Research Article

Effect of Genotypes and Planting Dates on Yield and Fibre Quality Parameters of Cotton

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Abstract | The present experiment was carried out at Cotton Research Station, Vehari, Punjab during 2020-21. The objectives of this experiment were to assess the effect of cotton genotypes and sowing dates on yield and fibre quality parameters. Three upland cotton genotypes *Viz.,* VH-402, VH-351 and VH-305 (check) were configured in a sub-plot using a randomized complete block design (RCBD) havinga split-plot arrangement with three replications. Eight sowing dates were arranged in the main plot starting from 1stMarch to 16th June with a uniform interval of two weeks. Data analysis depicted that sowing dates influenced all study traits significantly except for staple length. Similarly, genotypes and interactive effects were found significant. Genotype VH-351 yielded the highest (2523.3 kg ha^{-1}) when sown in 1stMarch, while VH-402 gave the lowest seed cotton yield (209 kg ha^{-1}) on the planting date of 16th June. The finest lint-bearing micronaire value (3.9656) was obtained by normal season sowing in 1stMay. Late sowing on 16th June resulted in coarse lint with (4.8189) micronaire value. Tough staple was found (33.511 g tex^{-1}) at 1st March sowing, while frail staple (28.856 g tex^{-1}) resulted in 16th May planting. In prevailing climatic conditions sowing of cotton on the earliest dates gave optimum seed cotton yield in South Punjab, while June sowing was proved uneconomical.

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Introduction

Upland cotton (*Gossypium hirsutum*. L) is a cash crop that earns foreign exchange via exports (Abro *et al.*, 2015). It contributed 0.82 % to the grand domestic product (GDP) of Pakistan during the year 2019-20 (GOP, 2020). Among cultivated species, upland cotton is prominent due tothe quantity of lint production in the world. It provides raw material to expanding textile industry, hence contributing more than 4.2% in agriculture value addition in the form of fabric and ready-made garments (GOP, 2020).

At the stage of pollination and boll formation, this crop is very sensitive to temperature fluctuations (Ali *et al.*, 2020). Research for optimum sowing dates for

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a particular area is important to get bumper crop yield (Kakar *et al*., 2012). Length of growing season adjustment through the date of sowing is very crucial for optimum yield (Muhsin *et al*., 2021). Sowing of cotton at the optimum date yielded a positive impact on lint quality and oil contents (Iqbal and Khan, 2011). Other climatic factors like relative humidity, the intensity of sunshine and rainfall also determine the crop outcome (Chen *et al*., 2012).

Increasing lint demand by the textile sector calls for cultivars that are the best yielder in uneven weather conditions, heat and drought stresses are expected due to the climate change process (Hassan *et al*., 2020). This phenomenon adversely affects crop husbandry at the global level as a result of elevated mean temperature and altered rainfall patterns (Abbas, 2020). Early cotton sowing in cool months like February and March results in poor germination, and hence less biomass production (Conaty *et al*., 2012). On the opposite side, a shorter growth duration in cotton due to late sowing also results in reduced yield (Elayan *et al*., 2015).

In summary, high yielder, efficient growing and resistant genotypes are capable to cope with the climate change menace (Devita *et al*., 2017). Lint length, strength and fineness are also linked with better counts of yarn and fabric quality, which is a prerequisite to fetch new markets for enhancing cotton-based exports. Optimization of sowing time in cotton related to lint quality is rarely reported in the literature. It was hypothesized that optimization of sowing date in cotton may boost high-quality lint production.

Keeping in view, the present study was carried out to sort the best yielder genotypes along with the optimum sowing date at the cotton production hub of south Punjab.

Materials and Methods

Description of experimental location

The present research trial was carried out at the cotton research station, Vehari during 2020-21. The location of the site was 72°37'E longitude, 30°25'N latitude, and 175m altitude. Before sowing, soil samples were drawn from the experimental area for physio-chemical analysis asthe procedure given by Homer and Pratt (1961). The Soil texture was found loamy, PH=8.1, organic matter contents= 0.9 %, and available phosphorus and potassium were 7 and 136 ppm respectively. Similarly, the soil was fellow, which make it well suited for cotton crop production. Plenty of quality irrigation water was also available for experiment throughout the season.

Planting materials and experimental design

Three upland cotton genotypes *Viz.*, VH-402, VH-351 and VH-305 (check) were sown by following the layout of RCBD with a split-plot arrangement. Eight sowing dates starting from 1st Marchto 16Th June (with an equal interval of two weeks) were arranged in the main plot, while genotypes were put in the subplot. The plot size was fixed at 9 × 3 m^2 and each entry was repeated thrice to calculate the experimental error.

Crop husbandry practices

Three healthy and delinted seeds were dibbled on 75cm apart raised beds with an interval of 30 cm between the hills. Recommended doses of potassium and phosphorus were applied at the time of bed preparation in the form of chemical fertilizer, while Nitrogen was split into three equal doses 1/3 at sowing, 1/3 at flowering and 1/3 at the bolls formation stage. Pre-emergence weedicide S-metachlor was applied @2.0 litre per hectare within a day after first irrigation. At the 3-4 leaf stage thinning was done manually and a 25-30 cm distance was maintained between the plants. All other agronomic and plant protection practices are performed equally among plots. Insect pest populations were kept below the economic threshold level with recommended agro-chemicals.

Meteorological data

The climate of the site was semi-arid with uneven rainfalls. During the study season, heavy rainfall occurred in March and July. The highest temperature was recorded in July and then gradually declined. The cotton-picking period was dry and hence was suitable for quality lint production.

Data collection

At crop maturity (when 90 % of bolls were opened) cotton picking was done manually with female labour. Seed cotton yield obtained from each plot was weighed with electronic balance and converted to Kg ha^{-1}. A representative sample was drawn from each plot and ginned with a single roller electric ginning machine after cleaning from trash and sun drying. Ginning out turn % (GOT) was calculated by formula.

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

Subsequently, lint samples were analyzed for quality traits by a high-volume instrument (HVI) as a procedure developed by Sasser (1981). This instrument provided data on fibre traits like Staple length (mm), fibre breaking strength (g tex^{-1}) and micronaire value indicating staple fineness.

Statistical analysis

Data of studied traits were subjected to the analysis of variance (ANOVA) technique under a split-plot arrangement (Steel *et al*., 1997). Then treatment means were compared following the least significance difference (LSD) test at a 5% probability level (Fisher, 1935). Statistix 8.1 computer-based software was used for data analysis.

Results and Discussion

The results showed that sowing dates, genotypes and their interaction posed a significant effect ($p \leq 0.01$) on seed cotton yield (SCY). The maximum yield (2164.4 kg ha^{-1}) was obtained when sown on 1st March followed by (2184.7 kg ha^{-1}) sowing on 1st April date. The lowest SCY was produced (286.9 kg ha^{-1}) by plots sown on 16th June followed by 1st June sowing (Table 2). It was also found that both tested genotypes yielded higher than VH-305(check). Genotype VH-402 produced the best yield (2428 kg ha^{-1}) on 16th April sowing, when compared with early sowing dates (Table 3). Contrary to this genotype VH-351 and VH-305 performed best when sown on the earliest date of 1st March. All tested genotypes performed poor during late planting in the hot month of June (Table 3). Panting date D-2 (16th March) yielded poor (1562.8 kg ha^{-1}) on average basis than three late sowing dates up to D-5.

Table 1: *Mean squares for SCY and fibre quality traits as swayed by genotypes and sowing dates during 2020-21.*

Source of variation	Degree of freedom	Seed cotton yield (Kg ha^{-1})	Ginning out turn (%)	Staple length (mm)	Staple strength (g tex^{-1})	Micronaire value
Replication	2	46643	0.73347	0.8952	18.5918	0.20069
Sowing dates	7	4597041^{a}	4.95665^{b}	1.6553$^{n.s}$	18.4298^{a}	0.51195^{a}
Error a	14	26390	2.31141	1.8404	4.3534	0.08064
Genotypes	2	220020^{a}	9.45181^{a}	12.3571^{a}	16.5872^{b}	0.23737^{b}
G × S	14	143170^{a}	4.56212^{a}	2.1390^{a}	9.8321^{b}	0.9805^{b}
Error b	32	14353	1.34333	1.2219	6.8759	0.11192

Whereas: ^{a}: Significant at ($p \leq 0.01$); ^{b}: Significant at ($p \leq 0.05$); $^{n.s}$: Non-Significant.

Table 2: *Outcome of cotton genotypes and planting dates on yield and fibre quality traits during 2020-21.*

Treatments	Seed cotton yield (kg ha^{-1})	GOT%	Staple length (mm)	Staple strength (g tex^{-1})	Micronaire value
Main plot (Sowing dates)					
D-1 (1st March)	2216.4^{a}	38.633^{abc}	25.749^{a}	33.511^{a}	4.3911^{b}
D-2 (16th March)	1562.8^{cd}	39.144^{a}	25.744^{a}	31.189^{bc}	4.3400^{b}
D-3 (1st April)	2184.7^{a}	37.289^{c}	26.079^{a}	31.400^{bc}	4.2500^{bc}
D-4 (16th April)	2005.3^{b}	37.911^{abc}	25.447^{a}	31.511^{abc}	4.3800^{b}
D-5 (1st May)	1654.4^{c}	37.522^{bc}	24.744^{a}	30.200^{cd}	3.9656^{c}
D-6 (16th May)	1435.1^{d}	38.922^{ab}	25.380^{a}	28.856^{d}	4.3611^{b}
D-7 (1st June)	586.2^{e}	39.222^{a}	25.931^{a}	32.022^{abc}	4.5022^{b}
D-8 (16th June)	286.9^{f}	38.633^{abc}	25.168^{a}	32.633^{ab}	4.8189^{a}
L.S.D ($p \leq 0.05$)	164.25	1.537	n.s	2.110	0.2871
Sub plot (Genotypes)					
V-1 (VH-351)	1532.4^{a}	38.125^{b}	25.351^{b}	30.621^{b}	4.2842^{b}
V-2 (VH-402)	1560.0^{a}	37.975^{b}	26.325^{a}	31.346^{ab}	4.4817^{a}
V-3 (VH-305) Check	1382.1^{b}	39.129^{a}	24.926^{b}	32.279^{a}	4.3625^{ab}
L.S.D ($p \leq 0.05$)	70.45	0.682	0.650	1.5419	0.1967

Means bearing a similar letter for a trait means not significant at ($p \leq 0.05$), n.s: means statistically non-significant.

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Results further related that GOT % were found significant (p≤0.05) for sowing dates, while genotypes and their interactive effects were highly significant (p≤0.01) as shown in Table 1. Check cultivar VH-305 gave maximum GOT (39.129 %) among tested genotypes, while D-3 (1st April) sowing produced lint with the least GOT (37.289%) among tested dates (Table 2). As for interaction results between both variables concerned, VH-305 when sown on 16th March gave the highest GOT (41.1%), but minimum GOT was obtained with the same variety when sown on 1st May (Table 3). Staple length results for sowing dates were found non-significant, but for genotypes and their interaction were significant (p≤0.05). Genotype VH-402 appeared as a long-staple (26.325mm) among tested materials. The best combination was found with VH-402 when sown on 1st April and produced the longest staple (28.38 mm) followed by (27.307mm) when sown on 16th May (Table 3).

Results for fibre strength and fineness were highly significant for sowing dates and significant at (p≤0.05) for both studied genotypes and interaction variables. On the overall check cultivar, VH-305 produced a strong fibre of (32.279 g tex^{-1}) than the other two tested genotypes. The promising genotype VH-351 gave the strongest lint (35.1 g tex^{-1}) when sown on 1st March, while fragile lint (26.7 g tex^{-1}) when sown on 1st May (Table 3). As for sowing dates are concerned fine lint was produced on mid-season sowing of 1st May and coarse lint on the latest-planted date of 16th June with the highest micronaire value of 4.8189 (Table 2). Genotype VH-402 also yielded a fine fibre of 3.8833 micronaire value on 1st May sowing and rough lint on 16th June sowing (Table 3).

Table 3: *Interaction effect of genotypes and planting dates on studied traits during 2020-21.*

Treatments (S×G)		SCY (Kg ha^{-1})	GOT (%)	Staple length (mm)	Staple strength (g tex^{-1})	Micronaire value
1st March (D-1)	VH-351 (V-1)	2523.3 a	37.200 efg	26.263 bcde	35.100 a	4.4933 abcd
	VH-402 (V-2)	1877.7 cdef	39.900 bcde	25.463 bcde	32.967 abcde	4.2667 bcdef
	VH-305 (V-3)	2248.3 abc	39.800 abcd	25.520 bcde	32.467 abcde	4.4133 abcde
16th March (D-2)	VH-351 (V-1)	1531.0 efg	37.700 cdefg	25.747 bcde	32.067 abcdef	4.4400 abcd
	VH-402 (V-2)	1758.0 cdef	38.633 bcdef	26.813 abc	29.967 defg	4.3933 bcde
	VH-305 (V-3)	1399.3 fg	41.100 a	24.673 e	31.533 abcdef	4.1867 cdef
1st April (D-3)	VH-351 (V-1)	2404.0 ab	36.867 efg	25.097 cde	31.933 abcdef	4.0233 def
	VH-402 (V-2)	2164.7 abcd	36.500 fg	28.3800 a	32.067 abcdef	4.3733 bcde
	VH-305 (V-3)	1985.3 bcde	38.500 bcdef	24.760 de	30.200 cdefg	4.3533 bcde
16th April (D-4)	VH-351 (V-1)	1746.0 cdef	36.633 fg	25.717 bcde	30.867 bcdef	4.1300 def
	VH-402 (V-2)	2428.0 ab	38.133 bcdef	25.167 cde	30.900 bcdef	4.6867 abc
	VH-305 (V-3)	1842.0 cdef	38.967 abcde	25.457 bcde	32.767 abcde	4.3233 bcde
1st May (D-5)	VH-351 (V-1)	1495.0 efg	38.133 bcdef	24.660 e	28.133 fg	3.7433 f
	VH-402 (V-2)	1770.0 cdef	38.533 bcdef	25.050 cde	28.900 efg	3.8833 ef
	VH-305 (V-3)	1698.3 defg	35.900g	24.613e	33.567 abcd	4.2700 bcdef
16th May (D-6)	VH-351 (V-1)	1495.0 efg	39.867 abc	24.570 e	26.7 g	4.2833 bcde
	VH-402 (V-2)	1590.7 efg	38.067 bcdefg	27.307 ab	28.133 fg	4.3300 bcde
	VH-305 (V-3)	1219.7 g	38.833 bcde	24.263 e	30.833 bcdefg	4.4700 abcd
1st June (D-7)	VH-351 (V-1)	646.0 h	40.167 ab	25.480 bcde	30.333 bcdefg	4.3867 bcde
	VH-402 (V-2)	682.0 h	37.400 efg	26.757 abcd	31.467 abcdef	4.7900 ab
	VH-305 (V-3)	430.7 h	40.200 ab	25.557 bcde	34.267 abc	4.3300 bcde
16th June (D-8)	VH-351 (V-1)	418.7 h	38.533 bcdef	25.273 cde	29.833 defg	4.7733 ab
	VH-402 (V-2)	209.0 h	37.633 defg	25.667 bcde	33.667 abcd	4.7433 ab
	VH-305 (V-3)	233.0 h	39.733 abcd	24.563 e	34.400 ab	4.9400 a
L.S.D (p≤0.05)	Within date	413.21	1.9276	1.8384	4.3611	0.5564
	Among dates	509.83	2.1993	2.0327	4.1378	0.5373

A continuous search for optimum planting time is the most crucial aspect for scientists because it is directly related to crop production. Climate factors like temperature, relative humidity, rainfall and magnitude of sunshine determine the best sowing time for that particular agro-ecological zone. The alone temperature at sowing time poses a great upshot on seed germination, seedling growth and plant population (Hussain *et al*., 2012). The outcome of this field experiment revealed that wide-ranging planting milieus plus genetic makeup of genotypes had significant sway on lint quantity and quality attributes. The optimum sowing time of cotton is gradually shifting towards the earlier side in south Punjab. In the present study optimum, SCY was obtained on 1st March sowing which is although statistically at par with 1st April sowing. These findings are in line with a conclusion drawn by Niamatullah (2019). Early sown cotton benefits due to escape from cotton leaf curl virus (CLCuD) disease along with encouraging weather situations for flower initiation and boll setting (Ali *et al*., 2009).

A general trend can be seen from this trial data that SCY gradually declined as the sowing was done on later dates (Table 2) except for a clear bend seen in form of lower production on 15th March sowing. The reason behind this is heavy rains at planting time and a thin plant population due to low seed germination. Production was drastically decreased in June sowing regardless of genotypes. The reason was elevated temperature and CLCuV disease infestation due to the abundance of sucking pests at the vegetative growth stage. Ahmed *et al*. (2014) proved that higher temperatures adversely decline the production of cotton. Another factor was short crop duration and cool nights in the coming months which were proved injurious for plant growth and boll filling (Yeates *et al*., 2013). Qamer *et al*. (2016) also stated that increased temperature and pest population pressure are the main reasons for the decline in production of cotton due to late sowing. Saleem *et al*. (2014) pinpointed that temperature stress at the flowering stage was the main cause of reduced SCY in a late sown crop. June sowed cotton (D-7 and D-8) was proved low yielder. A similar trend for June sown cotton was also observed by Ishaq *et al*. (2021).

Lint quality is a key factor and decides the number of counts (yarn length) produced. This trait is linked with the genetic makeup of the cultivars and is rarely altered by management practices adopted during crop husbandry (Bednarz *et al*., 2005). In this study, staple length was found non-significant, while GOT%, micronaire value and staple strength were significant for the sowing dates. These findings are partially in line with Awan *et al*. (2011), who found fibre quality traits non-significant for different planting dates in cotton. The genetic makeup of genotypes and changed climatic factor might be the possible reason behind this contradiction.

Conclusions and Recommendations

Results in this study proved that cotton preferably is sown on the1st March date in south Punjab for optimum SCY and quality lint. Late planting in June was proved uneconomical. Genotype VH-402 produced the highest seed cotton yield with long-staple lint.

Novelty statement

This research unwrapped the opportunity for the farming community to shift the sowing trend towards the earlier side to escape biotic and abiotic stress factors. This shift in sowing will enabled the growers to obtain optimum yield with superior quality lint.

Author's Contribution

Muhammad Jamil: Recorded the data and wrote the initial draft of this manuscript.
Muhammad Ihsan Ullah: Proofread the final draft of this manuscript.
Taj Muhammad: Performed fibre analysis.
Syed Waqar Hussain Shah: Performed the data analysis.
Khezir Hayat: Arranged raw data and prepared tables.
Muhammad Zahid Aslam: Reviewed recent literature.
Abdul Sattar: Performed soil analysis for this study.

Conflict of interest

The authors have declared no conflict of interest.

References

Abbas, S., 2020. Climate change and cotton production: An empirical investigation of Pakistan. Environ. Sci. Pol. Res., 27: 29580-29588. https://doi.org/10.1007/s11356-020-

09222-0

Abro, S., M.T. Rajput, M.A. Khan, M.A. Sial and S.S. Tahir. 2015. Screening of cotton (*Gossypiumhirsutum* L.) genotypes for heat tolerance. Pak. J. Bot., 47: 2085-2091.

Ahmed, D., Z. Tunio, S.Q. Chachar and F.C. Oad. 2014. Impact of sowing dates and picking stages on yield and seed maturity of cotton (*Gossypium hirsutum* L.) varieties. Sarhad J. Agric., 30(4): 404-410.

Ali, A., G.M. Aheer, M. Saleem, Z.U. Shah, M. Ashfaq and M.A. Khan. 2009. Effect of sowing dates on population development of *Helicoverpa armigera* (Hb.) in cotton genotypes. Pak. Entomol., 31: 128-132.

Ali, S., T.M. Khan, A. Shakeel and M.F. Saleem. 2020. Genetic basis of variation for physiological and yield contributing traits under normal and high-temperature stress in *Gossypium hirsutum* L. Pak. J. Agric. Sci., 57(6): 1491-1501.

Awan, H., I. Awan, M. Mansoor, E.A. Khan and M.A. Khan. 2011. Effect of sowing time and plant spacing on fibre quality and seed cotton yield. Sarhad J. Agric., 27: 411- 413.

Bednarz, C.W., W.D. Shurley, W.S. Anthony and R.L. Nichols. 2005. Yield, quality and portability of cotton produced at varying plant densities. Agron. J., 97: 235-240.

Chen, X., D. Min, T.A. Yasir and Y.G. Hu. 2012. Evaluation of 14 morphological, yield-related and physiological traits as indicators of drought tolerance in Chinese winter bread wheat revealed by analysis of the membership function value of drought tolerance (MFVD). Field Crops Res., 137: 195-201. https://doi.org/10.1016/j.fcr.2012.09.008

Conaty, W.C., J.J. Burke, J.R. Mahan, J.E. Neilsen and B.G. Sutton. 2012. Determining the optimum plant temperature of cotton physiology and yield to improve plant-based irrigation scheduling. Crop Sci., 52: 1828- 1836. https://doi.org/10.2135/cropsci2011.11.0581

Devita. P., S.A. Colecchia, I. Pecorella and S. Sai. 2017. Reduced inter-row distance improves yield and competition against weeds in a semi-dwarf durum wheat variety. Eur. J. Agro., 85: 69-77. https://doi.org/10.1016/j.eja.2017.02.003

Elayan, E.D., Sohair, A.M.A. Abdalla, A. Gawad, S.D. Nadia and A.E.F. Wageda. 2015. Effect of delaying planting date on yield, fibre and yarn quality properties in some cultivars and promising crosses of Egyptian cotton. American Eurasian J. Agric. Environ. Sci., 15(5): 754-763.

Fisher, R.A., 1935. The design of experiments. Oliver and Boyd, Edinburgh.

Go Pak (GOP), Economic Survey of Pakistan. 2020. Ministry of Food, agriculture and livestock, Islamabad, pp. 17-22.

Hassan, M.U., M.U. Chattha, L. Barbanti, A. Mahmood, M.B. Chattha, I. Khan, S. Mirza, S.A. Aziz, M. Nawaz and M. Aamer. 2020. Cultivar and seeding time role in sorghum to optimize biomass and methane yield under warm dry climate. Ind. Crops Prod., 145: 1983-1988. https://doi.org/10.1016/j.indcrop.2019.111983

Homer, D.C. and P.F. Pratt. 1961. Methods of analysis for soils, plants and waters. Davis University of California, Davis.

Hussain, M., G. Shabir, M. Farooq, K. Jabran and S. Farooq. 2012. Developmental and phonological responses of wheat to sowing dates. Pak. J. Agric. Sci., 49: 459-468.

Iqbal, M. and M.A. Khan. 2011. Response of cotton genotypes to planting date and plant spacing. Front. Agric. in China, 5: 262-267. https://doi.org/10.1007/s11703-011-1099-x

Ishaq, M.Z., U. Farooq, M.A. Bhutta, S. Ahmad, A. Bibi, H.U. Rehman, U. Farooq, J. Ashraf and S. Nisar. 2021. Effect of sowing dates and genotypes on yield and yield contributing traits of upland cotton (*Gossypium hirsutum* L). Sarhad J. Agric., 38(1): 16-25. https://doi.org/10.17582/journal.sja/2022/38.1.16.25

Kakar, N.U., F.C. Oad, S. Tunio, Q.U. Chachar and M.M. Kandhro. 2012. Response of sowing time to various cotton genotypes. Sarhad J. Agric., 28: 379-385.

Muhsin, M., M. Nawaz, I. Khan, M.B. Chattha, S. Khan, M.T. Aslam, M.M. Iqbal, M.Z. Amin, M.A. Ayoub, U. Anwar, M.U. Hassan and M.U. Chattha. 2021. Efficacy of seed size to improve field performance of wheat under late sowing conditions. Pak. J. Agric. Res., 34(1): 247-253. https://doi.org/10.17582/journal.pjar/2021/34.1.247.253

Niamatullah, S., 2019. Evaluation of yield, yield components and incidence of CLCV disease through planting times and varietal interaction in cotton inthe Multan region. Int. J. Cotton Res. Technol., 1(1): 33-36. https://doi.org/10.33865/IJCRT.001.01.0246

Qamar, R., A. Rehman, H.M.R. Javed, M. Saqib,

M. Shoaib, A. Ali and M. Ali. 2016. Influence of sowing time on cotton growth, yield and fibre quality. Int. J. Biotech., 13(1): 59-67.

Saleem, M.F., M.F. Bilal, S.A. Anjum, H.Z. Khan, M. Sarwar and W. Farhad. 2014. Planting time and N nutrition on cell membrane Thermo stability, bolls' retention and fibre traits in cotton. J. Anim. Plant Sci., 24: 829-837.

Sasser, P.E., 1981. The basics of high-volume instruments for fibre testing. Proc. Belt wide cotton prod. Res. Conf., New Orleans, LA 4-8 Jan., Natl. Cotton Counc. Am., Memphis, TN. pp. 191-193.

Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. Principles and procedures of statistics: A biometrical approach (3rd ed.). McGraw-Hill, New York.

Yeates, S.J., M.F. Kahl, A.J. Dougall and W.J. Müller. 2013. The impact of variable, cold minimum temperatures on boll retention, boll growth and yield recovery of cotton. J. Cotton Sci., 17: 89-101.