

Research Article



Influence of Sowing Dates on Cotton Growth (*Gossypium hirsutum*), Yield and Fiber Quality

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Abstract | Cotton plays important role in Pakistan's economy. It faces various environmental conditions which restricts its growth and production. The study was carried out at Cotton Research Station, Faisalabad, during the year 2018-19. The objective of the research was to evaluate the sowing date effects on growth, yield parameters and fiber quality of cotton and genotypic assessment in two sowing dates. The set of six genotypes was sown in two different dates viz., 10th April and 10th May in split plot design with three replications by allotting sowing dates in main plot and varieties in sub-plots. The results indicated that crop sown on 10th April produced more seed cotton yield (2881.1 kg ha⁻¹) than sown on 10th May with (2212.9 kg ha⁻¹). Comparing the average varietal performance in both sowing dates, FH-6071 produced maximum yield 2989.39 kg ha⁻¹ while minimum yield 2103.5 kg ha⁻¹ was exhibited by FH-152. Boll retention % was maximum in genotype FH-490. With respect to fiber quality fiber length and strength were not affected significantly due to sowing dates effects. In addition to yield, fiber quality of FH-6071 was better in both sowing dates with average fiber length, strength and micronaire values 27.3 mm, 30.87 g/tex and 4.5 µg/inch respectively. The results showed that late planting produced less yield due to shorter growing period. Among fiber quality parameters, length and strength were not affected significantly while micronaire was affected significantly.

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Keywords | Cotton, Fiber quality, Sowing date, Boll retention %, Yield parameters

Introduction

Cotton is an important cash crop as it contributes majorly towards the world's trade and economy particularly in Pakistan. Cotton can rightly be taken as an internationally traded crop that plays an important role for elevating a country's economy (Soomro *et al.*, 2014). Cotton is grown as a commercial crop in the tropical and subtropical regions of more than 70 countries (Farid *et al.*, 2017). China, India, Pakistan, USA, Turkey and Brazil are the major cotton producing countries. Textile industry adds 8.5% to total GDP. It

gives an employment of 38% as millions of people are engaged along the entire cotton chain. Despite of being most important fiber crop, cotton average yield is far below in Pakistan than other countries in the world. Among major obstacles, sowing date is one of the major hurdles which imparts negative influence on seed cotton yield and fiber quality (Soomro *et al.*, 2014).

In Pakistan, cotton crop faces extreme temperature, which is a particular feature than other cotton growing regions. As cotton have its own definite requirements

of temperature and light for different growth phases: germination, emergence, vegetative growth, reproductive growth and fiber development so these stages of crop are affected by different sowing times. Therefore, it is necessary to investigate optimum sowing date for exploiting full genetic potential of cotton under specific agro-climatic condition (Kakar *et al.*, 2012). Studies showed that cotton yield contributing traits were significantly affected by sowing dates (Niazi, 2005). For good crop establishment, cotton crop demands warm soil and air temperature for better germination and emergence. Too early planting leads to poor crop stand while late sown crop is more vulnerable to insect's pest and adverse environmental (Gormus and Yucel, 2002).

Cotton sowing early in May noticeably increased cotton seed yield by 45% than late planting in June along with improvement in yield components (Farid *et al.*, 2017). Similarly, Jamro *et al.*, 2017 also observed that cotton crop sown at 1st May showed more ginning out turn than late planted crop. Cotton cultivation before or after 19 April led to less seed cotton yield and cotton fiber quality deterioration due to shorter growing season and harsh environmental condition (Usman *et al.*, 2016). Sowing cotton crop too early faces cold weather which decreases boll weight on other hand, late sowing results in reduced yield and less GOT% (Bange and Milroy, 2004). An experiment on effects of planting dates on fiber quality documented that when sowing time was late, staple length, fiber strength and fiber maturity were considerably decreased (Arshad *et al.*, 2001).

Therefore, optimization of the sowing time is critical for the growers to get maximum seed cotton yield and improved fiber quality. By considering the importance of sowing time, the present study was conducted to check the effects of sowing dates on cotton growth, yield and fiber quality.

Materials and Methods

The research was carried out at Cotton Research Station, Faisalabad, Punjab, Pakistan during the Kharif season of 2018 for comparison and evaluation of six cotton genotypes and sowing dates effects on cotton growth, yield and fiber quality. Weather conditions are presented in (Figure 1). The set of six genotypes (FH-Lalazar, FH-142, FH-152, FH-444, FH-490 and FH-6071/16) were sown on two different dates viz.,

April 10th and May 10th in split plot design with three replications. Sowing dates were placed in main plots while genotypes in sub plot. Row to row and plant to plant distance were kept 75 cm and 30 cm respectively. Throughout the growing season, recommended cultural and agronomic practices (irrigation, hoeing, weeding and fertilizer application) were conducted. The net plot size was 107.5 × 30 ft² (30 rows) for each repeat. For measurement of morphological parameters, ten plants were selected randomly, however, yield (kg ha⁻¹) was taken from whole plot. Data was measured for germination (%), monopodia and sympodia per plant, plant height (cm), days to 1st square (DFS), days to 1st flower (DFF), boll retention %, fiber length (mm), strength (g/tex) and micronaire value. Monopodia and sympodia branches were recorded by counting number of vegetative and fruiting branches respectively. Plant height was recorded in centimeter from the base of plant to its tip at the time of maturity. Boll retention percentage was calculated by tagging the flowers on daily bases. At the maturity, effective bolls developed from these flowers were recorded. The calculations regarding total tagged flowers and bolls were taken from 10 tagged plants from 1st June to last picking from experimental plots (Heitholt, 1993). Staple length (mm), strength (g/tex) and mic were measured on HVI (1000). The recorded observations were analyzed for Least Significant Difference (LSD) at 0.05% after ANOVA by employing statistical software, Statistix® Version 8 (Ahmed *et al.*, 2014).

$$\text{Boll Retention \%} = \frac{\text{No. of Bolls Retained}}{\text{Total Flowers}}$$

Result and Discussion

Yield/plant (g)

Sowing date effectively influences seed cotton yield and yield contributing traits in cotton. To explore this effect there always have been conducted many studies. Early sowing is preferred than late sowing due to its positive effects on different traits especially yield. The increase in yield might be due to increased growing period and better growth under optimum temperature of early season. The late sowing of cotton decreases the yield contributing traits and ultimately the seed cotton yield. Seed cotton yield is cumulative effect of yield related parameters under specific environment. The results showed that sowing dates, varieties and their interaction mean square for yield (kg ha⁻¹) were significant (Table 1).

Table 1: Analysis of variance (ANOVA) for germination (%), DFS, DFF, PH, sympodial branches/plant, No. of bolls, boll retention percentage, yield, fiber length, strength and mic.

SOV	Germi- nation %	DFS	DFF	PH (cm)	Sympodial branches/ Plant	Number of bolls	Bolls reten- tion %	Yield (kg ha ⁻¹)	Fiber length (mm)	Fiber strength (g/tex)	Mic (µg/ inch)
Replication	10.63	7.69	6.36	169.36	8.08	30.25	10.73	43002	1.71	0.52	0.02
Sowing date (SD)	1899.51**	136.11**	455.11**	2773.78*	289.00*	361.00 NS	412.29**	1897047*	9.82N S	6.82 NS	0.10 NS
Error a	101.13	1.19	1.69	94.69	12.25	30.25	0.29	205101	3.67	1.52	0.14
Genotypes (G)	304.61**	6.57NS	3.04NS	2207.71**	17.86*	59.46NS	66.47**	211976**	8.05**	27.43**	0.24**
SD×G	224.67**	5.57NS	18.64**	272.38**	36.86*	65.26NS	28.15**	817948**	1.76NS	1.151NS	0.05**
Error	17.15	3.811	3.86	55.96	13.13	29.71	3.36	14380	0.73	2.12	0.01

NS: non-significant; * for significant; ** for highly significant.

The finding in Table 2 depicts that the crop sown on 10th April gave 23% more yield (2881.1 kg ha⁻¹) as compared to cotton sown on 10th May with produce (2212.9 kg ha⁻¹). It is evident from table 3 that maximum average yield of both sowing dates (2989.3 kg ha⁻¹) was recorded in genotype FH-6071/16 followed by FH-Lalazar (2569 kg ha⁻¹) and FH-444 (2537.7 kg ha⁻¹). Minimum seed cotton yield was recorded in FH-152 (2031.5 kg ha⁻¹). According to findings of Yucel and Gormus (2002) the possible main reasons of reduced yield are late sowing of crop and vulnerability of cotton crop to insects and bad weather. Ahmed et al., 2014 stated that late sowing reduced the season length which ultimately decreased the final yield. Nasrullah et al., 2003 reported that late sowing imparted negative effects on number of bolls and sight which led to less seed cotton yield. These results are similar with the key findings of Farid et al., 2017 which states that early planting of cotton crop increased the seed cotton yield by 45%. Furthermore, Ali et al., 2009 and Iqbal et al., 2012 also confirmed the decrease in seed cotton yield and yield contributing traits in late planting. More yield in early sowing is associated with better germination %, more sympodial branches and higher boll retention % (Table 1).

Sympodial/plant

The number of sympodial branches contributes significantly toward yield (Khan et al., 2017). The analysis of variance (Table 1) for sympodial branches depicted significant effects of genotypes, sowing dates and their interaction (P< 0.05%). Among the sowing dates, average number of sympodial branches per plant were significantly higher by 25% in the crop planted on 10 April (24) than the crop sown on 10 May (18) (Table 2). While among genotypes, maximum number of sympodial branches (25) was

recorded in cultivar FH-6071/16 while five other cultivars showed on average 20 sympodia per plant (Table 3). Farid et al., 2017 also reported the increase of 34% more number of sympodial branches in early sowing than late sowing.

Table 2: Effects of sowing dates on germination (%), DFS, DFF, PH, sympodial branches/plant, No. of bolls, boll retention percentage, yield, fiber length, strength and mic.

Traits	Sowing dates		LSD (P ≤ 0.05)
	10 th April	10 th May	
Germination %	87.6a	73.1b	4.5
DFS	41b	44a	1.6
DFF	59a	66b	1.9
PH (cm)	130.8a	111.3b	14
Sympodial branches/plant	24a	18b	5.01
No. of Bolls	36a	30a	7.8
Boll Retention %	50.4a	44.3b	0.79
Yield (kg/ha ⁻¹)	2881.1 a	2212.9 b	519.8
Fiber length (mm)	27a	25.8a	2.74
Strength (g/tex)	31.4a	29.7b	1.77
Mic	4.5a	4.4a	0.54

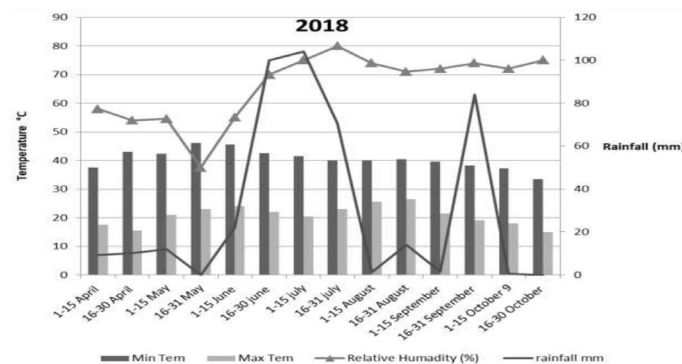


Figure 1: Temperature °C, relative humidity (%) and rainfall (mm) from April-2018 to October 2019.

Table 3: Average genotype performance for germination (%), DFS, DFF, PH, sympodial branches/plant, No. of bolls, boll retention percentage, yield, fiber length, strength and mic in two sowing dates.

Traits	FH-Lalazar	FH-142	FH-152	FH-444	FH-490	FH 6071/16	LSD (P ≤ 0.05)	Interaction
Germination %	71.5d	79bc	86.8a	80.9b	74.1cd	90a	4.9	S
DFS	44a	43ab	40b	42ab	43ab	43ab	2.3	NS
DFF	63a	61a	62a	62a	62a	63a	2.4	S
PH (cm)	113.3bc	110.2c	119.7b	118bc	111bc	160.5a	9.0	S
Sympodial branches/plant	20.2a	20.2a	20.7a	20.3a	20.2a	25b	4.4	S
No. of bolls	34ab	33ab	29b	31ab	30b	38a	6.6	NS
Boll retention %	44.4c	48.2b	47.8b	43.3c	52.2a	48.6b	2.2	S
Yield kg ha ⁻¹	2569a	2526.3b	2103.5c	2537.7b	2208.2c	2989.3a	196.9	S
Fiber length (mm)	26.9ab	25.4c	27.5c	26.7b	24.5c	27.3ab	1.03	NS
Strength (g/tex)	30.8b	28.4c	34.3a	29.3c	28.7c	30.87b	1.7	NS
Mic (µg/inch)	4.36c	4.5ab	4.1d	4.5b	4.7a	4.5b	0.1	S

Number of bolls/plant

The number of bolls/plant is an important yield parameter. The statistical analysis revealed that sowing dates, cultivars and their interaction with sowing dates was found non-significant ($P > 0.05$) (Table 1). With respect to sowing dates, average numbers of bolls/plant were higher by 17 percent in crop sown on 10 April (36) as compare to plants sown on 10 May (30) (Table 2). Among cultivars maximum number of bolls was observed in cultivar FH-6071/16 (38) followed by FH-Lalazar (34) and FH-142 (33) (Table 3). These results agreed with findings of Jamro *et al.*, 2017 who documented that subsequent delay in sowing time produced less number of bolls and a drastic decrease in number of bolls as sowing was delayed upto 30th May. Somroo *et al.*, 2014 also confirmed the similar results of adverse effects of delayed sowing than early sowing.

Plant height (cm)

Sowing dates imparts pronounced effects on plant height. The results depicted that plant height of cotton is significantly influenced by the sowing dates ($P < 0.05$). Genotypes and their interaction were found highly significant ($P < 0.01$) (Table 1). Average plant height was 14% more in crop sown on 10 April (130.8 cm). It reduced gradually with delaying the sowing date as in cotton sown on 10 May, plant height was 111 cm (Table 2). Cotton genotype FH-6071/16 was taller (160.5 cm) followed by FH-152 (119.7 cm) and FH-444 (118 cm) (Table 3). Qamar *et al.*, 2016 confirmed the gradual decrease in plant height with subsequent delay in sowing time.

Germination (%)

Cotton germination is highly sensitive to environmental

conditions. The statistical analysis showed that sowing dates, genotypes and their interaction imparted highly significant effects on cotton germination percentage ($P < 0.01$) (Table 1). Germination % was 16% higher in early sown crop (87.6 %) due to availability of favorable condition than late sown crop (73.1 %) (Table 2). Among different genotypes, maximum germination was observed in FH-6071/16 (90%) followed by FH-152 (86.8%) and FH-444 (80.9%) (Table 3). Shoaib *et al.*, 2015 showed that seed germination was maximum under the planting scheduling of 20th April while minimum under planting scheduling of 30th May.

Days to first square and flower

As early planting provide suitable environmental conditions for good crop stand. Late planted crop face environmental stress which delays the initiation of reproductive stage. It is cleared from the results that sowing dates effects on days to first square were highly significant ($P < 0.01$), however, genotypes and their interaction with sowing was found non-significant ($P > 0.05$) (Table 1). The 1st sowing date prompted early squaring (41 DAS) while late sown crop started squaring after 44 days (Table 2). Among genotypes, FH-152 was found early as started squaring 40 days after sowing followed by FH-444 (42 DAS). Similarly, effects of sowing dates on days to 1st flower (DFF) and their interaction with genotypes were highly significant ($P < 0.01$).

However, among the varieties, the difference was non-significant ($P > 0.05$). The 1st sowing date prompted early flowering (59 DAS) while late sown crop started squaring after 66 days (Table 2). FH-142 started flowering (61) days after sowing while genotype FH-

6071/16 started late flowering at (63) days (Table 3). Similarly, Aziz *et al.*, 2010 reported the 15 June as optimum time for less days taken to first flower than 15 May and 15 June sowing.

Boll retention percentage

Boll retention percentage is also highly sensitive to environment. The statistical analysis revealed that sowing date imparted pronounced effects on boll retention percentage ($P < 0.01$). Interaction of sowing dates and bolls retention % was also highly significant ($P < 0.01$). Boll retention percentage was significantly different among different varieties ($P < 0.01$) (Table 1). Maximum bolls were retained in early sown crop (50.4 %) while in late sowing retention percentage was reduced to 44.3 % (Table 2). Maximum retention percentage was observed in genotype FH-490 (52.2 %) followed by 6071/16 (48.6%) and FH-142 (48.2) (Table 3).

Fiber quality

Fiber quality mainly depends upon length, strength and micronaire value. The results revealed that sowing effects were non-significant for fiber length, strength and mic ($P > 0.05$), however, genotypic differences were highly significant for fiber length, strength and mic ($P < 0.01$). Sowing date and their interaction were found non-significantly for the fiber length and strength ($P > 0.05$), however, highly significant interaction was found for mic ($P < 0.01$) (Table 1). Fiber length, strength and mic were higher with value 27mm, 31.4 g/tex and 4.5 ug/inch respectively in early sown crop (Table 2). Fiber quality was better in FH-152 with fiber length, strength and mic value 27.5 mm, 34.3 g/tex and 4.1 ug/inch respectively (Table 3). Somroo *et al.*, 2014 revealed that higher values of fiber length, fiber fineness and fiber strength were obtained in early sowing than late sowing of 30 days.

Conclusion and Recommendations

The results of present studies concluded that the growth and yield parameters of cotton crop were affected by sowing times. Between the planting times early sowing (10 April) produced higher seed cotton yield that is may be associated with good germination percentage, more sympodial branches and increased boll retention percentage. Among the genotypes FH-6071/16 produced maximum values for all the valuable traits.

Novelty Statement

This work highlights that in the current scenario of climate change, cotton sowing after 10th May will lead to yield reduction in cotton due to heat stress. Therefore, keeping in view the prevailing weather conditions, best time for the cotton cultivation in Faisalabad zone is from 10th April.

Author's Contributions

Iram Sharif, Amna Nazir and Shahid Munir Chohan designed the study, conducted the experiments and analyzed the experimental data. Dr. Ghulam Sarwar provided the technical assistance at each step, resources for the research and revised the article. Eram Shahzadi participated in compiling the data and assisted in preparing the draft. Ali Nawaz managed the article revisions and provide financial assistance for article publication.

Conflict of interest

The authors have declared no conflict of interest.

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