



Performance Assessment of Three Cotton Varieties under the Coastal Region of Bangladesh

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Abstract: Cotton (*Gossypium* spp.) is an important cash crop in Bangladesh and serves as the primary raw material for the textile industry. Growth and development, yield and fiber quality of cotton production are negatively impacted by excessive soil salinity. To ensure effective cotton production, it is crucial to select varieties that are well-suited to the coastal area. The research was conducted at the farming field of the research field in the Department of Agriculture, Noakhali Science and Technology University, Noakhali, Bangladesh, during the period of November 2024 to May 2025. The main objective was to evaluate the three cotton varieties that are suited for cultivation in coastal areas. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Plant height (169.39 cm), branch number per plant (18.66), initial flower opening (67.43 days) and yield contributing parameters such as balls per plant (23.46), ball length (5.16 cm), ball diameter (15.94 cm), weight of individual cotton ball (4.77 g), yield per plant (111.99 g), yield per plot (2239.82 g) and yield per hectare (7.47 t ha⁻¹) all the studied parameters performed better in the hybrid variety Rupali-1, followed by Shuvra-3. On the other hand, inbred cotton varieties such as CB-15 are inferior to hybrid varieties. Hybrid varieties outperform in traits like ball size, branching, and early flowering, benefiting from genetic diversity and improved physiological efficiency. The findings of the experiment indicated that hybrid varieties performed better in all the parameters than inbred varieties in coastal areas. Therefore, it can be concluded that, hybrid varieties Rupali-1 and Shuvra-3 may be suitable for cultivating in coastal regions of Bangladesh.

Keywords: Cotton; Hybrid; Inbred; Ball; Yield.

INTRODUCTION

In Bangladesh, cotton (*Gossypium* spp.), a member of the Malvaceae family, is a significant cash crop. Cotton fiber is a prominent fiber used as a raw material in textile industries worldwide, with an annual economic impact of at least \$600 billion (Khan et al., 2020). Although it is primarily grown for its fiber, when the lint and long, twisted, unicellular hairs are removed by ginning, the seed can be crushed to produce vegetable oil and protein-rich animal feed (Mortuza et al., 2015). Cotton is grown in tropical and subtropical regions in more than 70 countries globally, making up 2.5% of all farmed land. As it

generates foreign cash, it is referred to as "white gold" in some nations (Khan et al., 2020).

As Bangladesh largely depends on the textile industry, quality cotton production is crucial. In recent years, there has been a significant fluctuation in the area planted to cotton, which frequently indicates a declining tendency. In Bangladesh cotton production area was 31 thousand acres in the year of 2020-2021, gradually decreased to 30 thousand acres in the year of 2021-2022, and 29 thousand acres in the year of 2022-2023 (BBS, 2023). Similarly, the yield reduced from 72 metric tons in 2020-2021 to 71

metric tons in the year 2021-22 and declined to finally 66 metric tons in 2022-23 (BBS, 2023).

Cotton production is severely hindered by various abiotic stresses, namely salinity, which is a serious phenomenon in coastal area of Bangladesh. About 35 million people, or 29% of the country's total population, live in the 47,201 km² coastline region of Bangladesh, which is divided into 19 districts (Ahmed, 2019) with pH values ranging from 6.0 to 8.4, soil salinity has varying effects on Bangladesh (Rahaman et al., 2023; Haque, 2006). Through ion toxicity, water deprivation, and osmotic stress, it impacts growth parameters and yield (Ahmed, 2022). Even when there may be adequate water in the root zone, salt limits plant growth since it can be poisonous to plants and inhibit their ability to absorb water (Payo et al., 2017).

Excessive soil salinity has detrimental effects on cotton's development and expansion, yield, and fiber quality (Qadir and Shams, 1997). Khorsandi and Anaghali (2009) stated that saline stress usually affects the growth of cotton shoots, lowers germination and emergence rates, and may ultimately lead to reduced seed cotton yield and fiber quality. One of the most effective methods to deal with salinity problems is to choose a variety that can withstand salt. Utilizing genotypes that are resistant to salinity is a feasible and cost-effective way to boost productivity in saline environments (Maas and Hoffman, 1977; Munns et al., 2006).

A crucial part of plant breeding is assessing inbred and hybrid lines in order to increase yield and other desired characteristics (Karim et al., 2021). To find the best breeding candidates, inbred and hybrid lines' performances are frequently compared. Hybrids in cotton showed early biomass vigor (Suyadi et al., 2024), whereas inbred lines were evaluated for yield components, with certain lines showing superior performance in traits like boll weight and lint yield (Hasan et al., 2022). Selecting cultivars that are well-suited to the coastal areas is essential to ensuring efficient cotton production. Additionally, local farmers frequently lack the knowledge to adopt a new cultivar since they are ignorant of the salt-tolerant varieties. Farmers in coastal locations may find it easier to choose the right cotton kinds if the popular and reasonably priced varieties are evaluated. Therefore, the study was conducted to evaluate the adaptability of cotton varieties in saline soil for identifying the suitable cotton varieties for coastal areas and analyzing the yield and yield contributing traits of three cotton varieties.

MATERIALS AND METHODS

Site of the study

The experiment was carried out in Noakhali Science and Technology University (NSTU), Noakhali-3814, which is located in the southeast region of Bangladesh (Figure 1). The experiment duration was 5 November 2024 to 25 May 2025. The experimental site was located within the Young

Meghna Estuarine Floodplain (AEZ-18). The site was situated in a tropical climate zone, with an average annual temperature of 25.6°C and about 2980 mm of precipitation.



Figure 1. Location of the experimental area in the map (Source: Bangladesh.gov.bd).

Soil condition

The pH 7.5 of the soil at the experimental site indicated a slight alkalinity. The soil was examined by Soil Resource Development, Noakhali. Since the soil's EC was 3.24 dSm⁻¹, it was slightly saline. The soil's organic matter content is 0.52, which is extremely low (SRDI, Noakhali).

Table 1: Characteristics of the soil in the study area

Soil characteristics	Amount
pH	7.5
Electrical conductivity	3.24 dSm ⁻¹
Organic matter	0.52
Total nitrogen (N)	0.04%
Phosphorus (P)	27.79µg/g
Potassium (K)	0.18mEq/100g

Experimental materials

In this experiment three cotton varieties were used. These materials were CB-15 (inbred), Rupali-1 (Hybrid), Shuvra-3 (Hybrid). The seeds of these varieties were collected from Cotton Development Board (CDB) Bangladesh.

Experimental design

Three replications of the single-factor experiment were carried out using a Randomized Complete Block Design (RCBD). Three blocks made up the entire 30 m² experimentation area. The field contained a total of 9 (3 × 3) unit plots. Three plots were included in each block, and treatments were distributed at random among the replications.

Field preparation

To level the soil and break up clods, the experimental site was first ploughed with a power tiller and then laddered, prior to removing the weeds and stubbles. After that, the field was arranged in accordance with the design, creating three blocks out of the main area. Three plots were

created from each block, and treatments were assigned at random. Well-raised single hills were ready for planting in order to promote the best possible cotton growth, development, and yield.

Fertilizer application

Recommendation dose of chemical fertilizer and manure for cotton cultivation show in Table 2. Urea, TSP and MOP were used as applications of phosphorus, potash, and nitrogen. During the land preparation process, the entire amount of well-rotten cow dung, TSP, and gypsum was applied. The entire amount of urea and MOP were applied in 3 split doses. The 1/3 of urea and potash were applied as basal during final land preparation. Remaining urea and potash were applied as side dressed at 30 days and 55 days after planting of cotton.

Table 2. Recommended doses of the fertilizers by Bangladesh Agriculture research council

Fertilizer name	Dose(kg ha ⁻¹)
Cow dung	5000
Urea	220
TSP	150
MoP	130
Gypsum	25

Transplanting of seedlings

In each plot, hills were prepared first, and seeds of the cotton variety were planting in designated holes, maintaining the sequence of varieties. Each plot measured 3 m², with a spacing of 90 cm between rows and 30 cm between plants. A total of 20 plants were established per plot.

Intercultural operation

The following intercultural operations were done in order to ensure and maintain the better growth of the crops. Weeding and mulching were done to keep the plots free from weeds, easy aeration of soil and to conserve soil moisture, which ultimately ensured better growth and development. Generally weeding was done at 20, 35, 50 and 65 days after planting. Earthing up was done on the same day of weed removal. Gap filling was done by healthy seedling of the same cultivar where initial planted seedlings were failed to survive. Drainage was done at the time of main land preparation. Irrigation was done at 10, 25, 35 and 50 days after transplanting. Bamboo sticks were used to provide supporting facilities to the plant with the advancement of growth. Fungicide and pesticide were applied three times to control diseases and insects.

Harvesting

Harvesting of cotton was done at suitable and marketable stage by cutting with knife.

Statistical analysis

The recorded data on the different parameter of the study were analyzed statistically by using Minitab 17. To evaluate the significant differences among the treatments LSD test at 0.01% level of significance was performed.

RESULTS AND DISCUSSION

Plant height

The tallest plants were recorded from the hybrid variety Rupali-1 and Shuvra-3. Plant height showed significant variation among the varieties evaluated at 1% level of probability (Table 3). The highest plant height was observed in Rupali-1 (169.39 cm), followed closely by another hybrid, Shuvra-3 (155.57 cm). The shortest plants were observed in CB-15 (128.98 cm). The result was supported by Juraina et al., (2022) where the hybrid Bt-008 x NIA demonstrated a maximum plant height. Hybrid cotton varieties exhibit greater plant height compared to inbred varieties primarily due to hybrid vigor (Donis et al., 2023).

Number of branches per plant

The highest number of branches was recorded in Rupali-1 and Shuvra-3. Branch number per plant varied significantly according to the varieties at 1% level of probability (Table 3). The maximum number of branches was recorded in Rupali-1 (18.66), followed by hybrid Shuvra-3 (17.52). The lowest number of branches was observed in inbred CDB-15 (16.04). Similar result was observed by Juraina et al. (2022) where the hybrid Bt-008 x NIA produced highest branch numbers. The increased branching in hybrids is attributed to improved nutrient uptake, higher photosynthetic efficiency, and better hormonal balance, particularly cytokinin, which promotes lateral growth. These factors collectively lead to more extensive in hybrids compared to inbred varieties (Donis et al., 2023).

Root length

A significant variation was observed with respect to root length across the three varieties (Table 3). Hybrid Rupali-1 had the root length (40.12 cm), followed by Shuvra-3 (38.36 cm) while the minimum root length was observed in CB-15 (34.80 cm). A study by Zhang et al., (2016) identified hybrids with high yield variety, which was often associated with increased root length.

Root weight

The data on Table 3 reflected a considerable variation in root weight of cotton within the varieties. The root weight of cotton ranged from 34.67 g to 39.78 g. The hybrid variety Rupali-1 produced the highest root weight of cotton at 39.78 g. This was followed by Shuvra-3, which recorded 36.66 g. On the other hand, the lowest root weight of was recorded in CB-15 (34.67 g). Similar result was obtained by Ramanjaneyulu et al., (2024) where hybrid cotton variety NCS-2778 produced significantly higher root weight ball.

Growth duration

Table 3 illustrated that growth duration varied significantly among the varieties at 1% level of probability. The growth duration ranged from 191.10 to 209.51 days.

The shortest life cycle was recorded in the inbred variety Rupali-1 (191.10 days), followed by Shuvra-3 (200.98 days). Among the tested genotypes, the longest lifecycle was observed in CB-15 (209.51 days).

Table 3: Growth parameters of inbred and hybrid cotton varieties

Treatment	Plant height (cm)	No. of branches per plant	Root length (cm)	Root weight (g)	Growth duration (days)
CB-15	128.98c	16.04c	34.80b	34.67c	209.51c
Rupali-1	169.39a	18.66a	40.12a	39.78a	191.10a
Shuvra-3	155.57b	17.52b	38.36a	36.66b	200.98b
CV%	2.05	1.75	2.85	2.34	1.46
LSD	11.67	1.14	4.04	3.26	10.99
Level of significance	**	* *	**	**	**

CV = Co-efficient of variation; LSD = Least significant differences, ** = Significant at 1% level of probability

Days to first flowering

Table 4 revealed that the germination to initial flower opening significantly differed among the varieties at 1% level of probability. The earliest flowering was observed in the hybrid Rupali-1 (67.43 days). This was followed by Shuvra-3 (70.55 days). On the other hand, CB-15 required the longest period to reach first flowering (73.28 days). In hybrid cotton, early flowering contributes to biomass vigor and yield through over-dominant gene expression, which enhances early seedling growth (Adamsen et al., 2005).

Ball length

A significant variation was observed with respect to ball length across the three varieties at 1% level of probability (Table 4). Hybrid Rupali-1 had the maximum length (5.16 cm), followed by Shuvra-3 (4.95 cm) while the minimum ball length was observed in CB-15 (4.49 cm). A study by Zhang et al., (2016) identified hybrids with high vigor in yield, which is often associated with increased ball size and number.

Ball per plant

The number of balls per plant varied significantly among the varieties at 1% level of probability (Table 4). The hybrid Rupali-1 recorded the highest number of balls per plant (23.46), followed by Shuvra-3 (20.86). CB-15 had the lowest number of balls per plant (18.82). Hybrids show significant ball number, with dominance effects and epistasis playing crucial roles (Lianguang et al., 2016) whereas inbred lines may not exhibit the same level of dominance as hybrids (Zhen-Yu et al., 2022).

Ball diameter

A significant variation was observed with respect to ball diameter among the three varieties at 1% level of probability (Table 4). Hybrid Rupali-1 producing the largest balls (15.94 cm), followed by Shuvra-3 (14.92 cm) while the smallest ball diameter was observed in CB-15 (13.02 cm). A study by Zhang et al., (2016) identified hybrids with high vigor in yield, which is often associated with increased ball size and number.

Table 4: Yield contributing parameters of inbred and hybrid cotton varieties

Treatment	Days of first flowering	Ball per plant	Ball length (cm)	Ball diameter (cm)
CB-15	73.28a	18.82c	4.49c	13.02c
Rupali-1	67.43c	23.46a	5.16a	15.94a
Shuvra-3	70.55b	20.86b	4.95b	14.92b
CV (%)	1.67	3.62	2.27	3.66
LSD (0.01)	4.43	2.86	0.42	2.01
Level of Significance	**	**	**	**

CV = Co-efficient of variation; LSD = Least significant differences, ** = Significant at 1% level of probability

Weight of cotton per ball

The data on Table reflected a considerable variation in weight of cotton per ball within the varieties at 1% level of probability (Table 5). The weight of cotton per ball ranged from 4.25 g to 4.77 g. The hybrid variety Rupali-1

produced the highest cotton per ball (4.77g), followed by Shuvra-3 (4.54 g). On the other hand, the lowest cotton weight per ball was recorded in CB-15 (4.25 g). Similar result was obtained by Ramanjaneyulu et al., (2024) where hybrid cotton variety NCS-2778 produced significantly higher ball weight.

Yield per plant

There was a remarkable variation regarding cotton yield per plant across the several studied varieties at 1% level of probability (Table 5). The production ranged from 79.92 g to 111.99 g, with the hybrid Rupali-1 yielding the highest cotton weight per plant (111.99 g), followed by Shuvra-3 (94.65 g). The lowest yield was observed in the inbred variety CB-15 (79.92 g). Donis et al., (2023) explained that hybrid cotton varieties exhibit increased yield traits due to heterosis, including larger and heavier cotton ball.

Yield per plot

Yield per plot varied significantly among the varieties at 1% level of probability (Table 5). Cotton yield per plot ranged from 1598.41 g to 2239.82 g. The hybrid Rupali-1

recorded the highest yield (2239.82 g), followed by Shuvra-3 (1892.97g). In contrast, CB-15 recorded the lowest plot yield (1598.41g). Anil et al., (2021) demonstrated that hybrids maintain higher boll retention under stress conditions compared to inbred.

Yield per hectare

Yield per hectare differed significantly across the varieties at 1% level of probability (Table 5). Cotton yield per hectare ranged from 5.33 t ha⁻¹ to 7.47 t ha⁻¹. The hybrid Rupali-1 showed the highest yield (7.47 t ha⁻¹), followed by Shuvra-3 (6.31 t ha⁻¹). However, CB-15 recorded the lowest plot yield (5.33 t ha⁻¹). Anil et al., (2021) found that hybrids had higher boll retention under stress compared to inbred as a result yield increases as well.

Table 5: Yield parameters of inbred and hybrid cotton varieties

Treatment	Weight per ball (g)	Yield per plant (g)	Yield per plot (g)	Yield per hectare (t)
CB-15	4.25c	79.92c	1598.41c	5.33c
Rupali-1	4.77a	111.99a	2239.82a	7.47a
Shuvra-3	4.54b	94.65b	1892.97b	6.31b
CV (%)	1.61	4.48	4.48	4.48
LSD	0.27	16.07	321.46	1.07
Level of Significance	**	**	**	**

CV = Co-efficient of variation; LSD = Least significant differences, ** = Significant at 1% level of probability

Correlation analysis

The correlation (Table 6) revealed that all traits exhibited strong and positive relationships with each other. Plant height showed a very strong positive correlation with all traits, particularly with branch per plant (r = 0.998), ball per plant (r = 0.998), yield per plant (r = 0.998), yield per plot (r = 0.998) and yield per hectare (r = 0.998). Branch per plant was also highly correlated with first flowering (r = 0.998), ball per plant (r = 0.999), ball diameter (r = 0.997), root length (r = 0.998), and root weight (r = 0.990).

Similarly, ball diameter was strongly associated with ball length (r = 0.999), weight per ball (r = 0.999), and root length (r = 0.994), indicating a consistent positive relationship among ball and root traits. Yield per plant, yield per plot and yield per hectare were perfectly correlated (r = 1.00), and showed very high positive correlations with plant height (r = 0.998), ball per plant (r = 0.998), branch per plant (r = 0.996), and root length (r = 0.990).

Table 6: Correlation of 13 morphological and yield contributing traits of cotton varieties

Traits	PH	BN	FF	BP	BL	BD	WB	GD	RL	RW	YP	YPt	YH
PH	1.00												
BN	0.998**	1.00											
FF	0.989**	0.998**	1.00										
BP	0.998**	0.999**	0.995**	1.00									
BL	0.992**	0.995**	0.994**	0.999**	1.00								
BD	0.993**	0.997**	0.995**	0.998**	0.999**	1.00							
WB	0.988**	0.991**	0.990**	0.998**	0.993**	0.999**	1.00						
GD	0.985**	0.991**	0.992**	0.991**	0.993**	0.993**	0.992**	1.00					
RL	0.992**	0.996**	0.996**	0.989**	0.993**	0.994**	0.993**	0.994**	1.00				
RW	0.992**	0.996**	0.997**	0.990**	0.995**	0.995**	0.993**	0.991**	0.999**	1.00			
YP	0.998**	0.996**	0.990**	0.998**	0.995**	0.995**	0.995**	0.983**	0.981**	0.983**	1.00		
YPt	0.998**	0.996**	0.990**	0.998**	0.995**	0.995**	0.995**	0.983**	0.981**	0.983**	1.00**	1.00	
YH	0.998**	0.996**	0.985**	0.998**	0.995**	0.995**	0.995**	0.983**	0.981**	0.983**	1.00**	1.00**	1.00

PH= Plant height, BN= Branch per plant, FF= First flowering, BP= Ball per plant, BL= Ball length, BD= Ball diameter, WB= Weight per ball, GD= Growth duration, RL= Root length, RW= Root weight, YP= Yield per plant, YPt= Yield per plot, YH = Yield per hectare

CONCLUSION

Data from growth and yield parameters were recorded and observed data were compared among the varieties, namely CB-15 (inbred), Rupali-1 (Hybrid), and Shuvra-3

(Hybrid). Plant height (169.39 cm), branch number per plant (18.66), initial flower opening (67.43 days) and yield contributing parameters such as balls per plant (23.46), ball length (5.16 cm), ball diameter (15.94 cm), weight of

individual cotton ball (4.77 g), yield per plant (111.99 g), yield per plot (2239.82 g) and yield per hectare (7.47 t ha⁻¹) all the studied parameters performed better in hybrid variety Rupali-1, followed by Shuvra-3. Hybrids outperform in traits like boll size, branching, and early flowering, benefiting from genetic diversity and improved physiological efficiency. Correlation co-efficient also showed positive relation among all the traits. Furthermore, hybrids typically exhibit greater plant height and branch numbers, which enhance light interception and resource utilization, vital for coping with competition in coastal regions. Based on this result it can be said that hybrid varieties Rupali-1 and Shuvra-3 may be suitable for cultivating in coastal regions of Bangladesh.

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Conflict of Interest

The authors state that there are no conflicts of interest related to the publication of this paper.

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