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PERFORMANCE OF DIFFERENT COTTON (*GOSSYPIUM HIRSUTUM* L.) GENOTYPES UNDER VARYING SOWING DATES AND THEIR INFLUENCE ON YIELD-CONTRIBUTING PARAMETERS

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A B S T R A C T

Cotton is globally significant economically and plays a major role in international trade and economies, particularly in Pakistan's economy. However, its growth and early seed cotton production face challenges due to various environmental conditions. This study aims to evaluate the effect of different planting dates on the growth and yield of cotton. The experiment used a randomized complete block design (RCBD) with three replications. Four cotton genotypes (M-32, NIA-88, IUB-13, and NIAB-878) were sown on March 25th, April 25th, and May 25th at the Nuclear Institute of Agriculture (NIA) Tandojam. The data showed that cotton crops sown on March 25th demonstrated significantly superior performance, with a plant height of 114.33 cm, an average of 20.83 sympodial branches per plant, an average of 22.66 bolls per plant, a boll weight of 2.68 g, a ginning outturn of 37.79%, a seed cotton yield of 61.05 g per plant, a staple length of 28.60 cm, a micronaire of 3.69 µg inch-1, and seed cotton. In the case of genotypes, the NIA-88 produced the maximum plant height of 102.67 cm, 20.44 sympodial branches per plant, 20.44 bolls per plant, a boll weight of 2.63 g, a ginning outturn of 38.72%, a seed cotton yield of 55.91 g per plant, a staple length of 29.31 cm, a micronaire of 3.87 µg inch-1, and a seed cotton yield of 1311 kg ha-1. It was concluded that the cotton genotypes sown on March 25th showed superior performance in terms of seed cotton yield.

Keywords: Cotton, Genotypes, Ginning out turn, Seed cotton yield, Sowing dates.

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INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is an important crop in Pakistan's economy, especially in the oil and textile industry. Known as "white gold," it belongs to the genus *Gossypium* and the family Malvaceae (Abro et al., 2015). However, cotton yield is greatly influenced by environmental conditions and cultural practices. It is mainly cultivated in warmer regions of the country (Abbas, 2020). High temperatures can speed up reproductive growth, leading to shorter photosynthesis duration and lower cotton yields. On the other hand, low temperatures promote unwanted vegetative growth and delay boll ripening. The sowing stage is affected by low temperatures, which can delay germination and increase the risk of pathogen attack. On the other hand, high temperatures and dry weather can lead to seedling death. Therefore, it is crucial to select the optimal sowing time for different ecological regions in order to ensure productivity (Farooq et al., 2015). The cotton crop

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is highly influenced by management and environmental changes. Among the various factors that impact cotton seed yield, high temperatures play a significant role in controlling the rate of cotton plant growth (Ali et al., 2020). The temperature range of 20 to 30 ºC is considered ideal for cotton growth, with 28ºC being the optimum temperature for photosynthesis (Abro et al., 2015). Temperature stress affects various aspects of cotton growth, including seed, root, vegetative growth, flowering, fruit set, yield, and fiber quality. In Pakistan, high temperatures reaching up to 50 ºC in the summer negatively impact cotton seed yield and fiber quality (Shah et al., 2021). The timing of planting is crucial for cotton growth and maturation, affecting both vegetative and reproductive phases. According to Niazi (2016), planting cotton too early or too late significantly reduces seed cotton yield. Different planting dates expose the crop to varying weather conditions, which impact growth and yield. Planting timing is optimized to align developmental stages with favorable environmental conditions. Fiber traits such as length, uniformity, and spinning consistency index are not significantly affected by planting time. However, delaying sowing decreases micronaire, fiber strength, and fiber elongation, while increasing the proportion of short fibers (Amin et al., 2018; Tariq et al., 2018). Selecting the optimal planting date is essential for maximizing the potential yield. Similarly, choosing the appropriate genotype for a specific region is crucial in determining the yield and quality characteristics of the cotton crop (Deho et al., 2012). Therefore, it is important to conduct research and identify the ideal sowing date in order to fully realize the genetic potential of cotton under specific agro-climatic conditions (Kakar et al., 2012).

MATERIALS AND METHODS

Experimental Site

The field experiment was conducted at the Nuclear Institute of Agriculture (NIA) Tandojam, District Hyderabad, Sindh, Pakistan during the Kharif season of 2022. The experiment followed a Randomized Complete Block Design with three replications. Four cotton genotypes (M-32, NIA-88, IUB-13, and NIAB-878) were sown under two different sowing times: March 25th, April 25th, and May 25th. The objective was to assess their yield potential in the Tandojam Agro climatic region.

Experimental Conditions

The experiment utilized a split-plot design with three replications. Main plots were assigned to the genotypes, while the subplots were assigned to the sowing dates. After land preparation, beds and furrows were created with a row-to-row distance of 75 cm and a plant-to-plant distance of 30 cm. The furrows were adequately irrigated, and delinted cotton seeds of the four genotypes were manually dibbled during both normal and late sowing conditions. Light irrigation was applied to promote seed germination, and any gaps in the planting were filled. Subsequent irrigations were applied until crop maturity, taking into account weather conditions. Various fertilizers and agronomic practices were employed to maintain the crop's health throughout the season.

Data Collection

The collected data on plant height, number of bolls per plant, boll weight, and cotton seed yield were analyzed using a statistical program. For the analysis of variance, means were separated using Fisher's protected least significant difference (LSD) test at a significance level of 5%.

RESULTS AND DISCUSSION

Plant Height (cm)

The selection of sowing dates exerts a notable influence on plant height. The analysis of variance proved that the genotypes by different sowing dates were effect significant at ($P<0.05$). Results showed in (Table 1) that the maximum plant height of the cotton crop was (114.33 cm) when the crop was sown on 25th March, followed by 25th April with 113.33 cm average plant height, respectively; while the minimum plant height of 71.33 cm was noted with 25th May. The interactive effect of genotypes × sowing date 25th March resulted in maximum plant height (116.67 cm) in NIAB-878 and the lowest plant height (64.33 cm) was noted in the interaction of IUB-13 × sowing date 25th May". It was confirmed from the study of Niazi (2016) that the delay in sowing date subsequently decreases in plant height.

Sympodial Branches Plant^{-1}

The quantity of sympodial branches plays a vital role in determining yield. The analysis of variance (Table 2) for sympodial branches indicated substantial impacts of genotypes, planting dates, and their interaction ($p < 0.05$%). Among the various planting dates, the maximum sympodial branches plant^{1} of cotton crop was (21.16) when the crop was sown on 25th April, while the minimum Sympodial branches plant^{-1} of 13.33 was noted on 25th May. The interactive effect of genotypes × sowing date 25th March resulted in maximum sympodial branches plant^{-1} (24.66) in NIAB-88 and the lowest sympodial branches plant^{-1} (13.33) was noted in the interaction of M-32 × sowing date 25th May". Farid et al. (2017) also reported that number of Sympodial branches are increase 34% more in early sowing

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than late sowing.

Number of Bolls Plant^{-1}

The analysis of variance proved that the genotypes by different sowing dates were affect significant at (P<0.05). Results showed in (Table 3) that the maximum number of bolls plant^{-1} of cotton crop was (22.66) when the crop was sown with 25th March, respectively, while the minimum number of bolls plant^{-1} of 14.66was noted on 25th May. The interactive effect of genotypes × sowing date 25th March resulted in a maximum number of bolls plant^{-1} (24.00) in NIAB-88 and the lowest number of bolls plant^{-1} (14.00) was noted in the interaction of IUB-13 × sowing date 25th May. These results substantiate the findings of Ali et al. (2020), who reported the number of bolls per plant increases in early sowing.

Table 1: Plant heights (cm) of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	112.00	115.33	113.33	116.67	114.33 a
S_2 =25th April	112.00	113.33	113.33	114.67	113.33 a
S_3 =25th May	73.33	79.33	64.33	68.33	71.33b
Mean	99.11bc	102.67 a	97.00c	99.89b	
LSD 0.05	Genotypes = 2.6241Sowing dates= 2.2725 S x G=4.5451				

Table 2: Sympodial branches plant^{-1} of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	22.00	24.66	18.00	18.66	20.83a
S_2 =25th April	22.00	23.33	19.33	20.00	21.16a
S_3 =25th May	13.33	13.33	13.33	13.33	13.33b
Mean	19.11a	20.44a	16.88b	17.33b	
LSD 0.05	Genotypes = 1.5190Sowing dates=1.3155 S x G=2.6310				

Table 3: Numbers of bolls plant^{-1} of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	31.26	32.81	28.16	29.71	30.48 a
S_2 =25th April	25.06	26.61	21.96	23.51	24.28 b
S_3 =25th May	18.96	20.41	16.06	17.61	18.26 c
Mean	25.09 b	26.61 a	22.06 d	23.61 c	
LSD 0.05	Genotypes=0.2058Sowing dates= 0.1029 S x G=0.1188				

Boll Weight (g)

The weight of bolls is a critical factor that directly affects seed cotton yield, and the study's results support this connection (Table 4). The maximum boll weight of the cotton crop was 2.68 g when the crop was sown on March 25th, followed by an average boll weight of 2.49 g when sown on April 25th. The lowest boll weight of 2.10 g was observed when sown on May 25th. The interactive effect of genotypes x sowing date on March 25th resulted in a maximum boll weight of 3.06 g in NIAB-88, while the lowest boll weight of 1.60 g was observed in the interaction of IUB-13 x sowing date on May 25th. Cotton plant boll retention and fiber quality both experienced significant reductions when exposed to temperatures exceeding 40°C and 30°C, respectively. Interestingly, our findings differ from those of Abbas (2020), who observed that delayed sowing resulted in higher boll weight.

Ginning Out Turn (%)

The ginning out turn (%) of cotton genotypes i.e. M-32, NIA-88, IUB-13 and NIAB-878 treated with different sowing dates is presented in (Table 5) and analysis of variance proved that the genotypes by different sowing dates were effect significant at (P<0.05). The maximum ginning out turn of cotton crop was (37.79%) when the crop was sown on 25th March and 25th May with 37.79% average ginning out turn, respectively; while the minimum ginning out turn of 37.54% was noted with 25th April. The interactive effect of genotypes × sowing date 25th April" resulted in maximum ginning out turn (39.04%) in NIAB-88 and the lowest ginning out turn (36.27%) was noted in the interaction of NIAB-878 × sowing date 25th April". Our findings similar with the results presented by Qamar et al. (2016) and Sharif et al. (2020), as all three studies reported that seed cotton yield had a positive and direct impact on the ginning outturn percentage.

Seed Cotton Yield Plant^{-1} (g)

The analysis of variance proved that the genotypes by different sowing dates were effect significant at ($P<0.05$). Results showed in (Table 6) that the maximum seedcotton yield plant^{-1} of cotton crop was (61.05 g) when the crop was sown on 25th March, followed by 25th April with 52.36 g average seedcotton yield plant^{1}, respectively; while the minimum seedcotton yield plant^{-1} of 30.76 g was noted with 25th May. The interactive effect of genotypes × sowing date 25th March resulted in maximum seedcotton yield plant^{-1} (73.60 g) in NIAB-88 and the lowest seed cotton yield plant^{-1} (23.26 g) was noted in the interaction of IUB-13 × sowing date 25th May". Our findings align with the research of Ahmed et al. (2024) and Soomro et al. (2014), both of whom observed reduced seed cotton yield when sowing was delayed. Additionally, it's worth noting that planting cotton either excessively early or exceedingly late also resulted in a significant decrease in seed cotton yield, as reported by Bange and Milroy (2004).

Table 4: Boll weight (g) of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	2.66	3.06	2.50	2.50	2.68a
S_2 =25th April	2.53	2.53	2.43	2.46	2.49a
S_3 =25th May	2.46	2.30	1.60	2.03	2.10b
Mean	2.55a	2.63a	2.17b	2.33ab	
LSD 0.05	Genotypes =0.3391Sowing dates=0.2937 S x G=0.5873				

Table 5: Ginning out turn (%) of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	38.43	38.57	36.92	37.25	37.79a
S_2 =25th April	38.43	39.04	36.40	36.27	37.54a
S_3 =25th May	38.43	38.57	36.92	37.25	37.79a
Mean	38.43a	38.72a	36.74b	36.93b	
LSD 0.05	Genotypes =1.4120Sowing dates= 1.2229 S x G=2.4457				

Table 6: Seedcotton yield plant^{-1} (g) of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	62.26	73.60	55.00	53.33	61.05a
S_2 =25th April	52.40	57.33	48.66	51.06	52.36b
S_3 =25th May	34.53	36.80	23.26	28.46	30.76c
Mean	49.73b	55.91a	42.31c	44.28c	
LSD 0.05	Genotypes =5.2712Sowing dates= 4.5650 S x G= 9.1299				

Staple Length (cm)

The staple length (cm) of cotton genotypes i.e. M-32, NIA-88, IUB-13 and NIAB-878 treated with different sowing dates is presented in table 4.7 and analysis of variance as appendix 7. The analysis of variance proved that the genotypes by different sowing dates were effect significant at ($P<0.05$). Results showed in table 4.7 that the maximum staple length of cotton crop was (28.60 cm) when the crop was sown with 25th March, followed by 25th May with 28.53 cm average staple length, respectively; while the minimum staple length of 28.32 cm was noted with 25th April. The interactive effect of genotypes × sowing date 25th March resulted in maximum staple length (29.33 cm) in NIAB-88 and the lowest staple length (27.43 cm) was noted in the interaction of NIAB-878 × sowing date 25th April". Similar findings were reported by (Ahmad et al., 2018).

Micronaire (µg inch^{-1})

Micronaire value showed negative effects on Ginning out turn (GOT) percentage and seed cotton yield. The micronaire (µ inch^{-1}) of cotton genotypes i.e. M-32, NIA-88, IUB-13, and NIAB-878 treated with different sowing dates is presented in table 4.8. The analysis of variance proved that the genotypes by different sowing dates were effect significant at ($P<0.05$). Results showed in (Table 8) that the maximum micronaire of cotton crop was (3.74 µg inch^{-1}) when the crop was sown on 25th March, followed by 25th May with 3.69 µg inch^{-1} average micronaire, respectively; while the minimum micronaire of 3.69 µg inch^{-1} was noted with 25th April. The interactive effect of genotypes × sowing date 25th May" resulted in maximum micronaire (3.96 µg inch^{-1}) in NIAB-88 and the lowest micronaire (3.50 µg inch^{-1}) was noted in the interaction of M-32 × sowing date 25th March. Our research findings corroborated the discoveries of Deho et al. (2012) and Ahmad et al. (2018), who noted that early sowing takes advantage of favorable climatic conditions and warm temperatures during the flowering and fruiting stages. Conversely, late planting resulted in a reduction in micronaire but an increase in fiber length.

Table 7: Staple length (cm) of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	28.86	29.33	27.96	28.26	28.60a
S_2 =25th April	28.66	29.26	27.93	27.43	28.32b
S_3 =25th May	28.66	29.33	28.13	28.00	28.53 ab
Mean	28.73b	29.31a	28.01c	27.90c	
LSD 0.05	Genotypes=0.2607Sowing dates= 0.2258 S x G= 0.4515				

Table 8: Micronaire (µg inch^{-1}) of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	3.50	3.80	3.60	3.86	3.69a
S_2 =25th April	3.53	3.86	3.66	3.70	3.69a
S_3 =25th May	3.53	3.96	3.66	3.80	3.74a
Mean	3.52c	3.87a	3.64c	3.78 ab	
LSD 0.05	Genotypes = 0.1719Sowing dates= 0.1489 S x G= 0.2977				

Seed Cotton Yield (kg ha^{-1})

The boll weight represents a pivotal factor with a clear impact on seed cotton yield, and the findings from the study provide supporting evidence for this association. The seed cotton yield (kg ha^{-1}) of cotton genotypes i.e. M-32, NIA-88, IUB-13 and NIAB-878 treated with different sowing dates is presented in table 9. The analysis of variance proved that the genotypes by different sowing dates were effect significant at ($P<0.05$).

Table 9: Seedcotton (kg ha^{-1}) of cotton genotypes as affected by various sowing dates.

Sowing dates	Genotypes				Mean
	M-32	NIA-88	IUB-13	NIAB-878	
S_1 = 25th March	1567	1901	1302	1227	1499a
S_2 =25th April	1169	1399	1047	1140	1188b
S_3 =25th May	581	633	365	429	502c
Mean	1106b	1311a	905c	932c	
LSD 0.05	Genotypes = 109.96 Sowing dates = 95.227 S x G = 190.45				

Results showed in table 9 that the maximum seed cotton yield of the cotton crop was (1499 kg ha^{-1}) when the crop was sown on 25th March, followed by 25th April with 1188 kg ha^{-1} average seedcotton yield, respectively; while the

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minimum seedcotton yield of 502 kg ha^{-1} was noted on 25th May. The interactive effect of genotypes × sowing date 25th March resulted in maximum seedcotton yield (1901 kg ha^{-1}) in NIAB-88 and the lowest seedcotton yield (365 kg ha^{-1}) was noted in the interaction of IUB-13 × sowing date 25th May". Our study's outcomes are consistent with the research conducted by Farooq et al. (2015) and Sharif et al. (2020), both of whom observed that the appropriate timing of sowing significantly impacts the growth and yield parameters in cotton.

CONCLUSIONS

The results of this study indicate that the timing of sowing greatly influenced the growth and yield of the cotton crop. Specifically, when the crop was planted on March 25th, there was a noticeable increase in the yield of seed cotton. This could be attributed to a rise in sympodial branches and a greater proportion of boll weight. Among the various genotypes examined, NIA-88 consistently exhibited the highest values for all significant traits.

CONFLICT OF INTEREST

The authors declare that there is no conflict in the publication of this article.

AUTHOR'S CONTRIBUTION

All the authors contributed equally in the manuscript.

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