

Research Article

Development and Growth: Influence of Sowing Dates on Performance of Cotton Cultivars

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Abstract | Agriculture has a principal impact on Pakistan's economy since its existence. The cotton crop is considered the backbone of agriculture and research are mandatory to augment its production. Indigenous cultivars have an impressive production potential while climatic sowing dates fluctuation during crop planting is the leading hindrance in its production. Therefore, this one-year field experiment was performed to assess the result of varying cultivars and sowing dates on developmental and allometric traits of cotton (*Gossypium hirsutum* L.) under the agro-ecological conditions at Sargodha, Punjab, during Kharif season, 2015. The study consisted of i) three cultivars viz. Bt. FH-142, Bt. MNH-886 and FDH-170 and ii) three sowing dates viz. 21st April, 5th May and 20th May. Cultivars and sowing dates improved developmental and allometric traits of cotton in the study year. Significantly, 21st April cotton sowing observed maximum days taken from planting to first flower and boll opening, fruiting branch and branch height (65.02), (112.56), (10.02) and (26.43 cm) in FDH-170, respectively while boll maturation (48.05) was noted in Bt. MNH886. Sowing date 5th May plot recorded more leaf area index and net assimilation rate in FDH-170 (4.45 and 3.87 g m⁻² day⁻¹) while leaf area duration and crop growth rate in Bt. FH-142 (282.32 and 6.67 g m⁻² day⁻¹), respectively. Significantly, higher TDM production was recorded on 21st April in Bt. FH-142 (1104.33 g m⁻²). Therefore, cotton should be grown among after 15th April to before 10th May with cultivars FHD-170, Bt. FH-142 and Bt. MNH-886 respectively under semi-arid conditions of Pakistan.

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Introduction

Cotton (*Gossypium hirsutum* L.) plant is recognized as white gold and warm humid area of the world under its cultivation (Meredith *et al.*, 1997). In the world, Pakistan ranked 3rd being a consumer and fourth in terms of production (GoP, 2015-16). It has a leading role in Pakistan's economy as a main cash crop.

Moreover, foreign exchange earnings and support about 1.5 million rural economies (Hussain *et al.*, 2010; Ahmad *et al.*, 2009). Cotton crop share in value addition is 5.1 % and in gross domestic production is 1.0% (GoP, 2015-16). Recent economic importance of cotton is 2.917 million hectares' areas with total production and average yield are 10.074 million bales and 587 kg per hectare, respectively (GoP, 2015-16).

It is the only main fiber crop of Pakistan however, its area under cultivation and production is lower than other cotton producing states of the world owing to continuous ambitious exertions of scientist in field of breeding and production (Ali *et al.*, 2005). There are several reasons like climatic/environmental, soil, water shortage and crop husbandry which are continuously creating a hindrance in cotton production. Among yield reducing factors, sowing time is one of major the agronomic factor which additively restricting the cotton growth and production by affecting yield related parameters.

Date of sowing dependent on mean maximum and minimum temperature which directly upsets cotton crop growth and yield that ultimately affect the fiber quality. Moreover, results revealed that one week delayed in sowing clearly reduced the cotton yield by influencing its growth and yield parameters (Abdel-Malak *et al.*, 1996). Temperature variations in different agro-ecological zones of Pakistan, it is necessary to research on appropriate sowing time for recommendation of cotton sowing in order to enhance its production (Kakar *et al.*, 2012). Moreover, climatic variations influenced the regional sowing calendar which determined the time of vegetative and reproductive stage of the crop. Cotton is a temperature sensitive crop and its production is drastically reduced by too early and too late sowing time (Bange and Milroy, 2004). It was experimented that appropriate sowing time improved the cotton yield by positively shape the growth and developmental stages (Soomro *et al.*, 2001). Moreover, it was perceived and recommended that 15th April to 1st May cotton crop sowing responded better growth and yield rather than first week of April to end of May (Arain *et al.*, 2001). Deviation from appropriate sowing date/time brings a significantly changed in fiber quality and yield attributes viz., ginning out turn (%), fiber length, number of bolls and weight and seed cotton weight (Niazi, 2005).

As discussed above, cotton sowing is temperature sensitive step and seeded in a wide range of agro-ecological zones. However, selection of appropriate sowing date for different cultivars under different regions is the key factor for getting maximum cotton production (Bozbek *et al.*, 2006). Different cultivars differ in the characteristics of fiber quality (Mohammad, 2001) and responded differently under different temperature regimes (Killi *et al.*, 2005).

Hence, appropriate sowing dates and cultivars have mark able effect on fiber quality and oil content traits (Iqbal and Khan, 2011). Most of the cotton cultivars exhibited better performance in terms of growth and yield up to 15th April as compared with late sowing beyond 1st June (Siddiqui *et al.*, 2004).

A field study was designed to test which cultivars performed better in developmental and allometric features as sown under different dates in semi-arid region of Pakistan.

Materials and Methods

Study site

To evaluate the effect of cotton (*Gossypium hirsutum* L.) sowing date on cultivars growth and development was studied through field experiments executed at research area of College of Agriculture, University of Sargodha, Sargodha, Pakistan, during Kharif season, 2015. The experimental area was located at 32.08°N and 72.67°E and altitude 193 m. The soil of experimental site was sandy clay loam.

Experimental design, treatments and cultural practices

Statistically RCBD with split plot arrangement was used having 03 replications while the net dimension of experimental unit was 6.0 m x 4.5 m. Three cultivars (C_1 = Bt.FH-142, C_2 = Bt.MNH-886, C_3 = FDH-170) were randomized in the main plots while three sowing dates (SD_1 = 21st April, SD_2 = 5th May, SD_3 = 20th May) were applied in subplots. After wheat crop harvest, the soil was prepared for cotton crop by disking twice in order to break soil clods and fine texture. Single row hand drill was used for cotton sowing by maintaining R x R distance 75 cm and seed @ of 20 kg ha⁻¹ was used. At the time of soil preparation, whole dose of phosphorous and potassium were incorporated while nitrogen was applied in three splits 1st at sowing, 2nd at first irrigation and 3rd at second irrigation. Moreover, uniform agronomic practices were applied in all the experimental units.

Methodology of developmental and growth parameters to be measured

Developmental and growth parameters of cotton, including first flower and boll opening, boll maturation, first fruiting branch and height (cm), leaf area index (LAI), total dry matter (TDM) (g m⁻²), leaf area duration (LAD), crop growth rate (CGR) (g m⁻² day⁻¹) and net assimilation rate (NAR) (g m⁻² day⁻¹). Crop

developmental parameters data were recorded after sowing. For this purpose, ten plants were selected and their averages were taken to calculate days taken to first flower and boll opening, boll maturation (days), first fruiting branch and height (cm). Leaf lamina of 5 g sample from each plot was taken and measured leaf area by using formula of [Watson \(1952\)](#) through operating CI-202. Portable Laser Leaf Area Meter.

$$LAI = \text{Leaf area} / \text{land area}$$

For total dry matter, 50 g fresh sample was harvested from each treatment than sun dried it for 3-4 days. After sun dried, sample was placed in oven for three days at 72 °C. Then dried leaves were weighed for calculating of total dry matter. For this purpose, weight of 1 m length of dried plants were converted into per square meter and then into per hectare. LAD, CGR and NAR were calculated by using [Hunt \(1978\)](#) formula respectively.

$$LAD = (LAI_1 + LAI_2) / 2 \times (t_2 - t_1)$$

$$CGR (g\ m^{-2}\ day^{-1}) = (W_2 - W_1) / (t_2 - t_1)$$

$$NAR (g\ m^{-2}\ day^{-1}) = TDM / LAD$$

Statistical analysis

Data of the experiment was statistically analyzed $p \leq 0.05$ by using SAS ([SAS Institute, 2008](#)) to evaluate the response of cotton cultivars under different sowing dates. Graphical presentation of data was calculated using R software ([R Core Team, 2012](#)).

Results and Discussion

Influence of sowing dates on phenological attributes of cotton cultivars

Sowing date had significant effect on development and growth parameters of cotton cultivars during year of study ([Figures 1 and 2](#)). Outcome of sowing dates on developmental attributes of cotton cultivars were depicted in [Figure 1](#). Sowing date 21st April produced maximum (65.02) first flower opening in FDH-170 while minimum flowers opening were observed on 20th May in all cotton cultivars. Likewise, maximum days taken to open first boll was noted on 21st April in FDH-170 (112.56). Moreover, cultivars sown on May, 20th showed minimum (108.34) days taken to first boll opening for FDH-170. Similarly, significantly maximum (48.05) days for boll maturation was recorded on April, 21st in Bt. MNH-886, followed by FDH-170 and Bt. FH-142 while

minimum was noted at 5th May and 20th May all cultivars respectively. Maximum number (10.12) of nodes from first fruiting branch was recorded at 21st April in FDH-170 while minimum number of nodes was noted at 20th May in all cultivars. Significantly first fruiting branch height (27.63 cm) was verified on 21st April sowing in FDH-170. Cultivars sown May, 20th produced shorter first fruiting branch and height in FDH-170 (25.67cm) followed by Bt. FH-142 (23.42 cm) and Bt. MNH-886 (22.95 cm).

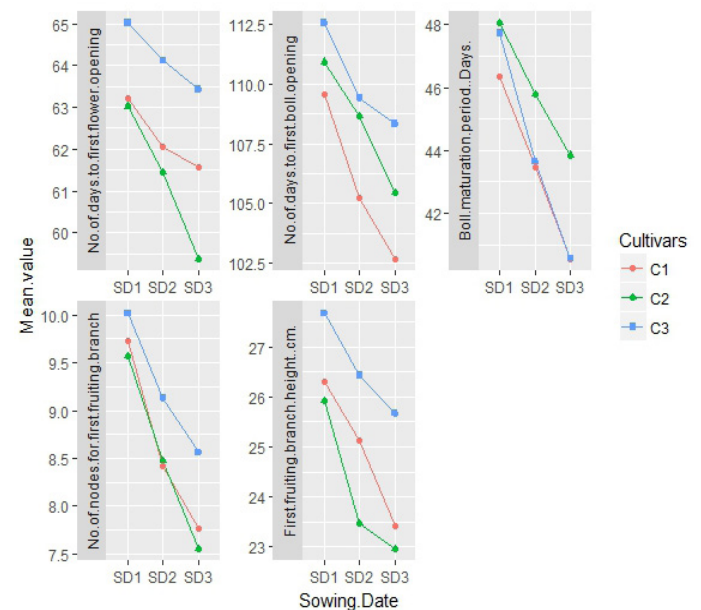


Figure 1: Influence of sowing dates on developmental attributes of cotton cultivars.

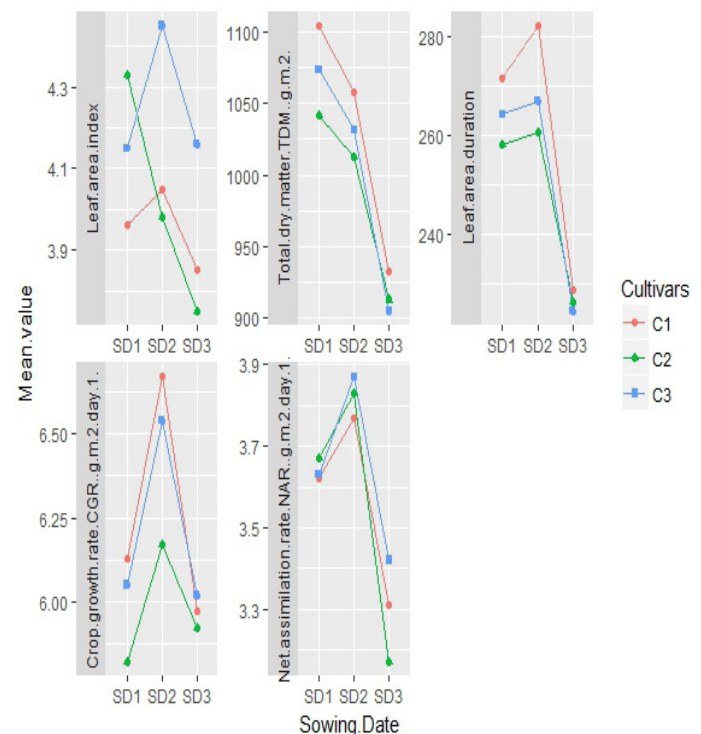


Figure 2: Influence of sowing dates on growth attributes of cotton cultivars.

Results revealed that cotton developmental and growth stages showed sensitivity to different sowing dates. Early plantation of cotton cultivars responds positively to developmental parameters (Pettigrew and Johnson, 2005). Suitable environmental conditions are available to crop plants when planted in the month of April which brings improvement in the developmental stages and reduced the risk of flower and boll opening. Late planting resulted in significant reduction in boll maturation due to high temperature and ultimately reduced the cotton yield (Butter *et al.*, 2004). Early sowing crop enjoy better agro-resources which protect the primary fruiting branch nodes and height in cotton cultivars from hot humid weather that cause fruit losses (Ali *et al.*, 2009). In our study, early sown cotton improved their developmental stages which may be efficient utilization of moisture and nutrients in the semi-arid arid region. Moreover, late sown crop showed lower developmental parameters like days to flower and boll opening and maturation and nodes for first fruiting branch and height might be due to high temperature at early growth stages and short time. Appropriate sowing time enhanced the cotton yield due to prolong period of flowering before the start of any stress and healthy plants improved the efficiency of nutrient and moisture uptake which was helpful during boll formation and maturation (Arian *et al.*, 2001; Tahir *et al.*, 2009). Moreover, optimum sown cotton enjoys the sufficient soil nutrients and moisture due to prolonged stay in field which resulted in formation of maximum floral buds and boll maturation due to optimum growing degree-days (Gormus *et al.*, 2002). Ali and El-Sayed (2001) reported that cotton cultivars showed positive response to early sowing which resulted in substantial increase in boll opening, boll maturation and days taken to first flower and boll open.

Influence of sowing dates on growth attributes of cotton cultivars

Influence of sowing dates on growth parameters of cotton cultivars were depicted in Figure 2. It is recorded that FDH-170 responded significantly (4.45) maximum leaf area index at 05th May than Bt. FH-142 and Bt. MNH-886 at 21st April and 20th May respectively. Sowing date 21st April produced maximum (1104.33 g m⁻²) total dry matter in Bt. FH-142 while significantly minimum TDM were observed on 20th May in all cotton cultivars. Moreover, Bt. FH-142 showed maximum (282.32) leaf area duration on 05th May sowing while minimum

(224.57) leaf area duration was recorded in 20th May sowing in all cultivars. Similar trend was recorded in case of crop growth rate in which Bt. FH-142 respond significantly (6.67 g m⁻² day⁻¹) maximum in 05th May sown crop. Significantly higher value of NAR (3.87 g m⁻² day⁻¹) was perceived on 05th May sown in FDH-170 cultivar while lower (3.17 g m⁻² day⁻¹) for NAR was documented when sown on May, 20th in all cultivars.

Cotton growth parameters are very sensitive to temperature fluctuation and directly influenced by planting time (leaf area index, total dry matter and days taken to flowering) (El-Hindi *et al.*, 2006). Our study results supported the findings of Gecgel *et al.* (2007) who found that optimum sowing dates had significantly and positively improves the plant growth. Moreover, optimum sowing is a key element for positive enhancement in growth and cotton crop growth tend to decrease when sowing was done at late (Bozbek *et al.*, 2006). The joint opinion regarding sowing date effect is that the appropriate planting improves the cotton growth that have indeterminate growth habit. Therefore, timely sowing acquires maximum growth time, leaf area index, leaf area duration which improved radiation interception that resulted in maximum total dry matter production (Akhter *et al.*, 2002). Ullah *et al.* (2015) recorded that 15th April to 1st May sown cotton gave maximum total dry matter, leaf area index and duration whereas too late or early sown crop showed minimum growth parameters as they receive less units of heat. Research on cotton sowing date had been concise by the researchers and they are agreed that late sown cotton resulted in cotton growth reduction due to short growing period (Bange *et al.*, 2008). Our finding in accordance with study of Siddiqui *et al.* (2004) they found that April to May sown crop showed maximum total dry matter production which enhances the growth rate and net assimilation rate than late sown. Similarly, fortnightly delay in sowing beyond 20th April resulted in a significant reduction in growth due to high temperature (Poonia *et al.*, 2002). Moreover, sowing in months of March to April gave significant effects on growth like LAI, LAD, TDM and NAR (Butter *et al.*, 2004).

Conclusions and Recommendations

Study showed that cotton cultivars strongly influenced by the change in sowing date. Late sown

cotton resulted in significant reduction in growth and developmental parameters. Therefore, smooth growth rate was achieved when cotton crop sowing was completed from last week of April to first week of May by using Bt. FH-142 cultivars than other cultivars.

Novelty Statement

Cotton cultivar's performance were evaluated in semi-arid region instead of tropical region of Pakistan.

Author's Contribution

Amjed Ali: Conceived the idea, overall management of the article data collection.

Rafi Qamar: Wrote abstract, introduction, methodology, result and discussion, conclusion, overall management of the article.

Muhammad Ehsan Safdar: Overall management of the article.

Salman Saleem: Technical input at every step.

Semi Ullah: Data entry and analysis.

Muhammad Arshad Javed: Wrote abstract and conclusion.

Syed Wasim Hasan: Technical input at every step.

Conflict of interest

The authors have declared no conflict of interest.

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