aminu, 2017a & b; Sattar et al., 2017). While excess N can cause excessive vegetative growth, delay maturity, create difficulty in defoliation, increase pest problems, and ultimately reduce the crop yield and fiber quality (Tewolde and Fernandez, 1997; Cisneros et al., 2001; Howard et al., 2001; Hons et al, 2003). Cotton fiber quality has direct effect on processing performance, yarn quality, and end products in the textile industry. Producing high-yielding and high-quality cotton requires careful fertilizer management. Nitrogen (N) nutrient can affect lint yield and fiber properties (Fritschi et al., 2003; Bauer and Roof 2004; Girma et al., 2007, Main et al., 2011).

The objective of this study was to investigate the effect of nitrogen (N) application rates on seed cotton yield and fiber quality of cotton cultivar CB-15.

Results

Location Effect of nitrogen on CB 15 growth and yield

The results revealed that location had significant effect ($p<0.05$) on plant height at harvest, number of monopodial branch/plant, number of sympodial branch/plant, number of boll/plant, individual boll weight and seed cotton yield (Table 1). The maximum plant height (128.0cm) was produced at Jagadishpur and the minimum plant height (101.70 cm) was recorded at Sreepur. The lowest monopodial branch/plant (1.2) was recorded at Sreepur and the highest monopodial branch/plant (2.9) was recorded at Sadarpur. The highest number of sympodial branch/plant (16.7) was found at Jagadishpur and the lowest number of sympodial branch/plant (15.10) was found at Sadarpur. The highest number of boll/plant (24.10) was produced at Sreepur and the lowest number of boll/plant (21.20) was recorded at Sadarpur. The lowest single boll weight (4.99 g) was recorded at Jagadishpur and the highest single boll weight (5.30 g) was recorded at Sreepur. The maximum seed cotton yield (2403kg/ha) was recorded at Sreepur and minimum seed cotton yield (2195 kg/ha) was recorded at Sadarpur.

Table 1. Effect of Location of N on CB-15 yield and yield contributing characters

Location	Plant Height (cm)	Monopodial branch/plant	Sympodial branch/plant	Boll/ plant	Boll weight (g)	Yield (kg/ha)
Sreepur	101.7	1.2	16.3	24.10	5.30	2403
Jagadishpur	128.0	1.9	16.7	24.0	4.99	2249
Sadarpur	118.6	2.9	15.1	21.2	5.18	2195
5% LSD	6.01	0.37	0.93	1.56	0.15	185
CV%	8.1	34.2	9.4	10.4	4.7	12.8

Treatment effect

The effect of various levels of N fertilizers on yield and yield contributing characters of CB-15 are found significant ($p<0.05$) on plant height at harvest, number of monopodial branch/plant, number of sympodial branch/plant, number of boll/plant, individual boll weight and seed cotton yield (Table 2).

Table 2. Effect of various levels of N fertilizer on yield and yield components of CB-15

N rates (kg/ha)	Plant Height (cm)	Monopodial branch/plant	Sympodial branch/plant	Boll/ plant	Boll weight (g)	Seed cotton Yield (kg/ha)
0	83.0	1.5	10.0	10.1	4.02	942
40	102.1	1.6	13.6	18.0	4.42	1763
80	113.9	1.8	15.8	21.4	4.88	2258
120	124.0	1.6	17.1	24.3	5.27	2594
160	140.7	1.7	18.5	33.3	5.78	3062
200	138.2	1.8	18.3	32.8	5.83	2945
240	140.4	2.3	18.3	30.9	5.63	2926
5% LSD	7.11	0.44	1.10	1.85	0.17	219
CV%	8.1	34.2	9.4	10.4	4.7	12.8

The minimum plant height (83cm) was recorded from control treatment (0 kg N/ha) and the maximum plant height (140.7 cm) was recorded from the treatment of 160 kg N/ha. The relationship between plant height vs. seed cotton yield is given in Figure1.

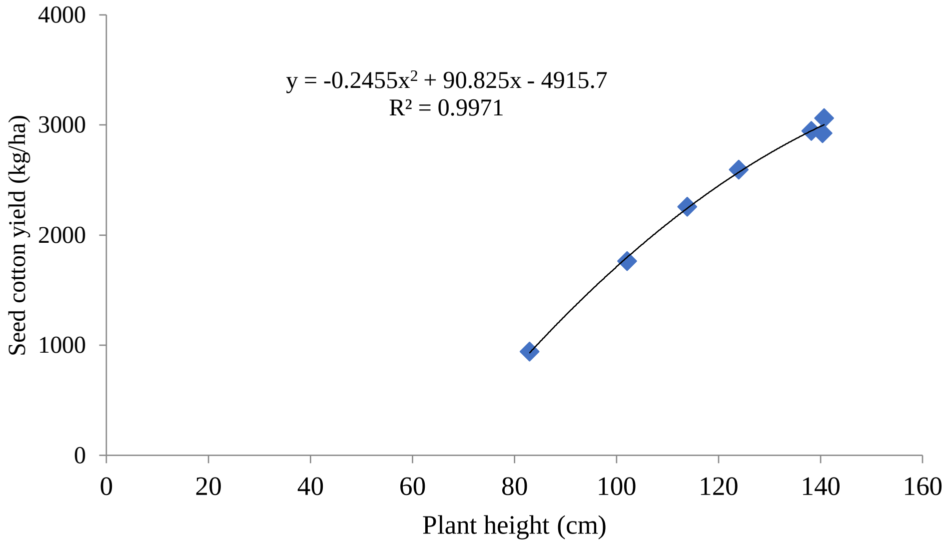

Figure 1. *The relationship between plant height vs. seed cotton yield*

The highest monopodial branch/plant (2.3) was recorded from 240 kg N/ha and the lowest number of monopodial branch/plant (1.5) was recorded from no nitrogen. The relationship between monopodial branches per plant vs. seed cotton yield is given in Figure 2.

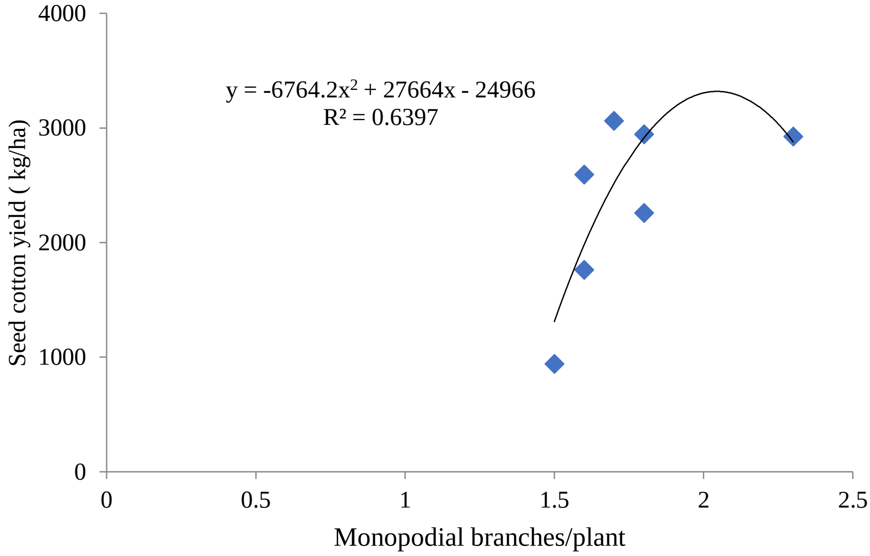

Figure 2. *The relationship between monopodial branches/plant vs. seed cotton yield*

The lowest sympodial branch/plant (10.0) was found in control treatment (0 kg N/ha) and the highest sympodial branch/plant (18.5) was found in of 160 kg N/ha. The relationship between sympodial branches per plant vs. seed cotton yield is given in Figure 3.

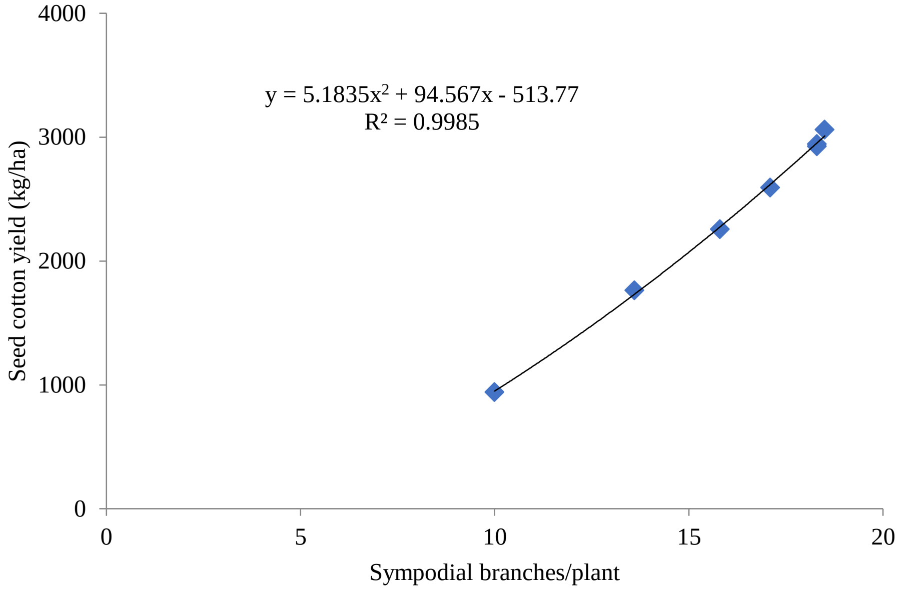

***Figure 3.** The relationship between sympodial branches/plant vs. seed cotton yield*

The lowest boll/plant (10.1) was recorded from control treatment (0 kg N/ha) and the highest boll/plant (33.30) was recorded from the treatment of 160 kg N/ha. Gangaiah et. al., 2013 reported that application of 180 kg N/ha produced mean boll number of 54/plant which was 40% greater over no nitrogen fertilizer application. The relationship between boll/plant vs. seed cotton yield is given in Figure 4.

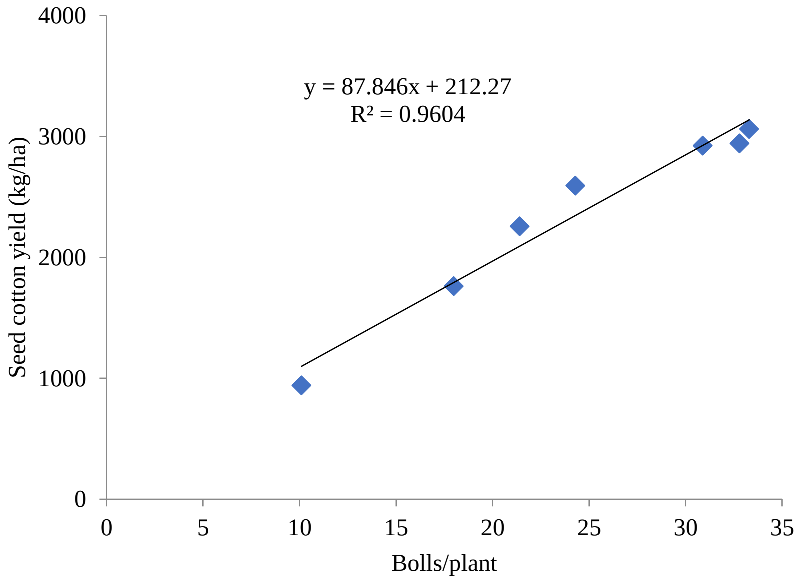

***Figure 4.** The relationship between bolls/plant vs. seed cotton yield*

The lowest single boll weight (4.02 g) was recorded from no nitrogen and the highest single boll weight (5.83 g) was recorded from the treatment of 200 kg N/ha. The relationship between single boll weight vs. seed cotton yield is given in Figure 5.

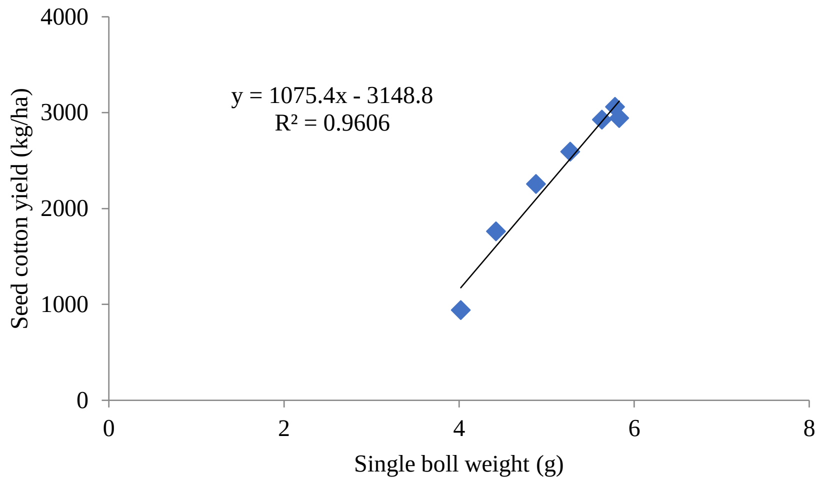

Figure 5. *The relationship between single boll weight vs. seed cotton yield*

The minimum seed cotton yield (942 kg/ha) was recorded from control treatment (0 kg N/ha) and the maximum seed cotton yield (3062 kg/ha) was recorded from the treatment of 160 kg N/ha.

Interaction Effect

The interaction effects of location × N were found significant ($p<0.05$) on plant height at harvest, number of monopodial branch/plant, number of sympodial branch/plant, number of boll/plant, individual boll weight and seed cotton yield (Table 3). The highest plant height at Sreepur Cotton Research Center (125.6 cm), Jagadishpur Cotton Research Center (150.8 cm) and Sadarpur Cotton Research Center (143.0 cm) were obtained from 240, 200 and 160 kg N/ha respectively. The highest number of monopodial branch/plant at Sreepur Cotton Research Center (1.8) and Sadarpur Cotton Research Center (4.1) were obtained from 240 kg N/ha while at Jagadishpur Cotton Research Center N rates from 40 kg/ha to 240 kg/ha had no significant effect on monopodial branch/plant. The highest number of sympodial branch/plant at Sreepur Cotton Research Center (19.4), Jagadishpur Cotton Research Center (20.3) and Sadarpur Cotton Research Center (16.8) were obtained from 240, 160 and 120 kg N/ha respectively. The highest number of boll/plant at Sreepur Cotton Research Center (31.8), Jagadishpur Cotton Research Center (32.9) and Sadarpur Cotton Research Center (32.4) were obtained from 200, 160 and 160 kg N/ha respectively. The highest single boll weight at Sreepur Cotton Research Center (5.99 g), Jagadishpur Cotton Research Center (5.93 g) and Sadarpur Cotton Research Center (5.07 g) were recorded from 200, 160 and 200 kg N/ha respectively.

Table 3. Location × nitrogen (N) interaction effect on CB-15

Location	N rates (kg/ha)	Plant Height (cm)	Monopodial branch/plant	Sympodial branch/plant	Boll/ plant	Boll weight (g)	Yield (kg/ha)
Sreepur, Gazipur	0	58.6	0.3	9.9	11.3	4.24	730
	40	70.5	0.7	13.9	16.8	4.72	1717
	80	103.8	1.2	16.5	22.3	5.13	2338
	120	110.8	1.3	17.6	24.1	5.42	2870
	160	121.4	1.2	18.6	31.6	5.92	3187
	200	120.9	1.7	18.4	31.8	5.99	3123
	240	125.6	1.8	19.4	30.3	5.69	2858
Jagadishpur, Jashore	0	84.5	1.1	9.8	10.7	3.90	975
	40	109.1	2.1	13.6	17.6	3.95	1450
	80	119.6	2.0	15.8	20.5	4.53	2212
	120	134.1	2.1	18.0	23.7	4.96	2396
	160	147.5	2.0	20.3	32.9	5.93	2862
	200	150.8	2.0	19.6	32.2	5.90	2963
	240	150.4	2.1	19.5	30.3	5.75	2883
Sadarpur, Dinajpur	0	77.7	2.9	9.9	9.1	3.93	1004
	40	104.9	2.3	13.3	14.0	4.43	1662

	80	113.7	3.1	15.0	15.2	4.97	2158
	120	115.4	2.7	16.8	18.7	5.53	2420
	160	143.0	2.7	17.7	32.4	5.77	2736
	200	136.9	2.4	16.7	29.9	6.07	2722
	240	138.8	4.1	16.0	28.9	5.57	2664
5% LSD		15.90	0.98	2.45	4.14	0.39	491
CV%		8.1	34.2	9.4	10.4	4.7	12.8

N availability and crop N uptake may vary considerably with soil properties, weather conditions, and interactions between these factors, optimal N rates vary from year to year and field to field (Tremblay, 2004; Olfs et al., 2005; van Es et al., 2005; Melkonian et al., 2007; Zhu et al., 2009). Optimum N rates for cotton production varied by soil type; production, climate, and various other soil and crop management factors (Boquet and Breitenbeck, 2000; Boquet, 2005). Cotton yield is affected by the different weather parameters such as temperature (Ghosh et al., 2014), rainfall (Gupta and Pandey, 1991), humidity (Singh et al., 2009) etc. The soil properties and weather parameters were different at Sreepur, Sadarpur and Jagadishpur (Table 1 and Table 2, respectively). The highest seed cotton yield at Sreepur Cotton Research Center (3187 kg/ha), Jagadishpur Cotton Research Center (2963 kg/ha) and Sadarpur Cotton Research Center (2736 kg/ha) were obtained from 160, 200 and 160 kg N/ha respectively. Saleem et al. (2010) obtained maximum seed cotton yield (3002 kg/ha) by applying N at the rate of 120 kg/ha. Rashidi et al. (2011) reported that application of N at the rate of 200 kg/ha produced the highest seed cotton yield (4363 kg/ha). Alitabar et al. (2013) found that application of 225 kg/ha N produced the maximum seed cotton yield (1731.06 kg/ha).

Optimum level of N was determined by equating the inverse price ratio with marginal product (Table 4) which indicated that it was profitable to apply N in the range of 160-200 kg/ha at Sreepur and Sadarpur cotton research centers and in the range of 200-240 kg/ha at Jagadishpur cotton research center.

Table 4. Marginal product and inverse price ratio at different levels of N application

Location	N rates (kg/ha)	Yield (kg/ha)	Total product due to N	Marginal product	Inverse price ratio
Sreepur	0	730			
	40	1717	987	24.68	0.68
	80	2338	1608	15.53	0.68
	120	2870	2140	13.30	0.68
	160	3187	2457	7.93	0.68
	200	3123	2393	-1.60	0.68
	240	2858	2128	-6.63	0.68
Jagadishpur	0	975	0		
	40	1450	475	11.88	0.68
	80	2212	1237	19.05	0.68
	120	2396	1421	4.60	0.68
	160	2862	1887	11.65	0.68
	200	2963	1988	2.53	0.68
	240	2883	1908	-2.00	0.68
Sadarpur	0	1004			
	40	1662	658	16.45	0.68
	80	2158	1154	12.40	0.68
	120	2420	1416	6.55	0.68
	160	2736	1732	7.90	0.68
	200	2722	1718	-0.35	0.68
	240	2664	1660	-1.45	0.68

Notes: Price of N= 39.13 Taka/kg, price of seed cotton= 57.50 Taka/kg

Regression analysis

CB-15 yield response to N fertilizer at Sreepur Farm is presented in Figure 6. The estimated equation for CB-15 yield in relation to N is $y = -0.075x2 + 27.03x + 725.1(R2=0.898)$. The higher value of R-square revealed that the yield is predictable.

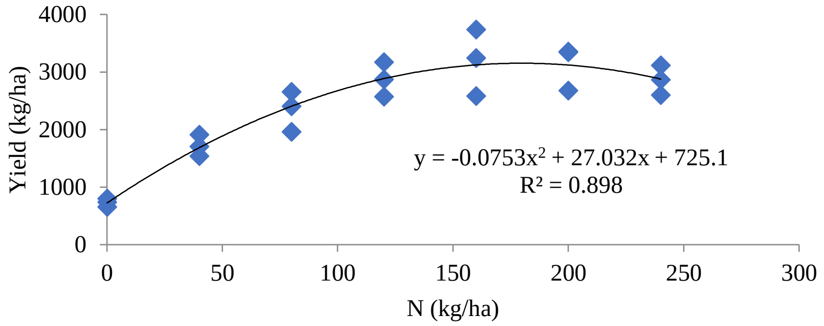

Figure 6. *CB-15 yield in response to N fertilizer at Cotton Research Center, Sreepur, Gazipur*

CB-15 yield response to N fertilizer at Jagadishpur Farm is presented in Figure 7. The estimated equation for CB-15 yield in relation to N is y = -0.041x2 + 18.24x + 913.1(R2=0.9473). The higher value of R-square revealed that the yield is predictable.

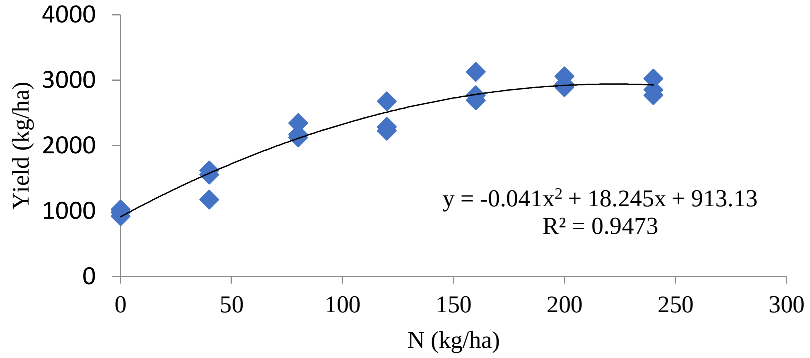

Figure 7. *CB-15 yield in response to N fertilizer at Cotton Research Center, Jagadishpur, Jashore*

CB-15 yield response to N fertilizer at Sadarpur Farm is presented in Figure 8. The estimated equation for CB-15 yield in relation to N is y = -0.044x2 + 17.61x + 1013(R2=0.9489). The higher value of R-square revealed that the yield is predictable.

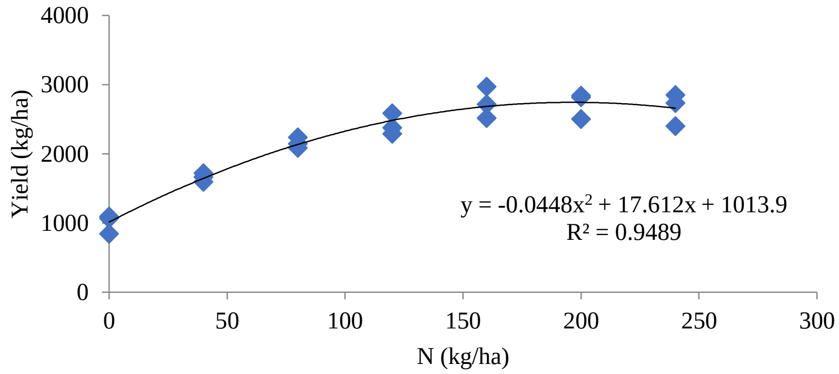

Figure 8. *CB-15 yield in response to N fertilizer at Cotton Research Center, Sadarpur, Dinajpur*

Predicted yield and marginal product at different locations obtained from fitting the regression equation were given in Table 5. It was estimated that maximum profitable yield at Sreepur, Jagadishpur and Sadarpur cotton research centers could be obtained by applying N at the rate of 176, 214 and 192 kg/ha respectively.

Table 5. Predicted yield and marginal product at different locations

Location	Regression equation	N rates (kg/ha)	Predicted yield (kg/ha)	Total product due to N	Marginal product	Inverse price ratio
Sreepur	$y = -0.075x^2 + 27.03x + 725.1$	176	3159	2429	0.71	0.68
Jagadishpur	$y = -0.041x^2 + 18.24x + 913.1$	214	2939	1964	0.73	0.68
Sadarpur	$y = -0.044x^2 + 17.61x + 1013$	192	2772	1768	0.76	0.68

Price of N= 39.13 Taka/kg, price of seed cotton= 57.50 Taka/kg

Fiber Quality

The correlation matrix among N and fiber quality of CB-15 was given in Table 6. Studies on correlation revealed that N had significant association with fiber strength ((r = 0.326) while the association among N and fiber length, uniformity index, short fiber index, elongation, micronaire, reflectance and yellowness were not significant. The highly significant negative association was found between fiber length and short fiber index (r=-0.566) and between micronaire and reflectance (r=-0.534). The N nutrition effect on certain fiber properties had been studied (Murray et al., 1965; Hearn, 1976; Koli and Morrill, 1976;Constable and Hearn, 1981; Bowman and Westerman, 1994; Rochester et al., 2001; Bogiani et al., 2011; Gottardo, 2012; and Sofiatti et al., 2013 and Kappes et al., 2016). Some studies found that N nutrition increased both lint yield and fiber length (Hearn, 1976; Constable and Hearn, 1981). Some other studies concluded that N nutrition does not affect any of the fiber quality parameters (Murray et al., 1965; Bowman and Westerman, 1994; Bogiani et al., 2011; Gottardo, 2012; and Sofiatti et al., 2013 and Kappeset al., 2016). Reports of cotton nutrition effect on fiber properties are sometimes contradictory that may vary depending on genotype, weather and soil (Jenkins et al., 1990; Minton and Ebelhar, 1991; Jones and Wells, 1998; Pettigrew, 2003; Reddy et al., 2004).

Table 6. Correlation matrix among the N and fiber quality

	N	Fiber length	Uniformity Index	Short Fiber Index	Fiber strength	Elongation	Micronaire	Reflectance
Fiber length	0.326ns							
Uniformity Index	0.413ns	0.988ns						
Short Fiber Index	0.237ns	-0.566**	-0.446ns					
Fiber strength	0.776*	0.544ns	0.628ns	-0.06214ns				
Elongation	0.185ns	0.525ns	0.561ns	-0.20139ns	0.745ns			
Micronaire	0.385ns	0.564ns	0.667ns	-0.36786ns	0.663ns	0.631ns		
Reflectance	-0.429ns	-0.524ns	-0.542ns	0.003202ns	-0.615ns	-0.499ns	-0.534**	
Yellowness	-0.512ns	-0.122ns	-0.135ns	-0.65616ns	-0.274ns	0.002ns	0.185ns	-0.379ns

*=significant ($p < 0.05$), **= highly significant ($p < 0.01$), ns=non-significant

In Bangladesh during 2018-2019 growing season American cotton was grown over 44185 ha of land of which 60% area was plain and 40% area was hill slope. Among the plain land, 36% area was located at Jashore region, 17% in Rangpur region and 7% in Dhaka region. Earlier recommended N application rates for the plain areas of Bangladesh were uniform (Islam et al., 2013; Ahmmed et al., 2018). The optimum N doses for Sreepur, Jagadishpur and Sadarpur will be applicable for Dhaka, Jashore and Rangpur region respectively and will be useful for the management of location specific N.

Conclusion

The results from this study indicate that nitrogen fertilizer rate as well as location have significant effect on plant height at harvest, number of monopodial branch/plant, number of sympodial branch/plant, number of boll/plant, individual boll weight and seed cotton yield of cotton variety CB-15. The optimum nitrogen rate of cotton variety CB-15ranges from 160-200 kg/ha for different locations. The finding of this study will be helpful for planning of resource allocation for increasing cotton production in Bangladesh.

Methods

Field experiments were conducted at 3 Cotton Research Center located at Sreepur, Gazipur; Jagadishpur, Jessore and Sadarpur, Dinajpur in 2018-2019. To know the effect of 7 different rates of N (0, 40, 80, 120, 160, 200, 240 kg/ha) on CB-15, experiments were set up in RCBD with 3 replications. Unit plot size was 5.4 × 4.5 m and plant spacing was 90 × 45 cm. The seed was sown on second week of July, 2018. Urea was applied as the source of N. Cotton Development Board recommended rates of TSP (280 kg/ha), Gypsum (150 kg/ha), Zinc sulphate (25 kg/ha), Magnesium sulphate (25 kg/ha), borax (25 kg/ha) and one-third urea (as per treatment) and one-third MoP (105 kg/ha) were applied as basal. The rest of Urea (as per treatment) and MoP were applied in three equal splits as top dressing at 25, 50 and 70 days after sowing.

Two irrigations were applied in the month of October and November. Intercultural operations such as weeding, thinning, gap-filling, earthling-up, insects and pest management were done in all plots uniformly. Cotton growth data were collected from 10 randomly selected plants at each plot. Average boll weight was calculated by dividing the weight of cotton obtained from 10 randomly picked bolls. Seed cotton was harvested from three middle rows to determine the plot yield. Data collected on different parameters were analyzed statistically by using CropStat 7.2 developed by International Rice Research Institute. The law of diminishing return was used to determine the optimum level of nitrogen by equating the inverse price ratio with marginal product (Sharma and Sharma, 1981).

The status of the initial soil was presented in Table 6.The characteristics of Sreepur soil are clay loam, moderately acidic (pH=5.6) with very low nitrogen (0.084%), low organic matter (1.68%) and low content of other nutrients. The characteristics of Jagadishpur soil are sandy loam, neutral in soil reaction (pH=7.20) with very low nitrogen (0.010%), very low organic matter (0.20%) and low content of other nutrients. The characteristics of Sadarpur soil are sandy loam, neutral in soil reaction (pH=6.73) with very low nitrogen (0.005%), low organic matter (1.03 %) and low content of other nutrients.

At Sreepur, the maximum average air temperature (34.1 °C) was recorded in the month of September, 2018 and the minimum average air temperature (14.7 °C) was recorded in the month of January, 2019. The maximum average relative humidity (80.1%) and the maximum average rainfall (11.5 mm) were recorded in the month of July, 2018. The minimum average relative humidity (57.5%) and no rainfall were recorded in the month of January, 2019. At Sadarpur, the maximum average air temperature (33.8 °C) was recorded in the month of August, 2018 and the minimum average air temperature (11.3 °C) was recorded in the month of December, 2018. The maximum average relative humidity (78.2%) and the maximum average rainfall (6.4 mm) were recorded in the month of September, 2018. The minimum average relative humidity (71.2%) and no rainfall were recorded in the month of January, 2019. At Jagadishpur, the maximum average air temperature (34.6 °C) was recorded in the month of September, 2018 and the minimum average air temperature (10.3 °C) was recorded in the month of January, 2019. The maximum average relative humidity (81.7 %) and the maximum average rainfall (13.9 mm) were recorded in the month of July, 2018. The minimum average relative humidity (72.6%) and no rainfall were recorded in the month of November, 2018.

Table 6. Initial soil status of Experimental plot

Location	pH	OM (%)	N (%)	K meq/100 g soil	P µg/g soil	S µg/g soil	Mg meq/ 100g soil	Zn µg/g soil	B µg/g soil	Soil Texture
Sreepur	5.60	1.68	0.084	0.12	6.87	0.004	0.82	1.33	0.43	Clay loam
Jagadishpur	7.20	0.20	0.010	0.12	2.41	0.002	0.79	0.92	0.13	Sandy loam
Sadarpur	6.73	1.03	0.05	0.38	5.50	4.50	1.20	1.12	0.18	Sandy loam

Mean monthly weather data for the cotton growing season 2018-2019 is presented in Table 7.

Table 7. Average monthly weather data for cropping season 2018-2019

Location	Month	Temperature (°C)		Relative humidity (%)	Rainfall (mm)
		Maximum	Minimum		
Sreepur	July-2018	32.6	26.7	80.1	11.5
	August-2018	33.8	27.1	75.0	4.5
	September-2018	34.1	27.0	74.7	2.5
	October-2018	32.0	23.6	67.9	1.5
	November-2018	30.3	19.8	65.4	0.4
	December-2018	26.1	16.2	64.0	0.4
	January-2019	27.2	14.7	57.5	0.0

Sadarpur	July-2018	33.3	27.0	77.6	5.5
	August-2018	33.8	26.9	78.0	4.9
	September-2018	33.3	26.1	78.2	6.4
	October-2018	31.3	21.5	76.3	0.3
	November-2018	29.6	15.7	75.3	0.0
	December-2018	25.5	11.3	77.4	0.3
	January-2019	25.8	13.7	71.2	0.0
Jagadishpur	July-2018	33.3	26.6	81.7	13.9
	August-2018	33.8	26.7	79.3	3.7
	September-2018	34.6	26.0	80.2	2.5
	October-2018	33.0	21.8	80.4	2.5
	November-2018	31.0	16.8	72.6	0.0
	December-2018	26.0	12.0	79.2	0.4
	January-2019	26.9	10.3	74.6	0.0

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Detopping is an Option to Reduce Field Duration of Cotton without Affecting the Yield and Quality of Cotton Fiber

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Abstract

Background: *Cotton (Gossypium hirsutum L.) is an important textile industrial crop. Detopping is a management technique for reducing field duration while increasing fiber yield of cotton. The study was conducted in the experimental field of Cotton Research, Training and Seed Multiplication Farm, Sreepur, Gazipur, Bangladesh during Kharif season of 2018–2019. The experiment included five genotypes (BC-479, BC-495, BC-514, JA-13/R and CB-12) and four detopping times (No detopping, detopping at 80, 90 and 100 days after sowing).*

Results: *Detopping practices significantly reduced plant height, monopodial, sympodial, secondary branches plant-1and field duration but increased flowering, bolls numberplant-1 and seed cotton yield. Genotype BC-479 produced the highest seed cotton yield (3.90 t ha-1) and the genotype gave 18 percent more seed cotton while detopping at 90 days after sowing (DAS). The genotype with detopping at 90 DAS also showed minimum field duration (155 days), which 30 days earlier than the duration required for the genotype without detopping. Fiber quality (staple length, strength, uniformity index and micronaire) was also significantly improved by significantly affected by detopping, genotype and their detopping irrespective of genotype.*

Conclusion: *Based on the results detopping is suggested as a good practice to reduce field duration and also to increase yield and quality of cotton fiber.*

Key Words: *Cotton (Gossypium hirsutum L.), detopping, field duration, lint quality, yield*

Background

Cotton (Gossypium hirsutum L.) is a cash crop that provides fiber, oil and fuel wood, and contributes a major part of income for farmers in the world. More than sixty countries of the world are growing cotton in tropical areas (Nawaz et al., 2019). Cotton is the second important cash crop as well as the main raw materials for the textile industry in Bangladesh. Cotton is a long duration crop which is cultivated in Bangladesh during July to February as a sole crop. Due to long duration of cotton, the crop cannot be fitted in the existing three crops based cropping patterns in the country. Therefore, cotton cultivation is being pushed to the marginal lands only. If the duration of cotton can be reduced to some extent, the crop can be fitted in the three crops based cropping pattern.

Detopping is one of the most important management practices in cotton plants. Cultural practices including detopping plays a very essential role in improving cotton yield. The main aim of detopping is to get good architecture, so that the plant can get required sunlight with a minimum of mutual shading and thus the picking efficiency can be increased with crop maturity. Rathinaval et al. (2003) found the detopping technique as a good practice for reducing field duration of cotton. Detopping at 75 cm plant height increased number of fruiting branches, percentage of boll on sympodial branches, boll weight, seed cotton yield and highest number of boll retention (Obasi and Msaakpa, 2005). Increased sympodial branches plant-1, number of bolls plant-1 and also seed cotton yield 15.1 to 21.1 percent at 75 DAS detopping (Kataria and Valu, 2018). The field experiment was conducted with a view to exploring the feasibility of using detopping technique in cotton to reduce the field duration of cotton and improving the yield or at least without affecting the yield.

Results

Plant height (cm) at maturity

Plant height of cotton varied significantly due to genotype, detopping and their interaction (Table 1). The tallest plant height (108.43 cm) was observed in the genotype CB-12 whereas the shortest plant height (95.98 cm) was found in genotype BC-479. The tallest plant height (117.79 cm) was obtained in no detopping (control) and the shortest plant height (88.45 cm) was found in detopping at 80 DAS. When detopping interacted with genotype, genotype CB-12 showed the tallest plant height of 135 cm with no detopping whereas the genotype JA-13/R produced the shortest plant height of 86.67 cm with detopping at 80 DAS.

Main stem node of a first fruiting branch (NFB)
The NFB was significantly different among the genotypes but it was not influenced by detopping and interaction of genotype and detopping (Table 1). Genotype BC-514 showed the lowest NFB (4.13) followed by BC-479 whereas the highest NFB (4.68) was obtained in genotype JA-13/R.

Monopodial branches plant^{-1}
The study observed that all treatments were significantly influenced by monopodial branch plant^{-1} (Table 1). The maximum number of monopodial branches plant^{-1}(1.06) was recorded in genotype CB-12 and the lowest one (0.67) was found in BC-479. Maximum monopodial branches plant^{-1}(0.97) was recorded in detopping at 100 DAS followed by detopping at 90 DAS and the minimum one (0.82) was found in no detopping. Among the interactions, the maximum monopodial (1.20) was showed genotype BC-514 with detopping at 80 DAS and minimum (0.50) was found genotype BC-479 with detopping at 80 DAS.

Sympodial branches plant^{-1}
The most important yield contributing character sympodial branch was significantly influenced by genotype and detopping. The maximum sympodial branches plant^{-1} (14.91) was recorded in BC-479 and the minimum (12.63) in CB-12 (Table 1). Treatment of no detopping showed the maximum sympodial branches plant^{-1} (14.77) and the minimum (13.22) was recorded in detopping at 100 DAS and there was no significant difference in interaction.

Secondary fruiting branches plant^{-1}
The results showed that secondary fruiting branches were significantly influenced in all treatments. As shown in Table 1, the maximum secondary fruiting branches plant^{-1} (3.06) was recorded in genotype BC-495 and minimum (2.10) in BC-479, whereas maximum secondary fruiting breaches plant^{-1}(2.76) was recorded in no detopping and minimum one (2.43) was found in detopping at 90 DAS. The maximum and minimum secondary fruiting breaches plant^{-1} (3.63) and (2.00) were recorded in genotype BC-495 with detopping at 100 DAS and genotype BC-479 with detopping at 90 days after sowing, respectively.

Days to the first flowering
The cotton genotypes were found indeterminate in flowering habits. The time required for the first flowering of the tested cotton genotypes was significantly different (Table 1). The shortest duration (55.92 days) was recorded in genotype BC-479 and the longest duration (61 days) was recorded in CB-12. No significant difference was observed due to detopping and its interaction with genotype.

Number of bolls plant^{-1}
The number of bolls plant^{-1}varied significantly due to all treatments. The results revealed that the maximum number of bolls plant^{-1} (38.08) was produced in genotype BC-479 and the minimum one (30.58) in CB-12. Detopping at 90 DAS and no detopping recorded the maximum (37.20) and minimum (32.87) bolls plant^{-1}, respectively. The maximum bolls (40.33) was obtained in genotype BC-479 when detopping was done at 90 DAS and minimum one (24.33) in genotype CB-12 when no detopping (Figure 1).

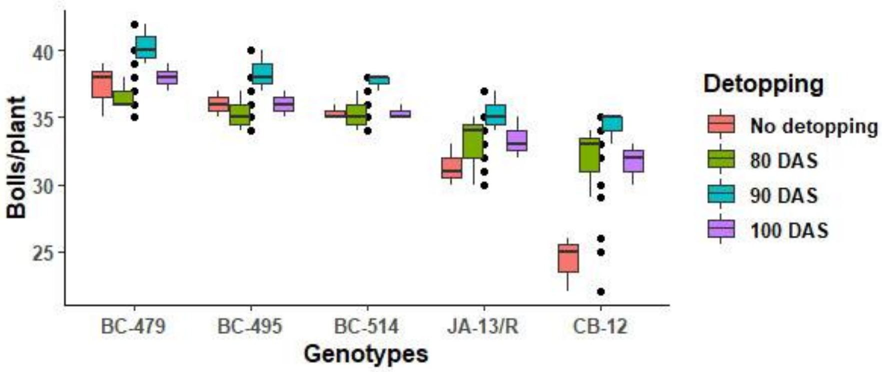

Figure 1. *Effect of Bolls plant^{-1}on genotypes with different detopping times*

Average boll weight

The results revealed significant differences in boll weight in genotypes (Table 1). The genotype CB-12 recorded maximum (5.06 g) average boll weight, whereas minimum boll weight (4.81g) was recorded in BC-479 followed by the genotype BC-514 which was recorded 4.96 g boll weight, but there was no significant difference in detopping and their interaction.

Seed cotton yield

The seed cotton yield was significantly influenced by genotypes, detopping and their interaction. The genotype BC-479 represented the highest seed cotton yield (3.90 t ha-1) followed by BC-495 and BC-514. The genotype (CB-12) was produced the lowest the seed cotton yield 2.93t ha-1 (Table 1).

The highest seed cotton yield (3.79 t ha-1) was recorded in detopping at 90 DAS and the lowest (3.07t ha-1) was observed in no detopping.

The results also indicated that genotype BC-479 gave the highest seed cotton yield (4.15 t ha-1) when detopping at 90 DAS and with the earlier or later detopping seed cotton yield significantly decreased. A similar trend in yield (4.11 t ha-1) of seed cotton was observed in genotype BC-495 for detopping at 90 DAS but the lowest seed cotton yield (2.67 t ha-1) was obtained in genotype CB-12 with no detopping.

Table 1. Effect of genotype and detopping on plant height, days to first flowering, NFB, Monopodial, Sympodial, Secondary fruiting branches plant-1 , Average boll weight (g) and Seed cotton yield (t/ha).

Genotypes	Plant height at maturity (cm)	Days to first flowering	Node of a first fruiting branch (NFB)	Monopodial branches plant-1	Sympodial branches plant-1	Secondary branches plant-1	Bolls weight (g)	Cotton yield (t ha-1)
G1	95.98 c	55.92 d	4.37 bc	0.67 d	14.91 a	2.10 c	4.81 b	3.90 a
G2	100.17	58.67 c	4.47 ab	0.98 b	13.93 bc	3.06 a	5.03 a	3.79 a
G3	102.18 b	59.50 bc	4.13 c	0.97 b	14.25 b	2.54 b	4.96 ab	3.58 b
G4	104.55	59.92 b	4.68 a	0.88 c	13.47 c	2.24 c	5.05 a	3.38 c
G5	108.43 a	61.00 a	4.32 bc	1.06 a	12.63 d	2.93 ab	5.06 a	2.93 d
Detopping								
D1	117.79 a	59.20	4.33	0.82 b	14.77 a	2.76 a	4.94	3.07 d
D2	88.45 d	58.80	4.56	0.89 b	13.89 b	2.57 b	4.94	3.54 c
D3	97.87 c	58.67	4.32	0.96 a	13.47 c	2.43 b	4.99	3.79 a
D4	104.95 b	59.33	4.36	0.97 a	13.22 c	2.53 b	5.05	3.67 b
Interaction								
G1×D1	55.67	4.47	0.77 def	16.20	2.23 d-h	103.53 d-g	4.59	3.50 fg
G1×D2	55.67	4.47	0.50 g	15.07	2.10 fgh	87.07 jk	4.62	3.92 a-
G1×D3	56.00	4.20	0.80 de	14.57	2.00 h	93.60 g-k	4.95	4.15 a
G1×D4	56.33	4.33	0.60 fg	13.80	2.07 gh	99.73 e-h	5.07	4.05
G2×D1	59.00	4.33	0.90 cd	14.60	3.07 b	111.00 cd	5.09	3.08 hij
G2×D2	58.67	4.93	0.80 de	13.73	2.90 bc	87.80 ijk	5.03	3.96 a-
G2×D3	58.00	4.20	1.13 ab	13.53	2.63 cd	98.27 f-i	4.90	4.11 ab
G2×D4	59.00	4.40	1.07 abc	13.87	3.63 a	103.60 d-g	5.09	4.00
G3×D1	58.67	3.73	0.73 def	15.00	2.60 cd	116.53 bc	4.87	3.04 hij
G3×D2	59.00	4.13	1.20 a	14.00	2.50 c-f	89.20 ijk	5.02	3.66 ef
G3×D3	61.00	4.53	0.80 de	13.67	2.47 d-g	98.00 f-i	4.90	3.81
G3×D4	59.33	4.13	1.13 ab	14.33	2.60 cd	105.00 def	5.07	3.82 b-
G4×D1	61.67	4.80	0.70 ef	14.60	2.27 d-h	122.87 b	5.05	3.08 hij
G4×D2	59.67	4.87	0.90 cd	13.87	2.13 e-h	86.67 k	5.01	3.27 gh
G4×D3	58.33	4.67	0.90 cd	13.07	2.53 cde	102.27 d-g	5.12	3.68 def
G4×D4	60.00	4.40	1.00 bc	12.33	2.03 h	106.40 def	5.04	3.50 fg
G5×D1	61.00	4.33	1.00 bc	13.43	3.63 a	135.00 a	5.08	2.67 k
G5×D2	61.00	4.40	1.03 abc	12.80	3.23 b	91.53 h-k	5.05	2.88 jk
G5×D3	60.00	4.00	1.17 ab	12.50	2.53 cde	97.20 f-j	5.11	3.18 hi
G5×D4	62.00	4.53	1.03 abc	11.77	2.30 d-h	110.00	4.98	2.97 ij
LSD(0.05)	1.0024ns	0.2928ns	0.0813**	0.4766ns	0.1809**	4.6084*	0.1816ns	0.1303*

Notes: G1=BC-479, G2=BC-495, G3=BC-514, G4=JA 13/R, G5=CB-12; D1= No detopping, D2= Detopping at 80 DAS, D3= Detopping at 90 DAS, D4= Detopping at 100 DAS

Field duration

Field duration was significantly influenced by genotypes, detopping, and their interaction. The results showed the shortest field duration (164.92 days) was recorded in genotype BC-479 and the longest (187.00 days) in CB-12 which was the most popular variety in the country. In case of detopping, the shortest and longest field duration 172.07 and 187.80 days were observed with detopping at 90 DAS and no detopping, respectively. The interaction effect showed minimum field duration (155 days) in genotype BC-479 when detopping was done at 90 DAS and maximum duration (195 days) was found in the genotype CB-12 when no detopping was done (Figure 2).

Quality parameters

Lint qualities are very important for the textile industry. The results of lint quality were significantly influenced by genotype, detopping and their interaction (Table 2). The results showed that the longest fiber length (30.73 mm) observed in genotype CB-12 and shortest on BC-495. The longest fiber length (30.02 mm) observed detopping at 100 DAS and shortest (29.52) in detopping at 90 DAS. Among the longest length (32.11 mm) was observed in genotype CB-12 with detopping at 100 DAS and genotype BC-495 showed shortest length (28.42 mm) with detopping at 90 DAS.

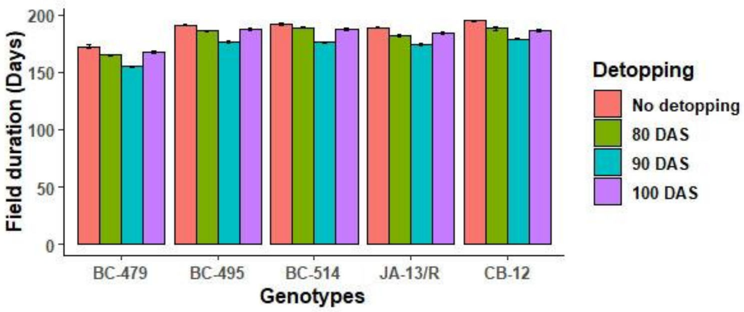

Figure 2. *Field duration of cotton as influenced by genotype and detopping*

The maximum value of fiber strength (31.78 g/tex) observed in genotype BC-479 and minimum (29.85 g/tex) was genotype JA-13/R. The maximum strength (35.13 g/tex) was showed in detopping at 100 DAS and minimum (30.54 g/tex) at no detopping. The maximum strength (35.13 g/tex) showed in genotype CB-12 with detopping at 100 DAS and minimum one (28.37 g/tex) obtained JA-13/R genotype with detopping at 90 DAS.

The highest value of Uniformity index (84.33 %) was showed in genotype CB-12 and lowest one (83.13 %) genotype BC-495. The highest uniformity (83.80 %) observed detopping at 80 DAS and lowest one (83.25 %) at 90 DAS. Among the interaction, the highest uniformity (85.27 %) showed genotype CB-12 with detopping at 100 DAS and lowest (82.34 %) was genotype BC-495 with detopping at 100 DAS.

The highest value of micronaire (5.58) observed in genotype JA-13/R and lowest one (4.80) genotype BC-479. The highest micronaire (5.38) showed no detopping and lowest on (5.15) detopping at 100 DAS. In interaction of genotype and detopping, the highest value of micronaire (6.16) showed in genotype BC-495 with detopping at 80 DAS and lowest one (4.37) genotype BC-479 with detopping at 100 DAS.

Discussions

Detopping is a management practice for reduced field duration of the cotton crop. Significantly differences among genotypes were found where field duration ranges from 164 to 187 days and after detopping it was 155 to 189 days. During detopping practices at 80, 90 and 100 DAS, the genotypeBC-479 showed field duration 4, 10 and 2 percent earlier, respectively, BC-495 genotype 2, 7 and 1 percent earlier, respectively, BC-514 genotype 1, 8 and 2 percent earlier, respectively, JA-13/R genotype 3, 7 and 2 percent earlier, respectively and CB-12 genotype 3, 8 and 4 percent earlier, respectively over no detopping. In a similar study, Rathinavel et al. (2003) found the detopping technique as a good practice for reducing field duration of cotton. Although the main aim of detopping is to get good architecture so that the plant can get required sunlight with the minimum of mutual shading and in this way, the picking efficiency is increased with the progression of crop maturity. Xu et al. (2001) and Dai et al. (2003) explained vegetative growth and strengthening of reproductive growth as the driving factors for early maturity in cotton in case of detopping.

As the amount of sunlight received by the plant canopy is higher in case of detopping, the practice is also very effective to increase the yield of cotton. In this study, significant cotton yield differences were observed among the genotypes used ranging from 2.93 to 3.90 t ha-1. The highest seed cotton yield (3.90 t ha-1) was produced by the genotype BC-479. While detopping was done at 80, 90 and 100 DAS, cotton yield in the genotype increased by 12, 18 and 15 percent, respectively. A similar yield increase was also found in all other genotypes due to detopping practice. According to Renou et al. (2011), detopping practices improved the yield due to more biomass allocation to reproductive organs, such as green and opened bolls (Yang et al., 2008). Similar results were reported by Singh and Sandhu (1996) where detopping also recorded significantly higher seed cotton yield over no detopping reflecting an increase of 17.8 percent. Brar et al. (2002) reported that plant height significantly decreased by detopping and yet it significantly increased sympodial branches, total and open bolls plant-1 as compared to no detopping and eventually seed cotton yield.

Table 2. Effect of detopping and genotype on cotton fiber length, fiber strength, uniformity index and micronaire

Genotypes	Fiber	Fiber	Uniformity	Micronaire
G1	30.55 ab	31.78 a	83.38 c	4.80 e
G2	29.28 d	30.79 d	83.13 d	5.50 b
G3	30.08 b	31.56 b	83.87 b	5.43 c
G4	29.51 c	29.85 e	83.45 c	5.58 a
G5	30.73 a	31.32 c	84.33 a	5.08 d
Detopping				
D1	29.77 b	30.54 d	83.67 b	5.38 a
D2	30.01 a	31.17 b	83.80 a	5.36 b
D3	29.52 c	30.68 c	83.35 c	5.22 c
D4	30.02 a	31.85 a	83.71 ab	5.15 d
Interaction				
G1×D1	29.75 g	30.39 g	83.56 e	4.93 no
G1×D2	29.18 i	30.52 g	83.04 f	4.91 o
G1×D3	29.54 h	33.77 b	83.38 e	4.37 p
G1×D4	29.71 g	32.46 c	83.54 e	4.98 l
G2×D1	30.04 f	32.25 cd	83.82 d	5.54 d
G2×D2	30.07 f	32.06 d	83.87 d	6.16 a
G2×D3	28.42 k	29.25 i	82.34 g	5.34 g
G2×D4	28.60 j	29.59 h	82.48 g	4.95 mn
G3×D1	30.21 e	30.96 f	83.98 cd	5.81 c
G3×D2	30.57 c	33.63 b	84.30 b	5.51 e
G3×D3	30.01 f	30.49 g	83.81 d	5.39 f
G3×D4	29.55 h	31.15 f	83.38 e	5.02 k
G4×D1	29.19 i	29.25 i	83.49 e	5.36 fg
G4×D2	29.53 h	30.87 f	83.37 e	5.11 i
G4×D3	29.19 i	28.37 k	83.04 f	6.01 b
G4×D4	30.11 ef	30.93 f	83.89 d	5.81 c
G5×D1	29.68 g	29.86 h	83.49 e	5.26 h
G5×D2	30.69 b	28.77 j	84.39 b	5.08 j
G5×D3	30.43 d	31.52 e	84.16 bc	5.00 kl
G5×D4	32.11 a	35.13 a	85.27 a	4.98 lm
LSD(0.05)	0.0537**	0.1456**	0.1175**	0.0137**

Notes: G1=BC-479, G2=BC-495, G3=BC-514, G4=JA 13/R, G5=CB-12; D1= No detopping, D2= Detopping at 80 DAS, D3= Detopping at 90 DAS, D4= Detopping at 100 DAS

In the study plant height (cm) was significantly different at maturity stage. The tallest plant height (135 cm) was observed in genotype CB-12 without detopping whereas the shortest plant height (86.67 cm) was observed in JA-13/R with detopping at 80 DAS. Alam et al. 1996) reported that shorter plant height is desirable for cotton plants. According to Farooq et al. (2013), positive correlation and positive indirect effects of seed cotton yield in plant highest. Several authors (Khan et al. 2009; Batool et al. 2010; Suinaga et al. 2006; Taohua and Haipeng, 2006; Meena et al., 2007) studied the stability and adaptability and observed varied values for plant height and other yield components of Gossypium hirsutum cultivars.

Monopodial, sympodial and secondary fruiting branches plant-1 showed significantly highest values in genotype CB-12 without detopping and they decreased with detopping practices but highest bolls plant-1 (40.33) was observed in genotype BC-479 with detopping at 90 DAS because this practice inhibited vertical plant growth and subsequently promoted lateral growth including branching. The similar results are in conformity with the findings of Anonymous (2010) and Kumari and George (2012). Shwetha et al. (2009) observed maximum bolls plant-1asproduced by detopping practices compared with no detopping. Further, Venkatakrishnan and Pothiraj (1994) reported that detopping decreased the number of monopodial branches but increased sympodial branches due to the reason that it breaks apical dominance and leads to increased lateral fruiting branches number.

Lint quality character of cotton is an important character for textile industry. In the study all genotypes showed medium of good lint quality. The highest Fiber length, strength and uniformity index 32.11mm, 35.13g/tex and 85.27% showed genotype CB-12 with detopping at 100 DAS, respectively and highest value of micronaire 6.16 showed genotype BC-495 detopping at 80 DAS. According to study Rathinavel et al. (2001) reported that lint quality of cotton fiber in American upland cotton medium staple length (25-29 mm), strong >29 g/tex, fiber fineness (3 -3.9), uniformity >45 was Good.

It was clear from the studies of detopping on cotton and other crops that crop yield was unaffected due to detopping, in turn, yield levels were increased in some occasions as the plant stature changes on account of termination of apical dominance in cotton. Further, the results can be better used as canopy modifier under excess growth conditions.

Conclusion

Genotype BC-479 with detopping at 90 days after sowing took minimum field day while produced maximum yield and yield contributing character and fiber quality. Therefore, the present study strongly suggests the use of the genotype BC-497 with detopping practice at 90 DAS to improve the yield and quality of cotton and also to reduce the field duration. So that it can be fitted in the existing cropping patterns of Bangladesh with a provision to have a rabi crop after cotton harvest.

Methods

An experiment was carried out during Kharif season (Monsoon) 2018-2019 at the Central Cotton Research, Training and Seed Multiplication Farm, Sreepur, Gazipur, Bangladesh which is geographically situated 24.090N latitude and 90.260E longitudes. The design followed in the experiment was Randomized Complete Block Design (RCBD) with factorial arrangement having three replications. The experiment composed of two factors- Factor A: Five genotypes viz. G1: BC-479, G2: BC-495, G3: BC-514, G4: JA-13/R and G5: CB-12and Factor B: Four detopping practices viz. D1: no detopping (control), D2: detopping at 80 DAS, D3: detopping at 90 DAS and D4: detopping at 100 DAS. The plot was 16.2 m2 where spacing 90 cm and 45 cm between row and plant, respectively were used. The distance between plots and replications were 1 m and 2 m, respectively. Data were recorded on plant height (cm), main stem node of first fruiting branch (NFB), number of monopodial branches plant-1, number of sympodial branches plant-1, days to first flowering (days), number of bolls plant-1, average boll weight (g), seed cotton yield (t ha-1), field durations (days). Lint quality was measured as staple length (mm), strength (g tex-1), uniformity (%) and micronaire. The collected data were statistically analyzed using analysis of variance (ANOVA) technique and Least Significant Difference was considered for comparing the treatment means by computer package R studio.

Abbreviations

DAS: Days after sowing, T. aman : Transplant aman

NFB: Main stem node of a first fruiting branch, CBD: Cotton Development Board

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