

Optimization of Sowing Intervals for Growth and Yield of Cotton (*Gossypium hirsutum*) in Uthal Balochistan

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ABSTRACT

Cotton is a major fiber and cash crop that is referred to as the "Queen of Fiber Plants" globally. It is also a significant crop in Pakistan, particularly in Balochistan, and there is enormous potential to increase cotton production. Hence, this study was conducted to evaluate the response of different cotton varieties against diverse sowing interval at agro-ecological conditions of Uthal, District Lasbela, Balochistan. Experiments were designed in randomized complete block design (RCBD) in factorial arrangements with 3 replications. The treatments were comprised of two factors such as factor-A Sowing interval (1st April, 15th April and 25th April) and Factor-B cotton varieties (CRIS-CRIS-543 and CRIS-CRIS-585). Best performing cotton varieties were identified for different morphological traits at lasbela Uthal region. Based on these studied results, variety (CRIS-543) performed better for yield and growth parameters. Sowing on 15th April date significantly increased the plant height by (2.5%), ginning out turn (5%), staple length (2%) and seed cotton yield (8%), bolls plant⁻¹ (17%), monopodial branches plant⁻¹ (19%), and germination (2%) as compared to sowing on 1st April. Variety CRIS-543 produced 15% higher seed cotton yield compared to CRIS-585 sowing at 15th April. While, sowing at 1st April date also improved sympodial branches, boll weight, days to flowering and number of bolls of cotton as compared to 25th April. These findings provide Uthal cotton growers with a clear, region-specific sowing period to maximize yield and input efficiency under local climate and soil conditions.

Keywords: Sowing interval, (*Gossypium hirsutum* L.), Lasbela, Growth, Yield.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) belong from Malvaceae family, commonly known as white gold. It is widely cultivated as profitable fibre crop in Pakistan.

The crop has the potential of sustainable development of national economy, and has gained much attention

towards research on multiple aspects related to its development (Kouser, 2015; Rahman et al., 2016; Sharif et al., 2020). The textile industry in the world is primarily based on cotton fibre and cotton is also a main source of edible oil production. Pakistan globally ranks 4th in the cotton production (1785 thousand tons) after India, China, United States and Brazil producing 6205, 5987, 4555 and 1894 thousand tons, respectively. Being a major cash crop of the Pakistan, cotton is reflected the main pillar of the economy. It pays about 0.8% to GDP and 4.1% of the total value addition in the agriculture. Cotton production is expected at around 9.178 million bales, which is lower by the 6.9 % over the last time's production of 9.861 million bales. Even yet the overall area improved over last year, the overall presentation persisted below due to the adverse weather and lower water availability during the important stages of the plant growth along with the pest attacks (Economic Survey of Pakistan, 2020).

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The physiological and morphological characteristics of cotton plants in the Uthal region of Balochistan, Pakistan, are significantly influenced by different sowing intervals. Research indicates that early sowing generally enhances growth metrics such as plant height, boll number, and overall yield, while delayed sowing can lead to reduced fiber quality and lower seed cotton yield. The following sections elaborate on these effects (Godara et al., 2023; Malik et al., 2022; Sarwar et al., 2023; Rehan et al., 2024). Mudassir et al., (2021) reported that different sowing dates significantly affect the growth stages, seed cotton yield, and heat use efficiency across various locations in Pakistan. Khaskheli et al., 2024 revealed that based on the experimental results, the yield of seed cotton varied significantly among different varieties and sowing dates. Specifically, variety Star-2 combined with the May 23rd planting date consistently produced higher yields compared to other combinations. Wahid et al., 2024 findings concluded that sowing cotton up to April 15 optimally enhances growth, yield, and quality traits. Any delay in sowing by subsequent fortnights leads to a simultaneous decline in all evaluated attributes.

Cultivation of cottons crops remains as occupied spell route by maintaining complexes balances amid all vegetative and reproductives phases (Ali et al., 2009; Salih et al., 2019; Sankaranarayanan et al., 2020). Sowing date from 1st May to 15 May give significant cotton seed yield that is determined the rough conducting experiment with three cotton varieties (Sadori, Chandi-95 and Malmal) under sowing interval i.e. 15th April, 1st May, 15th May and 1st June (Deho et al., 2012).

Three commercial varieties Sadori, Chandi-95 and Malmal were used to study the impact of different sowing date and it was concluded that 1st May sown crop give highest seed cotton yield and many other related traits as well (Deho et al., 2014; Deho et al., 2021). Another study has been conducted by using three different cotton cultivars, i.e. Star-2, NIAB-78 and Sindh-1, with three sowing interval (20th April, 10th May and 25th May) and concluded that cultivar of Sindh -1 showed highest cotton seed yield with sowing date of 20th April (Shoaib et al. 2015) and decrease in the yield happens due to the late sowing because of the delayed maturity and reduced fruiting period (Shah et al., 2017; Copur et al., 2019). Early sown of cotton produces more seed cotton yield due to the higher boll retention and cotton yield differs among cultivars and climatic zones (Ali et al., 2009; Mehboob et al., 2020; Ishaq et al., 2022). Initial scattering of filament may give greater yield equally paralleled near late strewing (Ali et al., 2009; Farid et al., 2017).

Most cotton sowing date trials in Pakistan have been concentrated in irrigated plains of Punjab and Sindh, where soils are alluvial, rainfall is higher, and humidity moderates' temperature extremes. Uthal, Lasbela represents a distinct agro-ecological niche with <250 mm annual rainfall, calcareous and coarse-textured soils, high wind velocity, and a unique pest-disease complex. These factors alter soil moisture retention, crop emergence, flowering window, and boll development. Consequently, sowing recommendations from Punjab/Sindh lead to poor stand establishment, terminal heat stress, and suboptimal yields when applied in Uthal. No prior study has systematically tested multiple sowing intervals specifically for *Gossypium hirsutum* L. under Uthal's arid coastal environment. Previous studies on optimal sowing dates for cotton in Pakistan have largely been conducted in Punjab and Sindh, where agro-ecological conditions differ markedly from those in Uthal, Balochistan. Those regions typically experience higher summer rainfall, greater humidity, and alluvial soils with higher organic matter and water-holding capacity. This research evaluates a range of sowing intervals for cotton in Uthal to determine the period that best aligns crop growth stages with favorable temperature, soil moisture, and low pest pressure. It quantifies the response of key growth and yield components to sowing time under local soil and climate constraints. The output is a Uthal-specific sowing calendar that bridges the disconnect between national recommendations and field realities, giving farmers and extension staff a validated, practical tool for maximizing productivity in this region. Keeping these evidences in the mind the following aims were set 1) to evaluate the impact of different sowing interval on the growth and yield of cotton under climate condition of Lasbela district. 2) To examine the best sowing interval of cotton crop at agro climatic condition of Lasbela district.

MATERIALS AND METHODS

Experimental Site

Balochistan coastline region is divided into two districts, Lasbela and Gwadar and is located in an extremely dry zone. The research experiment titled 'effect of different sowing interval on growth and yield of cotton under climatic conditions of Uthal' was carried out at the research farm of Lasbela University of Agriculture, Water & Marine Sciences, Uthal, with geographical coordinates of Latitude 25.8270 ° N, Longitude 66.6236 ° E. The baseline soil physicochemical properties were characterized as follows: the soil exhibited a sandy clay loam texture with a slightly alkaline pH of 7.8, the organic matter content was 9 g kg⁻¹, available phosphorus was measured at 5.50 mg kg⁻¹, available potassium content

was 135 mg kg⁻¹ and the bulk density was 1.20 g cm⁻³.

Climate conditions

Mean daily temperatures were highest during early summer (June–July), with average highs around 38–42 °C and lows near 26–29 °C. Temperatures gradually declined through autumn (October–November) and reached their minimum in winter (December–January), where mean highs dropped to approximately 22–26 °C and lows to 8–12 °C. From February onward, temperatures steadily increased again, reaching favorable conditions (30–38 °C) during March–May. Relative humidity showed moderate fluctuations, with higher levels coinciding with peak rainfall periods, thereby enhancing soil moisture availability. Rainfall was sporadic, with a few pronounced peaks—particularly around late summer (August–September)—and minimal precipitation during the winter months, indicating a predominantly dry phase. Mean relative humidity was highest during the monsoon and late summer period (July–September), generally ranging between 70–85%, indicating a consistently moist atmospheric condition. Humidity levels began to decline during autumn (October–November), dropping to around 40–60%. The lowest humidity was observed in winter (December–January), where average values fluctuated between 30–50%, reflecting drier air conditions. From early spring onwards (February–April), humidity gradually increased again, typically ranging from 45–70%, showing a transition toward more humid conditions approaching the summer season.

Soil conditions

Soil being a natural medium encompassing a variety of functions and roles, particularly in supporting plant growth and development. Though, different types of soil exist here, but sandy loam soil is the dominant class in this part of Balochistan.

Experimental design and treatments

Experiments was designed in Randomized Complete Block Design (RCBD) having factorial arrangements with three replications. The treatments were comprised of two factors such as factor-A Sowing interval and Factor-B Cotton varieties, Treatments detail is as under;

Factor (A) Sowing Interval	Factor (B) Cotton Varieties
S ₁ : 1 st April 2022	V ₁ : CRIS-543
S ₂ : 15 th April 2022	V ₂ : CRIS-585
S ₃ : 25 th April 2022	
Experimental design	RCBD
Replication	3
Net plot size	3 x 5m = 15 m ²

Land preparation

A good seedbed was prepared adopting recommended land preparation practices of cotton. The experimental

field was made primarily with discs' cultivars to break the solid part of soil and level by balancing and land planking.

Sowing time and sowing method

The sowing was done in 60 cm apart rows by cotton seed drill. The sowing of two cotton cultivars was done on different interval with fortnight interval.

Fertilization

Experimental soil was supplied with usual NPK fertilizers at recommended rates, where N was given as urea (46 %) 40 kg ha⁻¹, 25 kg ha⁻¹ of P was applied and also 20 kg ha⁻¹ of K was given to fulfill the requirement of NPK.

Irrigation

As irrigation requirements of any crop depends on soil and climatic conditions. Therefore, first irrigation was given two weeks after sowing.

Pest management and weed control

During experiment various pests like weeds, diseases, and insects attacked the crop. For controlling Pest management and hand weeding was done.

Harvesting

Harvested was done, when the cotton bolls ripen and burst into white, fluffy and shiny bolls of fibre. All other culture and agronomic practices including hoeing weeding and irrigation was carried out uniformly for all treatment. Recommended pesticides were applied upon pest infestation and their severity.

Growth and yield parameters to be recorded

Germination percentage (%)

There were three time of sowing 1st April, 15th April & 25th April. Germination % was recorded after 3-6-9 days of interval.

Plant height (cm)

Plant height was measured at the maturity stage of crops; 5 plants were collected from each row randomly to record the annotations.

Days of flowering

Days were taken to flowering in cotton, is generally inherited by varieties from their parental material; but this trait is also influenced by the crop management including sowing time. The cotton varieties were monitored for the days to initiate flowering as affected by different sowing interval.

Boll weight (g)

Boll weight was measured after picking of cotton bolls of each variety and weighted by using electronic balance in agronomy laboratory of faculty agriculture.

Days of maturity

Maturity of cotton fibers were measured as the relative wall thickness, but crop maturity could be linked with the opening of bolls that produce fiber.

Number of sympodial branches plant⁻¹

Amount of sympodial branches were counted from the plants that were selected.

Number of monopodial branches plant⁻¹

From each replication plants were collected to observe the amount of monopodial branches on each plant.

Number of bolls plant⁻¹

Amount of bolls per plants were randomly counted in every plot by selecting five plants. Then bolls were calculated per plant.

Seed cotton yield per hectare

Seed cotton hectare⁻¹ yield was calculated from seed cotton plot⁻¹ yield.

Ginning out turn (GOT)

Using the given formula computed the ginning out turn (GOT) by Singh (2004).

GOT (%) = (Weight of lint in sample / Weight of seed cotton in that sample) x 10.

Staple length

The staple length is the average. Length the longer. One of the fibers also called the upper half mean length or Staple. Among all measured characteristics of cotton. Staple length has always been considered to be the most crucial. The fiber end use and processes are determined by its length.

Statistical analysis

One way ANOVA was used to investigate statistical differences in biomass and yield characteristics of cotton crop. When the difference was significant the data were subjected to a HSD post hoc test ($p < 0.05$) to determine the differences among the treatments. The Pearson correlation was used to know the

relationship between different growth and yield components of cotton crop. All of the statistical analyses were performed using Statistix 8.1 and all figures were created using Excel 2013 edition (Microsoft®, 2013).

Result and Discussion**Germination Percentage (%)**

Analysis of variance (ANOVA) revealed highly significant differences ($p < 0.01$) in germination percentage among the two cotton varieties and across the different sowing intervals. Moreover, coefficient of variance was noted as 4.67%. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 85.94%. In T1 (1st April) maximum germination percentage was noted in V1 (CRIS-543) with mean value of 88.20% whereas minimum germination was recorded in V2 (CRIS-585) with mean results of 86.33% (Figure 1). Moreover, In T2 (15th April) maximum germination percentage was noted in V1 (CRIS-543) with mean value of 88.66% whereas minimum germination was recorded in V2 (CRIS-585) with mean results of 83%. Similarly, In T3 (25th April) maximum germination percentage was noted in V1 (CRIS-543) with mean value of 88% whereas minimum germination was recorded in V2 (CRIS-585) with mean results of 81% (Figure 1). Hence, it is assumed that cotton grown on 1st April is suitable to obtain maximum germination percentage %.

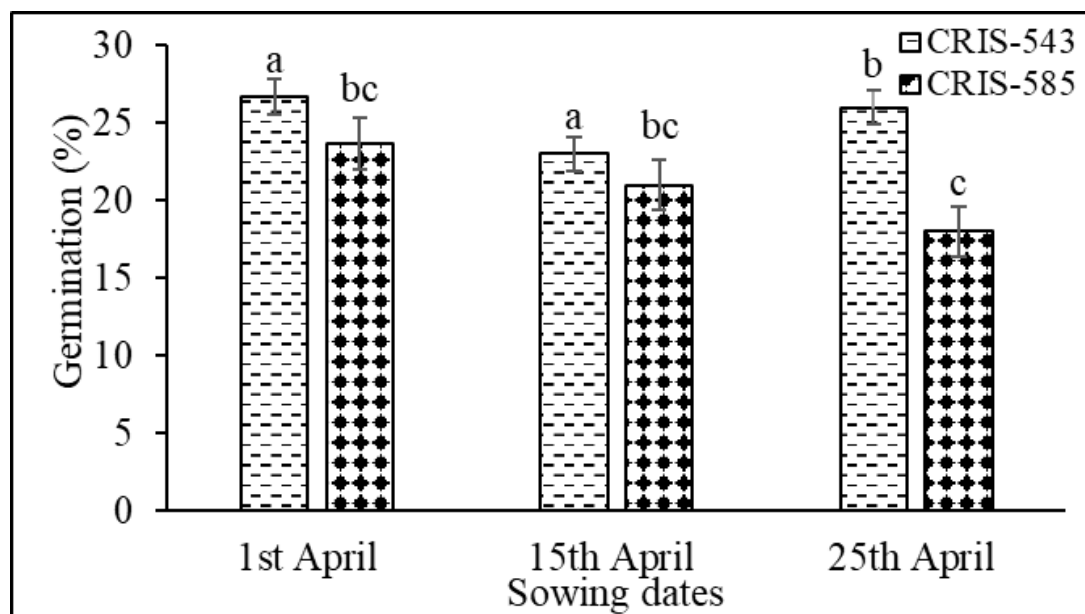


Figure 1. Influence of sowing dates on germination (%) of different cotton varieties.

Number of Sympodial Branches Plant⁻¹

Analysis of variance (ANOVA) revealed highly significant differences ($p < 0.01$) in sympodial branches per plant among the two cotton varieties and across the different sowing intervals. Moreover,

coefficient of variance was noted as 4.57%. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 23.056. In T1 (1st April) maximum results for sympodial branches were noted in V1 (CRIS-543) with mean value of 26.67 whereas minimum number of branches were

recorded in V2 (CRIS-585) with mean results of 23.67 (Figure 2). Similarly, In T2 (15th April) maximum results for sympodial branches were noted in V1 (CRIS-543) with mean value of 23 whereas minimum number of branches were recorded in V2 (CRIS-585) with mean results of 21 (Figure 3). Furthermore, In T3 (25th April) maximum results for sympodial branches

were noted in V1 (CRIS-543) with mean value of 26 whereas minimum number of sympodial branches were recorded in V2 (CRIS-585) with mean results of 18. Hence, it is assumed that cotton grown on 1st April is suitable to obtain maximum results of sympodial branches.

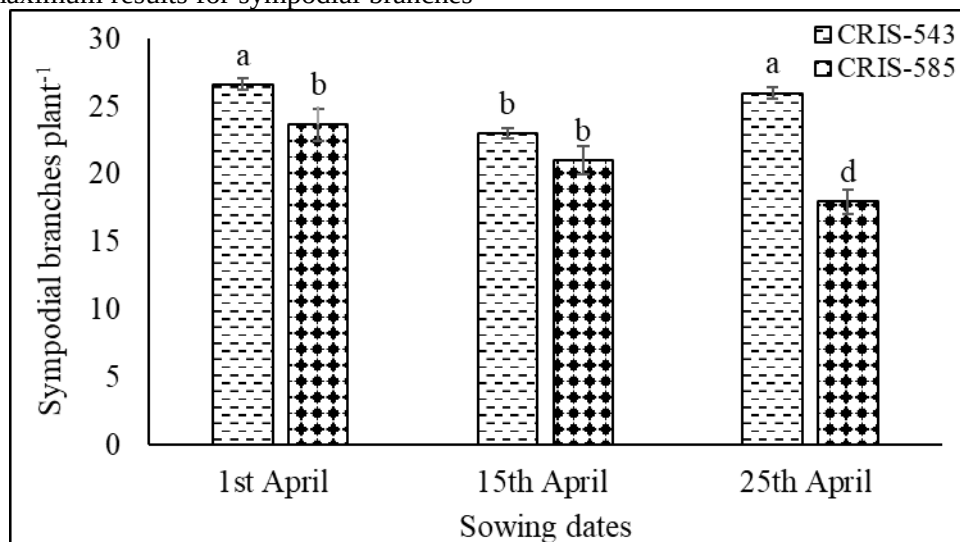


Figure 2. Influence of sowing date on number of sympodial branches plant⁻¹ on different cotton varieties

Number of Monopodial Branches Plant⁻¹

Analysis of variance (ANOVA) revealed highly significant differences ($p < 0.01$) in monopodial branches per plant among the two cotton varieties and across the different sowing intervals. Moreover, coefficient of variance was noted as 16.6%. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 4.667. In T1 (1st April) maximum results for monopodial branches were noted in V1 (CRIS-543) with mean value of 5.20 whereas minimum number of branches were recorded in V2 (CRIS-585) with mean results of 4.33 (Figure

3). In addition to this, In T2 (15th April) maximum results for monopodial branches were noted in V1 (CRIS-543) with mean value of 5.40 whereas minimum number of branches were recorded in V2 (CRIS-585) with mean results of 4.33 (Figure 3). Moreover, In T3 (25th April) maximum results for monopodial branches were noted in V1 (CRIS-543) with mean value of 4.66 whereas minimum number of branches were recorded in V2 (CRIS-585) with mean results of 4. Hence, it is assumed that cotton grown on 1st April and 15th April are suitable to obtain maximum results of monopodial branches.

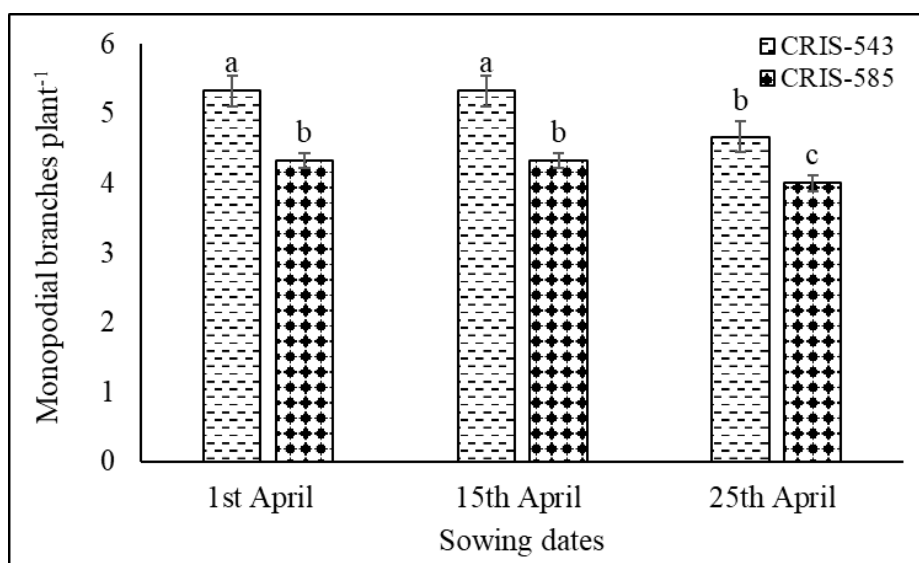


Figure 3. Influence of sowing date for number of monopodial branches per plant of on different cotton varieties

Boll Weight (g)

Boll weight has major role in enhancing the overall yield. Increase in boll weight result in more fiber production. Boll weight is another essential trait that has a direct impact on seed cotton yield. Cotton yield increases as boll size increases. Bolls are categorized as large, medium, or small according on their weight. For higher yields, bigger bolls might be a little more significant. From ANOVA, it was clearly showed a significant difference which was observed ($p > 0.01$) for boll weight for two different varieties along with their different sowing interval. Moreover, coefficient of variance was noted as 17.04%.

Based on the results drawn from different sowing interval, grand mean for both varieties were noted as

4.0556g. In T1 (1st April) maximum results for boll weight were noted in V1 (CRIS-543) with mean value of 5.56 whereas minimum results for boll weight were recorded in V2 (CRIS-585) with mean results of 5.33. In addition to this, In T2 (15th April) maximum results for boll weight were noted in V1 (CRIS-543) with mean value of 4.33 whereas minimum results for boll weight were recorded in V2 (CRIS-585) with mean results of 3.33. Furthermore, In T3 (25th April) maximum results for boll weight were noted in V1 (CRIS-543) with mean value of 3.33 whereas minimum results for boll weight were recorded in V2 (CRIS-585) with mean results of 2.33 (Figure 4). Hence, it is assumed that cotton grown on 1st April is suitable to obtain maximum results boll weight.

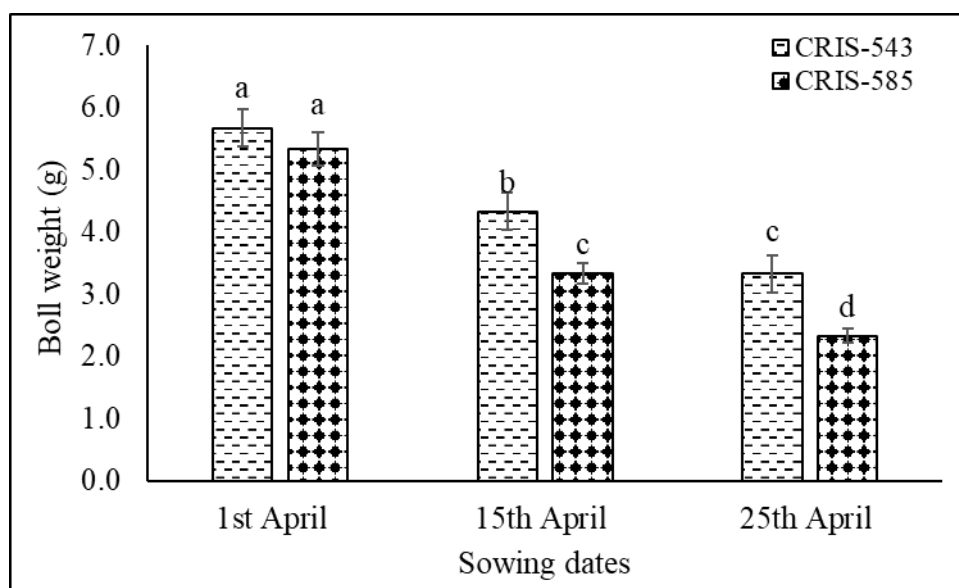


Figure 4. Boll weight of cotton as effected by different sowing interval

Plant Height (cm)

Analysis of variance (ANOVA) revealed highly significant differences ($p < 0.01$) in plant height among the two cotton varieties and across the different sowing intervals. Moreover, coefficient of variance was noted as 6.06%. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 128.06cm. In T1 (1st April) maximum results for plant height were noted in V1 (CRIS-543) with mean value of 132.33 cm whereas minimum results for plant height were recorded in V2 (CRIS-585) with mean results of 128. In addition to

this, In T2 (15th April) maximum results for plant height were noted in V1 (CRIS-543) with mean value of 135.66cm whereas minimum results for plant height were recorded in V2 (CRIS-585) with mean results of 121.33cm. In T3 (25th April) maximum results for plant height were noted in V1 (CRIS-543) with mean value of 134.33cm whereas minimum results for plant height were recorded in V2 (CRIS-585) with mean results of 116.66cm (Figure 5). Hence, it is assumed that cotton grown on 1st April and 15th April are suitable to obtain maximum results of plant height.

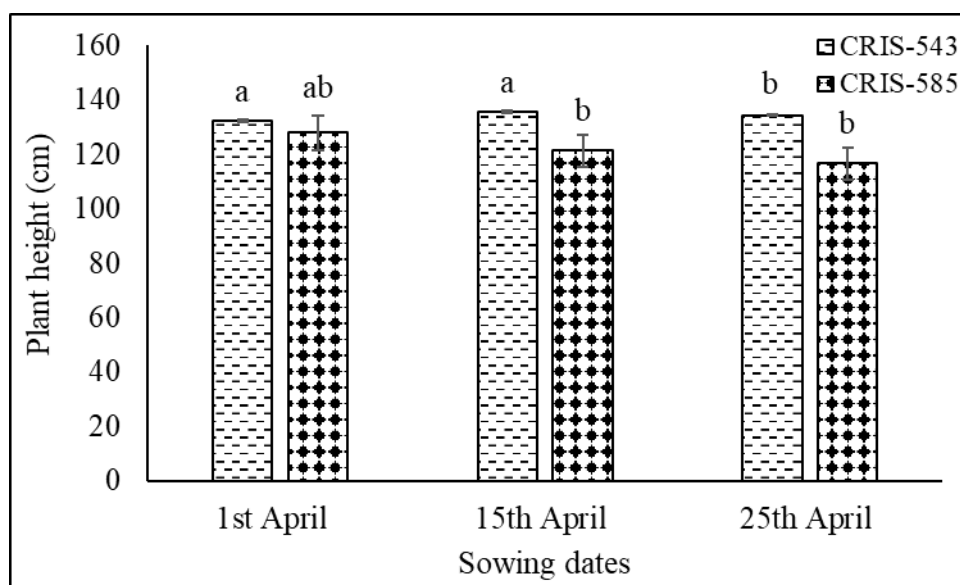


Figure 5. Plant height (cm) of cotton as effected by different sowing interval

Days to Flowering

Analysis of variance (ANOVA) revealed a significant difference ($p < 0.01$) in days to flowering among the two cotton varieties and across the different sowing intervals. Moreover, coefficient of variance was noted as 7.17%. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 80.667. In T1 (1st April) maximum results for days to flowering were noted in V1 (CRIS-543) with mean value of 88.33 whereas minimum results for flowering days were recorded in V2 (CRIS-585) with mean results of 87. In addition to this, In T2 (15th

April) maximum results for days to flowering were noted in V1 (CRIS-543) with mean value of 85.66 whereas minimum results for days to flowering were recorded in V2 (CRIS-585) with mean results of 71.66 (Figure 6). In T3 (25th April) maximum results for days to flowering were noted in V1 (CRIS-543) with mean value of 80.33 whereas minimum results for flowering days were recorded in V2 (CRIS-585) with mean results of 71. Hence, it is assumed that cotton grown on 1st April is suitable to obtain maximum results of existences towards blossoming.

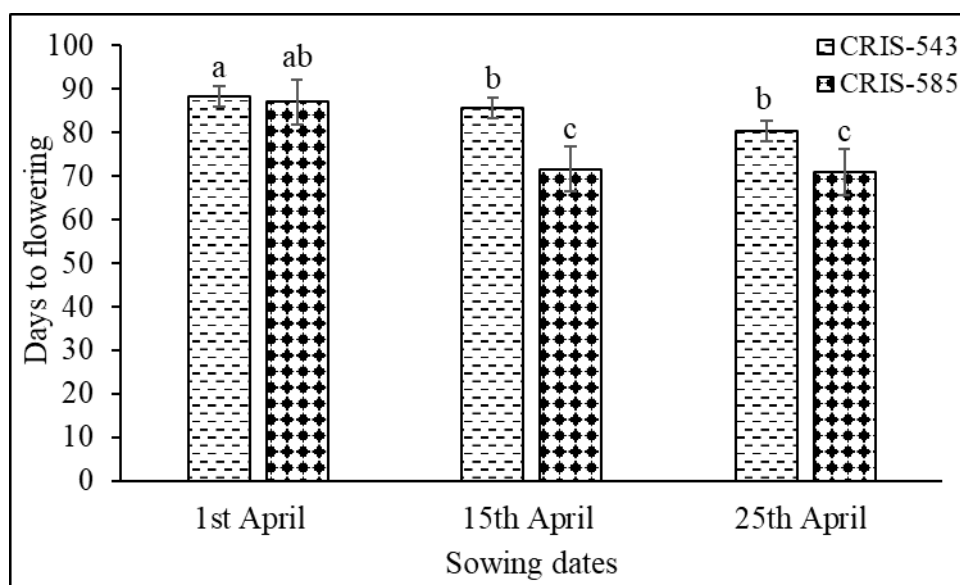


Figure 6. Days to flowering of cotton as effected by different sowing interval

Days to Maturity

Analysis of variance (ANOVA) revealed a significant difference ($p < 0.01$) in days to maturity among the two cotton varieties and across the different sowing intervals. Moreover, coefficient of variance was noted as 3.55%. Based on the results drawn from different

sowing interval, grand mean for both varieties were noted as 133.06. In T1 (1st April) minimum results for days to maturity were noted in V1 (CRIS-543) with mean value of 132.33 whereas maximum results for maturity days were recorded in V2 (CRIS-585) with mean results of 133.33. In addition to this, In T2 (15th

April) maximum results for days to maturity were noted in V1 (CRIS-543) with mean value of 134.66 whereas minimum results for days to maturity were recorded in V2 (CRIS-585) with mean results of 125 (Figure 7). In T3 (25th April) maximum results for days to flowering were noted in V1 (CRIS-543) with

mean value of 140 whereas minimum results for flowering days were recorded in V2 (CRIS-585) with mean results of 128. Hence, it is assumed that cotton grown on 25th April is suitable to obtain maximum results for days to maturity.

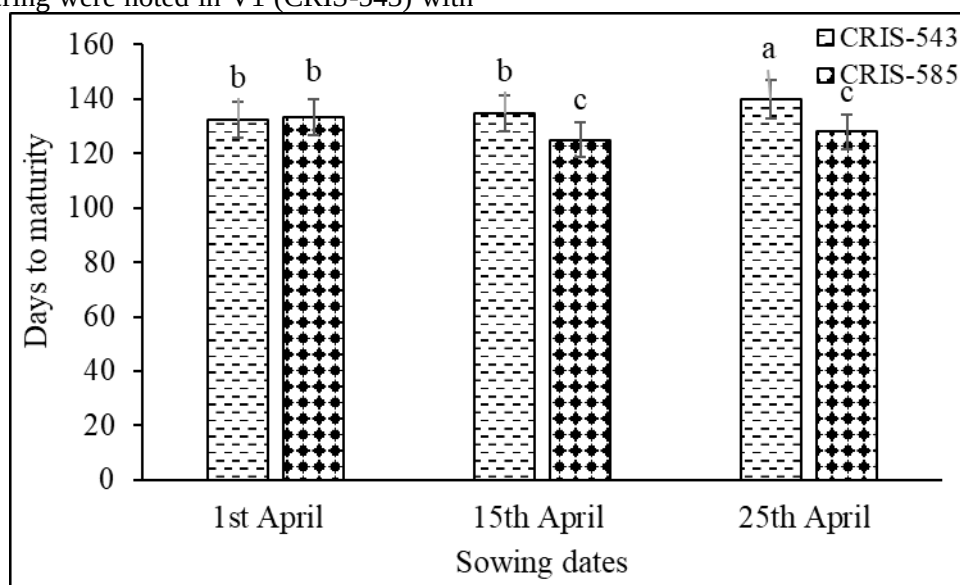


Figure 7. Days to maturity of cotton as effected by different sowing interval

Number of Bolls Plant⁻¹

Analysis of variance (ANOVA) revealed a significant difference ($p < 0.01$) in bolls per plant among the two cotton varieties and across the different sowing intervals. Additionally, a coefficient of variation of 7.26 % was recorded. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 28.5. In T1 (1st April) maximum results for number of bolls per plant were noted in V1 (CRIS-543) with mean value of 25 whereas minimum results for number of bolls were recorded in V2 (CRIS-585) with mean results of 26. In addition to this, In T2 (15th April) maximum results

for number of bolls per plant were noted in V1 (CRIS-543) with mean value of 29.66 whereas minimum results for number of bolls per plant were recorded in V2 (CRIS-585) with mean results of 28.33. In T3 (25th April) maximum results for number of bolls per plant were noted in V1 (CRIS-543) with mean value of 29.33 whereas minimum results for number of bolls per plant were recorded in V2 (CRIS-585) with mean results of 28 (Figure 8). Hence, it is assumed that cotton grown on 1st April and 15th April are suitable to obtain maximum results of number of bolls.

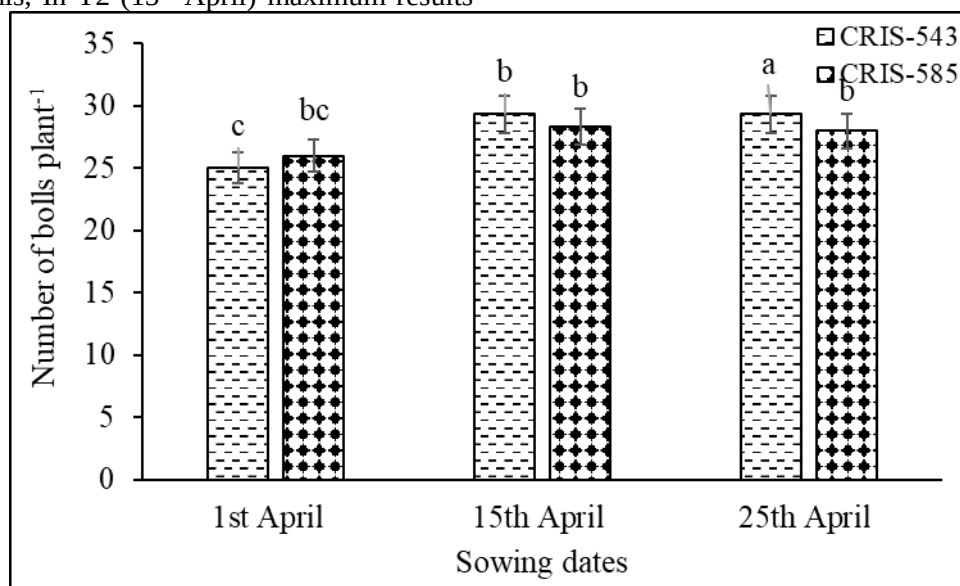


Figure 8. Number of boll plant⁻¹ of cotton as effected by different sowing interval.

Seed Cotton Yield Per Hectare

Analysis of variance (ANOVA) revealed a significant difference ($p < 0.01$) in seed cotton yield per hectare among the two cotton varieties and across the different sowing intervals. Moreover, coefficient of variance was noted as 5.71%. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 2364.9 kg ha⁻¹. In T1 (1st April) maximum results for seed cotton yield per hectare were noted in V1 (CRIS-543) with mean value of 2368.33 kg ha⁻¹. Whereas, minimum results for seed cotton yield were recorded in V2 (CRIS-585)

with mean results of 2312 kg ha⁻¹. In addition to this, In T2 (15th April) maximum results for seed cotton yield per hectare were noted in V1 (CRIS-543) with mean value of 2517.66 kg ha⁻¹. Whereas, minimum results for seed cotton yield per hectare were recorded in V2 (CRIS-585) with mean results of 2255.66 kg ha⁻¹ (Figure 9). In T3 (25th April) maximum results for seed cotton yield per hectare were noted in V1 (CRIS-543) with mean value of 2391 kg ha⁻¹ whereas minimum results for seed cotton yield were recorded in V2 (CRIS-585) with mean results of 2345 kg ha⁻¹.

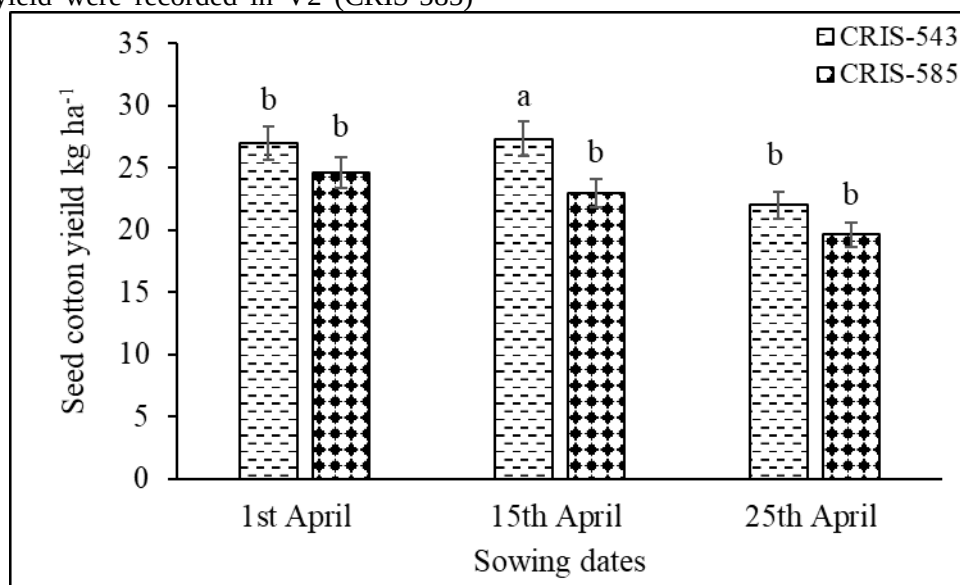


Figure 9. Seed Cotton yield hectare⁻¹ of cotton as effected by different sowing interval

Ginning Out Turn (GOT)

Analysis of variance (ANOVA) revealed a significant difference ($p < 0.01$) in ginning out turn among the two cotton varieties and across the different sowing intervals. Moreover, coefficient of variance was noted as 9.87%. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 34.72. In T1 (1st April) maximum results for ginning out turn were noted in V1 (CRIS-543) with mean value of 38.66 whereas, minimum results for ginning out turn were recorded in V2 (CRIS-585) with

mean results of 33. In addition to this, In T2 (15th April) maximum results for ginning out turn were noted in V1 (CRIS-543) with mean value of 39 whereas, minimum results for ginning out turn were recorded in V2 (CRIS-585) with mean results of 31.66 (Figure 10). In T3 (25th April) maximum results for ginning out turn were noted in V1 (CRIS-543) with mean value of 34.66 whereas minimum results for ginning out turn were recorded in V2 (CRIS-585) with mean results of 31.33.

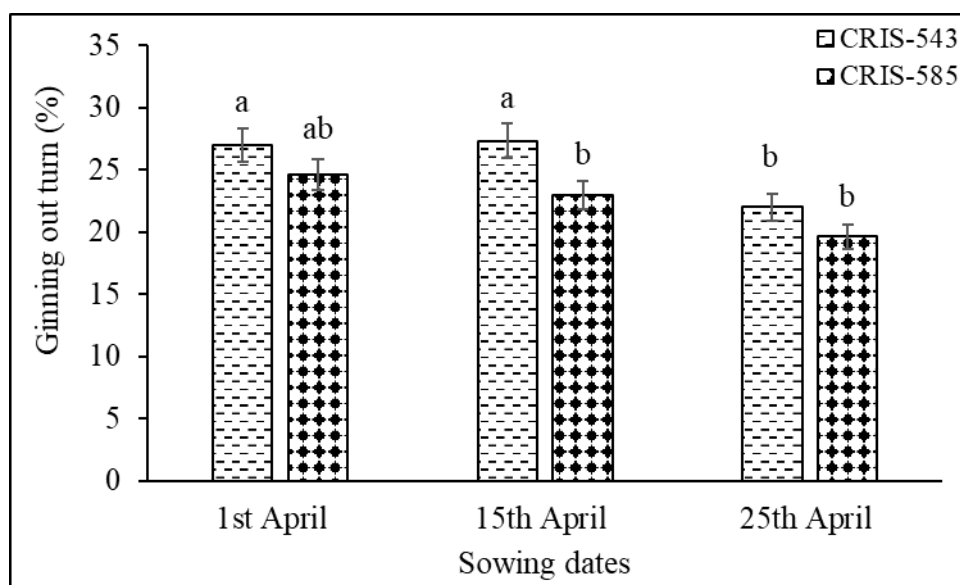


Figure 10. Ginning out turn of cotton as effected by different sowing interval

Staple Length (cm)

Analysis of variance (ANOVA) revealed a significant difference ($p < 0.01$) in staple length among the two cotton varieties and across the different sowing intervals. Moreover, coefficient of variance was noted as 10.14%. Based on the results drawn from different sowing interval, grand mean for both varieties were noted as 23.94 cm. In T1 (1st April) maximum results for ginning out turn were noted in V1 (CRIS-543) with mean value of 27 cm whereas, minimum results for ginning out turn were recorded in V2 (CRIS-585) with

mean results of 24.66 cm (Figure 11). In addition to this, In T2 (15th April) maximum results for ginning out turn were noted in V1 (CRIS-543) with mean value of 27.33 cm whereas, minimum results for ginning out turn were recorded in V2 (CRIS-585) with mean results of 23 cm (Figure 11). In T3 (25th April) maximum results for ginning out turn were noted in V1 (CRIS-543) with mean value of 22 cm whereas minimum results for ginning out turn were recorded in V2 (CRIS-585) with mean results of 19.66 cm.

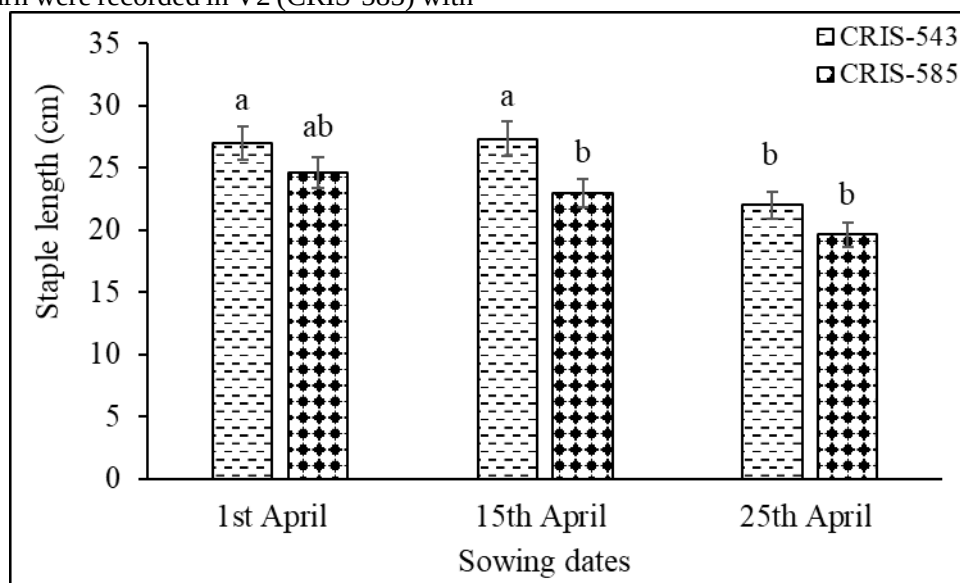


Figure 11. Staple length (cm) of cotton as effected by different sowing interval

DISCUSSION

The improvement in staple length observed under mid-April sowing can be explained through a more favorable alignment of crop phenology with key physiological drivers, particularly thermal time accumulation, photoperiod sensitivity, and assimilate partitioning during the fiber development phase (Han

et al., 2023). From a thermal perspective, cotton is a heat-unit-driven crop in which fiber elongation is highly responsive to cumulative growing degree days (GDD). Mid-April sowing ensures that the critical stages of flowering and boll development coincide with an optimal temperature regime (generally 25–32 °C), which promotes sustained cell elongation in

developing fibers (Huang et al., 2026). Early sowing often exposes the crop to suboptimal temperatures during early growth, slowing metabolic activity, while late sowing shifts boll development into periods of excessive heat stress ($>35^{\circ}\text{C}$), which accelerates maturity and truncates the fiber elongation phase (Bista et al., 2025). In contrast, mid-April sowing allows a balanced accumulation of heat units, extending the duration of fiber elongation and ultimately increasing staple length. Photoperiod also plays a regulatory role in cotton development, particularly in modulating the transition from vegetative to reproductive growth and influencing hormonal balance. Mid-April sowing aligns crop growth with gradually increasing day length, which enhances photosynthetic efficiency and promotes a favorable source sink relationship (Bista et al., 2025). This ensures adequate assimilate supply during boll formation, a prerequisite for proper fiber elongation. In contrast, delayed sowing under shortening day lengths may limit photosynthate production and redirect assimilates toward survival rather than fiber development (Guo et al., 2025). Physiologically, fiber elongation is governed by turgor-driven cell expansion and the activity of enzymes involved in cell wall loosening (e.g., expansins). These processes are highly sensitive to temperature and plant water status. Mid-April sowing typically synchronizes boll development with periods of moderate evaporative demand and improved soil moisture availability (often supported by residual spring moisture or early seasonal rainfall), thereby maintaining cell turgidity and prolonging the elongation phase (Thenveetil et al., 2025). Conversely, late sowing often subjects the crop to terminal drought or heat stress, which reduces turgor pressure and shortens fiber length. Furthermore, hormonal regulation particularly the balance of auxins, gibberellins, and abscisic acid is optimized under moderate environmental conditions (Bista et al., 2025). Mid-April sowing minimizes stress-induced abscisic acid accumulation, which otherwise restricts fiber elongation, while supporting growth-promoting hormones that enhance cell expansion (Yao et al., 2025).

Seed cotton yield was significantly increased across different sowing intervals. This research further supported by (Batoool et al., 2010; Farooq et al., 2018) similar findings were obtained, indicating variability within upland cotton genotypes for this particular trait was obtained when grown on different sowing interval respectively. According to (Dhivya et al., 2014) they observed that the yield traits were indicated a strong positive correlation with sympodial branches plant^{-1} , as bolls each plant has a through influence from sympodial branches. No of sympodial branches are greatly affected by different sowing interval when

multiple cotton varieties were sown at different times as reported by the (Hassan et al., 2011). Number of sympodial branches plant^{-1} is very good indicator of seed cotton yield plant^{-1} as the sympodial mean boll bearing / fruit bearing branches in cotton (Khan et al., 2017). Amna et al. (2013) also reported in their studies for the variation among different cotton genotypes for sympodial branches plant^{-1} , with different genotypes influenced by genetic as well as environmental factors which included multiple sowing times as treatments. Same experimental observations were taken by Solangi et al. (2019) as well for number of sympodial branches. Our results are in confirmation with Hussain et al. (2007) where it was estimated that integer of monopodeal undergrowth/ plant^{-1} exhibited noteworthy effect for altered varieties of cotton and extreme integer of monopodeal twigs/ plant^{-1} were produced when sown at different times of growing which were related to our study. Kumbhar et al. (2020) examined various *Gossypium hirsutum* cultivars for yield and additional financial characteristics, finding significant differences in boll weight and a favorable impact on seed cotton yield. Plant height and some other yield attributes changed amongst genotypes who evaluated the stability and adaptation of *Gossypium hirsutum* cultivars similar findings were reported by (x et al., 2022). Same results were reported for plant height by the (Zubillaga et al., 2002) when they grew cotton varieties on multiple times and observed non-significant differences at all. Kumbhar et al. (2020) estimated maximum mean performance for the parameter number of bolls plant^{-1} was 56.50 and minimum mean was 39.50 in various genotypes of upland cotton at agro climatic conditions of Tandojam. Similar findings had done by Jarwar et al. (2019) at multiple sowing interval. Nizamani et al. (2017) also observed similar results which were drawn when seeds were planted on different interval. The effect of early sowing on the cotton seed index and Got% and fiber characteristics is greatly increased as reported by the Coker et al., (2009). Khokhar et al. (2018); Kumar (2017) also observed similar results for cotton cultivars when planted on different interval as compared to normally grown cotton interval.

CONCLUSION

The present study demonstrated significant varietal and sowing date effects on the growth, yield, and fiber quality attributes of cotton under the agro-climatic conditions of Lasbela. Among the tested genotypes, CRIS-543 consistently outperformed other varieties in terms of overall yield and key growth parameters, indicating its superior adaptability and productivity in the region. Sowing date markedly influenced morphological and phenological traits. Early sowing on 1st April proved optimal for achieving enhanced

germination, increased numbers of monopodial and sympodial branches, higher boll weight, earlier flowering, and a greater number of bolls per plant. In contrast, sowing on 15th April significantly improved plant height, ginning outturn, staple length, and ultimately seed cotton yield, suggesting this period as the most favorable for maximizing economic returns. Meanwhile, late sowing on 25th April was only advantageous for extending days to maturity. Overall, the findings highlight that while CRIS-543 is the most promising variety for cultivation in Lasbela, mid-April sowing (15th April) is recommended for optimizing yield and fiber quality, whereas early April sowing may be preferred when targeting improved early growth and reproductive traits. These results provide a practical basis for refining sowing strategies to enhance cotton productivity under similar agro-ecological conditions.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this research.

Authors Contribution

Conceptualization and study design were carried out by Abdul Barri and Muhammad Ramzan Lund. Field experimentation and data collection were conducted by Kashif Ali Kubar, Sultan Ahmed, and Muneer Ahmed. Data analysis, interpretation, and manuscript preparation were performed Habib Rehman Lakho, Imdad Hussain Khoso, Adil Hameed, Mehar un-Nisa Narejo.

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Ethical Statement

This study was conducted in accordance with established institutional and agricultural research guidelines. All experimental procedures complied with standard agronomic practices and ethical considerations for field-based research.

SDG Address

This research contributes to SDG 2: Zero Hunger by enhancing cotton productivity through optimized varietal selection and sowing time, thereby supporting sustainable agricultural practices and improved crop yields.

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