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Comparative study of yield attributing characters under six cotton genotypes (*Gossypium Spp.*)

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Abstract
Cotton (*Gossypium spp*.) is one of the most important commercial crops worldwide, particularly in countries where it forms the backbone of the agricultural and textile industries. The present investigations on the research entitled, "Ontogenical study of cotton genotype (*Gossypium spp*.)" was carried out during *Kharif*, 2019 and 2020.The region experiences a tropical climate, with rainfall ranging between 700-900 mm annually during the monsoon. The soil type is predominantly sandy loam, with moderate water-holding capacity. Six cotton varieties (Phule Yamuna, Phule Rukhmai, Phule Dhanwantary, Phule Swetambari, Ajeet-155, Phule Mahi) were selected for the study based on their commercial importance and contrasting growth traits. A randomized block design (RBD) was employed with four replications for each variety. Each plot measured 10 x 10m, and the sowing was done at a uniform spacing of 90cm between rows and 45cm between plants. Standard agronomic practices, such as irrigation, fertilization, and pest control, were uniformly applied across all plots.
The data were subjected to analysis of variance (ANOVA) to test the significance of differences among the varieties. Correlation analysis was performed to determine the relationships between plant height, branching, and yield. Regression models were used to predict yield based on the measured agronomic traits. This research investigates the yield characteristics of various cotton (*Gossypium spp*.) varieties grown during the *Kharif* season. Key agronomic traits such as plant height, branching patterns, boll formation, and their influence on yield potential were analyzed. Field trials were conducted over multiple seasons and data were gathered to compare yield performance in different environmental conditions. Results revealed that plant height and branching patterns significantly impact yield, with varieties exhibiting a balance of moderate height and extensive branching producing the highest boll counts. Additionally, adaptability to environmental factors like rainfall and water availability was a crucial determinant in variety performance. The findings offer insights into optimizing cotton production by selecting varieties based on their yield traits and adaptability.

Keywords: (RBD), (*Gossypium* spp.), Cotton

Introduction
The most significant natural fiber source that has supplied clothes to humans for thousands of years is cotton, or *Gossypium Spp*. This plant has a significant impact on the social structure and economy of many nations; in fact, it has influenced the course of several regions' histories. Despite the availability of numerous alternative natural and synthetic fibers, the expanding global population, the cost-benefit ratio of cotton lint, and its numerous distinctive properties will guarantee a sustained rise in the market for seed cotton. One of the world's most significant cash crops in terms of both economics and society, cotton is used as a raw material by the textile industry. Cotton, also known as the "white gold" or "king of fibers," is a significant crop that produces fiber. More than 80 countries worldwide have tropical and subtropical climates where this is grown. The United States, China, India, Pakistan, Uzbekistan, Egypt, Argentina, Australia, Greece, Brazil, and Turkey are the main producers of cotton. Four countries account for 70% of the world's total cotton production: China (27%), India (22%), the United States (13%), and Pakistan (8%). (Anonymous, 2013). 77 countries cultivate commercial cotton, while 123 countries engage in activities related to cotton. Association analysis between seed cotton yield and its component characters is crucial to identify trait combinations on which selection can be made in breeding programs because seed cotton yield is a complex trait that is influenced by a variety of environmental factors, making selection based solely on yield potentially unsatisfactory

(Baloch *et al*. 2014) [2]. The goal of the current study is to characterize various American cotton genotypes that have been developed at various Indian cotton breeding centers in order to identify genotypes that perform better and estimate the genetic variability found in the genotypes under study that contribute to yield and related characteristics.

Certain stages of cotton development, like germination, floral initiation, square development, flower creation, and boll development, are fairly distinct and have set timings. Wide-ranging data sets and response algorithms are required, taking into account the current global cotton producing areas and the temperatures to which the crop is typically exposed. Plants grown under nonlimiting water and fertilizer conditions are measured for the number of days from emergence and First Square as well as the daily rate of development (reciprocal of days) during the same period. Parameters for the rates of floral development and boll maturation are comparable.

When it comes to deciding the quantity and quality of the cotton output, the developmental stage known as the filling period in cotton (*Gossypium spp*.) is crucial. The length of time that the fibers and seeds actively collect mass is known as the real effective filling period, and the filling rate indicates how quickly this accumulation occurs. Knowing how these two variables relate to one another in respect to various cotton genotypes can help with breeding decisions and growing condition optimization.

Materials and Methods

The meteorological data during the experimental period were obtained from the meteorological observatory Mahatma Phule Krishi Vidyapeeth, Rahuri. The different material used, and methods followed during these studies are presented in detailed as under.

Experimental Site

Field experiment was conducted at All India Coordinated Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, during *Kharif* season of the year 2019 and 2020. The geographical situation of Rahuri is on 19.38^0N latitude and 74.65^0E longitude, with an elevation of 511 metres above mean sea level.

Sr. No	Genotype	Cross/Type	Salient features
T_1	Phule Yamuna	Hirsutum	Medium height (110-120cm). duration (158-164 days) yield (18-20 qt/ha)
T_2	Phule Rukhmai	Barbadense	Very tall (160-170cm). duration (178-184 days) yield (8-10 qt/ha)
T_3	Phule Dhanwantary	Arboreum	Medium height (110-120cm). duration (160-165 days) yield (14-16 qt/ha)
T_4	Phule Swetambari	H×H (Non-Bt.)	Medium tall (100 - 120 cm). duration (150-160 days) yield (22-25 qt/ha)
T_5	Ajeet-155	H×H (Bt.)	Very tall (160-170cm). duration (158-164 days) yield (20-22 qt/ha)
T_6	Phule Mahi	H×B	Very tall (160-170cm). duration (158-164 days) yield (15-16 qt/ha)

Yield Observations

Seed Cotton Yield per Plant

Cotton was picked from the plants in the net plot area and weighed. The yield obtained from five tagged plants was also added to this. The yield per hectare was worked out based on net plot yield from all pickings.

Ginning (%)

The seed cotton obtained from net plot area in different pickings was mixed thoroughly (treatment wise) and 100 grams of sample was drawn from all the replications. This seed cotton was ginned separately treatment wise with a hand. Ginning per cent was calculated by using the formula given by Santhanam (1976).

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

Lint index

Lint index is the absolute weight of lint obtained per seed lint index and was calculated following the procedure given by Santhanam (1976).

$$\text{Lint index (g)} = \frac{\text{Weight of 100 seeds}}{\text{100-Ginning (\%)}} \times \text{Ginning (\%)}$$

Statistical Analysis

The data obtained from field experiment (*Kharif* 2020 and 2021) for screening were analysed by using Randomized Completely Randomized Design (RBD) and data were pooled to test the significance of differences of genotypes for all the characters as per the methodology suggested by Panse and Sukhatme (1989).

The population dynamics data obtained during studies in the above experiment were analysed for variance by adopting $2\sqrt{n+1}$ transformation.

Results and Discussion

Yield characters of cotton genotypes

The data observed in cotton genotypes carrying various yield characters are given below with details mostly in harvesting stage of cotton plant.

Seed Cotton Yield per plant

Year-wise Performance

Genotypes	Yield characters of cotton genotypes					
	Seed Cotton Yield per plant			Seed Cotton Yield (kg/ha)		
	Kharif 2019	Kharif 2020	Pooled	Kharif 2019	Kharif 2020	Pooled
Phule Yamuna	31.25	35.12	33.19	915.50	955.25	935.38
Phule Rukhmai	29.30	30.45	29.88	925.50	950.50	938.00
Phule Dhanwantary	25.44	27.63	26.54	889.25	932.75	911.00
Phule Shwetambari	36.18	32.46	34.32	1012.75	1001.25	1007.00
Ajeet-155	35.34	37.62	36.48	1037.00	1016.25	1026.63
Phule Mahi	27.36	29.36	28.36	958.50	991.25	974.88
SE(M)	0.82	0.84	0.96	28.49	29.07	26.32
CD@5%	2.44	2.31	2.16	84.65	86.39	85.96

In Kharif 2019, Phule Shwetambari had the highest seed cotton yield per plant at 36.18 g, indicating superior performance. Ajeet-155 followed with 35.34 g, showing strong yield potential. Phule Yamuna had a yield of 31.25 g, demonstrating good performance. Phule Rukhmai and Phule Mahi had lower yields of 29.30 g and 27.36 g respectively. Phule Dhanwantary had the lowest yield at 25.44 g.

In Kharif 2020**,** Ajeet-155 again led with the highest yield per plant at 37.62 g. Phule Yamuna showed an increase to 35.12 g, improving from 2019. Phule Shwetambari had a yield of 32.46 g, slightly lower than in 2019. Phule Mahi and Phule Rukhmai had yields of 29.36 g and 30.45 g respectively. Phule Dhanwantary had the lowest yield at 27.63 g.

Pooled Data Interpretation

Ajeet-155 has the highest pooled yield per plant at 36.48 g, indicating consistently superior performance across both years. Phule Shwetambari follows with a pooled yield of 34.32 g. Phule Yamuna has a pooled yield of 33.19 g, showing good overall performance. Phule Mahi and Phule Rukhmai have pooled yields of 28.36 g and 29.88 g respectively. Phule Dhanwantary has the lowest pooled yield at 26.54 g. Differences greater than these values between varieties are considered statistically significant.

Seed Cotton Yield (kg/ha)

Year-wise Performance

In Kharif 2019, Ajeet-155 achieved the highest seed cotton yield per hectare at 1037.00 kg/ha. Phule Shwetambari followed with 1012.75 kg/ha, showing strong performance. Phule Yamuna had a yield of 915.50 kg/ha. Phule Mahi and Phule Rukhmai had yields of 958.50 kg/ha and 925.50 kg/ha respectively. Phule Dhanwantary had the lowest yield at 889.25 kg/ha. In Kharif 2020, Ajeet-155 maintained the highest yield per hectare at 1016.25 kg/ha. Phule Yamuna showed an increase to 955.25 kg/ha. Phule Shwetambari had a yield of 1001.25 kg/ha, slightly lower than in 2019. Phule Mahi and Phule Rukhmai had yields of 991.25 kg/ha and 950.50 kg/ha respectively. Phule Dhanwantary had the lowest yield at 932.75 kg/ha.

Pooled Data Interpretation

Ajeet-155 has the highest pooled seed cotton yield per hectare at 1026.63 kg/ha, indicating consistent superior performance. Phule Shwetambari follows with a pooled yield of 1007.00 kg/ha. Phule Yamuna has a pooled yield of 935.38 kg/ha.Phule Mahi and Phule Rukhmai show lower pooled yields of 974.88 kg/ha and 938.00 kg/ha respectively. Phule Dhanwantary has the lowest pooled yield at 911.00 kg/ha. Differences greater than these values between yields of different varieties are considered statistically significant.

Discussion & Key Findings

Ajeet-155 consistently showed the highest yield per plant and per hectare across both seasons, highlighting its potential as a high-yielding genotype. With pooled yields of 36.48 g/plant and 1026.63 kg/ha, Ajeet-155's performance suggests superior genetic potential for seed cotton production. This variety is particularly promising for regions aiming to maximize cotton yield, as it maintained its productivity across different environmental conditions over two seasons.

Similarly, Phule Shwetambari demonstrated strong yield performance, with a pooled yield of 34.32 g/plant and 1007 kg/ha. However, the slight decrease in yield from 2019 to 2020 may point to some environmental sensitivity. Despite this decline, its overall performance remains commendable, making it a strong candidate for cultivation in areas with favorable growing conditions.

Phule Yamuna and Phule Rukhmai showed relatively stable yields across both seasons, with pooled yields of 935.38 kg/ha and 938 kg/ha, respectively. While these varieties did not achieve the highest yields, their stability and consistent performance suggest that they may be well-suited for regions where consistent but moderate yield is preferred. The slight improvement in seed cotton yield per plant for Phule Yamuna from 31.25 g to 35.12 g suggests that it may respond well to favorable environmental conditions or improved management practices.

Phule Dhanwantary and Phule Mahi had the lowest seed cotton yields per plant and per hectare. However, it is notable that both varieties showed an upward trend in yield from 2019 to 2020, particularly in seed cotton yield per hectare. Phule Dhanwantary increased from 889.25 kg/ha to 932.75 kg/ha, while Phule Mahi rose from 958.50 kg/ha to 991.25 kg/ha. This trend suggests that, with further improvements in agronomic practices or genetic enhancement, these varieties may have the potential to increase their productivity.

The data show slight variations in yield between the two seasons, which could be attributed to environmental factors such as rainfall, temperature, and soil conditions. For instance, most varieties saw a slight improvement in seed cotton yield from 2019 to 2020, indicating that the growing conditions in 2020 were more favorable for cotton production.

Genotypes	Yield characters of cotton genotypes					
	Lint Index			Ginning%		
	Kharif 2019	Kharif 2020	Pooled	Kharif 2019	Kharif 2020	Pooled
Phule Yamuna	4.71	4.69	4.70	33.28	32.95	33.12
Phule Rukhmai	5.22	5.36	5.29	31.43	30.63	31.03
Phule Dhanwantary	4.79	5.03	4.91	35.58	36.50	36.04
Phule Shwetambari	5.27	5.30	5.27	33.58	33.48	33.53
Ajeet-155	5.34	5.40	5.60	34.88	34.98	34.93
Phule Mahi	5.19	5.20	5.20	33.70	33.23	33.47
SE(M)	0.12	0.11	0.24	0.92	0.94	0.96
CD@5%	0.53	0.48	1.12	2.74	2.81	2.86

Lint Index

Year-wise Performance

In Kharif 2019, Ajeet-155 has the highest lint index at 5.34, indicating better fiber yield per unit of seed cotton. Phule Shwetambari follows with 5.27. Phule Mahi and Phule Rukhmai have lint indices of 5.19 and 5.22 respectively. Phule Dhanwantary has a lint index of 4.79. Phule Yamuna has the lowest lint index at 4.71.

In Kharif 2020, Ajeet-155 maintains the highest lint index at 5.40. Phule Shwetambari shows a lint index of 5.30. Phule Rukhmai and Phule Mahi have indices of 5.36 and 5.20 respectively. Phule Dhanwantary has a lint index of 5.03. Phule Yamuna has the lowest lint index at 4.69.

Pooled Data Interpretation

Ajeet-155 has the highest pooled lint index at 5.60, indicating superior fiber yield efficiency across both years. Phule Shwetambari follows with a pooled lint index of 5.27. Phule Rukhmai and Phule Mahi have pooled indices of 5.29 and 5.20 respectively. Phule Dhanwantary has a pooled lint index of 4.91. Phule Yamuna has the lowest pooled lint index at 4.70. Differences greater than these values between lint indices of different varieties are considered statistically significant.

Ginning%

Year-wise Performance

In Kharif 2019, Phule Dhanwantary has the highest ginning percentage at 35.58%. Ajeet-155 follows with 34.88%. Phule Shwetambari has a ginning percentage of 33.58%. Phule Mahi and Phule Yamuna show ginning percentages of 33.70% and 33.28% respectively. Phule Rukhmai has the lowest ginning percentage at 31.43%.

In Kharif 2020, Phule Dhanwantary continues to have the highest ginning percentage at 36.50%. Ajeet-155 follows with 34.98%. Phule Shwetambari has a ginning percentage of 33.48%. Phule Mahi and Phule Yamuna show ginning percentages of 33.23% and 32.95% respectively. Phule Rukhmai has the lowest ginning percentage at 30.63%.

Pooled Data Interpretation

Phule Dhanwantary has the highest pooled ginning percentage at 36.04%, indicating more efficient fiber extraction from seed cotton. Ajeet-155 follows with a pooled ginning percentage of 34.93%.

Phule Shwetambari has a pooled percentage of 33.53%. Phule Mahi and Phule Yamuna show pooled ginning percentages of 33.47% and 33.12% respectively. Phule Rukhmai has the lowest pooled ginning percentage at 31.03%.Differences greater than these values between ginning percentages of different varieties are considered statistically significant.

Discussion & Key Findings

The table presents data on two important yield characters of cotton genotypes during the Kharif seasons of 2019 and 2020: the lint index and ginning percentage. These factors are essential for determining the fiber quality and processing efficiency of cotton varieties. The lint index reflects the amount of fiber produced per seed, while the ginning percentage (ginning outturn) indicates the proportion of fiber extracted from the seed cotton.

Lint Index – Fiber Production per Seed

The lint index is a crucial indicator of fiber yield, showing the efficiency of each seed in producing usable fiber. Among the cotton genotypes: Ajeet-155 consistently showed the highest lint index across both years, with values of 5.34 in 2019 and 5.40 in 2020, resulting in a pooled lint index of 5.60. This indicates that Ajeet-155 is a superior variety in terms of fiber production per seed, making it a valuable option for maximizing fiber yield. Phule Shwetambari and Phule Rukhmai also demonstrated high lint indices, with pooled values of 5.27 and 5.29, respectively. These values indicate that these varieties are also efficient in producing fiber per seed, though slightly below Ajeet-155. Phule Dhanwantary exhibited moderate performance, with a pooled lint index of 4.91, while Phule Yamuna had the lowest pooled lint index of 4.70. This suggests that these two varieties may produce less fiber per seed compared to others, which could influence their total fiber yield.

Ginning Percentage – Fiber Extraction Efficiency

The ginning percentage is a critical indicator of how much usable fiber can be extracted from the seed cotton, making it important for the economic viability of cotton production. The data show several key trends: Phule Dhanwantary recorded the highest ginning percentage, with a pooled value of 36.04%. This suggests that this variety has the highest efficiency in fiber extraction, which is beneficial for processing and overall fiber output. Ajeet-155 followed closely, with a pooled ginning percentage of 34.93%, demonstrating its high potential for producing a significant amount of ginned fiber. Combined with its high lint index, Ajeet-155 emerges as a strong performer for both fiber production per seed and fiber extraction. Phule Shwetambari, Phule Mahi, and Phule Yamuna all showed moderate ginning percentages, with pooled values of 33.53%, 33.47%, and 33.12%, respectively. These values indicate that while these varieties are efficient in ginning, they lag slightly behind Phule Dhanwantary and Ajeet-155. Phule Rukhmai exhibited the lowest ginning percentage, with a pooled value of 31.03%, suggesting that it may produce less fiber during the ginning process, which could

reduce its overall economic value in terms of fiber production.

Stability and Consistency

Several varieties, particularly Ajeet-155 and Phule Shwetambari, showed consistent lint index and ginning percentage values across both seasons. This stability is important for farmers and breeders, as it indicates that these varieties can reliably produce high fiber yields and maintain ginning efficiency across different growing conditions.

On the other hand, Phule Dhanwantary demonstrated an increase in both lint index (from 4.79 to 5.03) and ginning percentage (from 35.58% to 36.50%) from 2019 to 2020. This suggests that the environmental conditions or agronomic practices in 2020 may have favored better fiber production and extraction efficiency in this variety.

Conclusion

Overall, Ajeet-155 consistently shows the highest seed cotton yield per plant and per hectare, making it the most productive variety. Statistically significant differences are observed when comparing Ajeet-155 with other varieties, especially against Phule Rukhmai and Phule Dhanwantary. Varieties such as Phule Shwetambari and Phule Yamuna also demonstrate strong performance, though not as consistently high as Ajeet-155.

Overall, Ajeet-155 shows the highest lint index, reflecting better fiber yield efficiency across both years. Phule Dhanwantary exhibits the highest ginning percentage, indicating superior fiber extraction efficiency.

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