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# Performance of *Bt* and non *Bt* cotton cultivars under different sowing environment of south western Punjab

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**ABSTRACT:** A field experiment was conducted at Punjab Agricultural University, Regional Research Station, Faridkot and Bathinda during *kharif* 2017 to evaluate the effects of sowing dates on growth and yield attributes of different cotton cultivars. Three sowing dates *i.e.* April 20, May 10 and May 30were kept in main plots while four cotton cultivars including two non *Bt* (F 2228 and F 1861) and *Bt* cultivars (NCS 855 BGII and RCH 650 BGII) were kept in sub plotsof split plot design replicated thrice. Pooled data analysis for both locations indicated a significant decline in seed cotton yield of all the tested cultivars gradually with each delay in sowing date. Cotton crop sown on April 20 (2947 kg/ha) and May 10 (2727 kg/ha) recorded 29.1 and 7.5 per cent higher seed cotton yield (SCY) as compared to May 30 (2091 kg/ha) sowing. This increase in SCY was mainly attributed to higher growth attributes like leaf area index which lead to improved boll number and better boll weightover late sown crop. Among tested cultivars, *Bt* hybrids *i.e.*, NCS 855 BGII (2997 kg/ha) and RCH 650 BGII (2884 kg/ha) recorded higher seed cotton yield as compared to non *Bt* hybrids *i.e.,* F 2228 (2295 kg/ha) and F 1861 (2177 kg/ha) owing to higher number of bolls/plant and boll weight. Therefore, sowing in April using *Bt* hybrids was found to be the best option for higher seed cotton yield realization in south western Punjab.

**Key words:** *Bt* cultivar, leaf area index, non *Bt* cultivar, seed cotton yield, sowing dates

Cotton, one of the most important fibres, is grown in more than 77 countries covering more than 33 million hectare across a wide range of environments. With one third (12.3 million ha) of the global cotton area, India is world's largest producer (28.5M bales of 480 lb) as well as consumer (24.5M bales) of cotton next to China with a low productivity of 504 kg/ha (Anonymous, 2018a). In Punjab, cotton cultivation is mainly confined to south-western parts of the state with 0.358M ha, 1.26M bales production and 756 kg/ha productivity (Anonymous, 2018b). Cotton yield is a result of genetic, physiological, agronomic and environmental factors. Among important management aspects, sowing time of cotton crop determine the rate of several plant processes like, phenological development, conversion of assimilates into biomass and economic returns. The optimum sowing time is the most important manageable factor for cotton cultivation in a region. Timely sown crop experiences optimum conditions like optimum solar radiation to produce more biomass (Arshad *et al.,* 2017) than late sown crop. Conversely, delayed sowing is exposed to sub optimal and super optimal

temperature during vegetative and reproductive stages. Similarly, late sown crop took lesser days to reach at different phenological stages than normal sowing (Ban *et al.,* 2015).South western cotton belt of Punjab is characterized by semi-arid climate, poor rainfall (400 mm annually) and low soil fertility having cotton wheat as predominant cropping pattern. In cotton wheat cropping system, sowing of cotton is staggered from April to May depending upon the vacation of field after *rabi* crops besides availability of canal water for irrigation. *Bt* cotton hybrids are comparatively early maturing, high yielding and perform better even under late sown conditions than non *Bt* cultivars (Sankaranarayanan *et al.,* 2011). Hence, an experiment was conducted to find out the suitable sowing window and the productivity potential of recently released *Bt* cultivars in two distinct agro climatic zones of the Punjab state.

The field experiment was conducted in two different agroclimatic zones at Punjab Agricultural University (PAU) Regional Research Station(RRS), Faridkot (latitude 30°40' N, longitude 74°44' E, altitude 200m above mean sea level) and at PAU,RRS, Bathinda (latitude 30°58'N, 74°18'E longitude, altitude 211m above mean sea level) during *kharif,* 2017. The experiment comprised of three sowing dates (April 20, May 10 and May 30) in main plots and four cotton cultivars *viz.,* two non *Bt* cultivars (F 2228 and F 1861)andtwo *Bt* hybrids (NCS 855 BGII and RCH 650 BGII) in subplots of split plot design with three replications.The soil of the experimental field at Faridkot was loamy, normal in pH (8.5), EC (0.11), low in OC (0.39%) and at Bathinda it was sandy loam, pH (8.4), EC (0.14), OC (0.38%). The sowing was done by dibbling two seeds/hill, later thinned to one seedling/hill. As per university recommendations, a planting geometry of 67.5×75 cm was kept for *Bt* and 67.5×60 cm for non *Bt* cultivars. A basal dose @30 kg/ha phosphorous was applied to all the treatments and nitrogen was given in two splits *i.e.*first at thinning and remaining at flowering stage @150 kg/ha for *Bt* and @75 kg/ha for non *Bt* cultivars. For weed control, pendimethalin (stomp 30 EC) @ 2.5 l/ha as pre emergence was applied and intercultural operations were carried out using tractor drawn cultivator as per requirement. All the recommended cultural and plant protection measures were givenfollowing standard "Package of Practices for *Kharif* Crops of Punjab" (Anonymous 2018b).For biometric observations five plants from each plot were randomly selected, tagged and averaged to measure the plant height, leaf area index, monopods, sympods and bolls/plant. Leaf area index was recorded using canopy analyzer CI-110 (CID Bio Science, Camas, WA USA) between 1100 and 1400 h. Monopodial (vegetative) and sympodial (fruiting) branches as well as total bolls (opened)/plant were recorded at maturity. Average weight (g) of boll/plot was calculated randomly taking twenty bolls from each plot and then dividing the weight by twenty.The open cotton bolls were picked from the plants in the net plot area and weighed. The yield obtained from five tagged plants was also added to the final yield and yield/ha was worked out based on net plot yield obtained from all pickings.The seed cotton obtained from each plot was mixed and a sample from this composited harvest was taken for ginning. Clean and dry samples of seed cotton were weighed and then ginned separately with a single roller electric gin. The lint obtained from

each sample was weighed and its ginning outturn was calculated by using forth mentioned formula.

**Ginning outturn (%)** = [{(Weight of lint (g))/ (Weight of seed cotton (g)} ×100].

The experimental data were analysed using CPCS I statistical software. Since trends in results were almost similar at both locations, therefore, data were pooled to increase the precision for better interpretation.

**Effect of sowing dates on growth and yield attributes :** Pooled data regarding growth parameters revealed significant variations among sowing dates as well as tested cultivars (Table 1).Significantly taller plants were observed in April 20 (165.2 cm) sown crop along with higher leaf area index (4.58)and monopods/ plant (2.2) than crop sownon later dates. Furthermore, when sowing was delayed from May 10 to May 30, plant height, leaf area index and monopods/plantwere reduced significantly. With each delay in sowing, leaf area index gradually declined and reported significant reduction in canopy surface area to entrap maximum solar radiation in late sown cotton. However, Buttar *et al.,* (2010) observed non significant differences in monopods, sympods and plant height with delay in sowing from April 30 to May 30. As a result of improved vegetative characteristics, early sowing (April 20) exhibited better yield contributing characteristics like., sympods/plant (29.6), bolls/plant (58.3) and higher boll weight (3.59g), while under May 10 sown crop the respective parameters were reduced by 12.8, 16.8 and 3.8 per cent and further delay in sowing under May 30 reduced them by 36.8, 50.6 and 14.4 per cent, respectively (Table 2). Favourable weather conditions lead to improvement in plant height, leaf area index and number of monopods, sympods and higher yield attributes in early sowing environments over later sown crop.Higher seed cotton yield in April sown crop (2947 kg/ha) in present investigations was due to improved number of bolls/plant and boll weight reported higher seed cotton yield in early sown crop primarily due to higher boll number. Similarly, Kumar *et al.,* (2014) reported higher seed cotton yield in early sown crop due to better number of sympods and bolls/plant wasthe decisive character. Maximum reduction in seed cotton yield was observed in May 30 (2091 kg/ha) sown crop *i.e.* 29.1 per cent lower than April 20 (2947 kg/ha). However,when sowing was further delayed from April 20 to May 10 (2727 kg/ha), yield was reduced only 7.5 per cent, which was non significant and in conformity with Singh *et al.,* (2011) who also reported non-significant difference in seed cotton yield with delay in sowing from April 20 to May 10. The trend for lint yield and seed yield also followed the same pattern as that of seed cotton yield and it was reduced by 8.4 and 6.9 per cent in May 10 sown crop and by 35.8 and 25.5 per cent in May 30 sown crop as compared to April 20 sowing. There was non significant difference in ginning outturn between April 20 (33.7%) and May 10 (33.5%) sowing environments though the crop sown on May 30 exhibited statistical least GOT values (30.4%). In late sown crop, duration of different phenological stages was decreased along with the overlapping of vegetative and reproductive growth stages (Herkal and Mummigatti, 2018), a probable reason for low

yield.Present results are in line with the findings of Kumar *et al.,* (2014) who reported significantly higher seed cotton yield for crop sown on April 20 as compared to crop sown May 6, May 18 and June 6 owing to higher sympods and bolls/plant.

**Effect of cultivars on growth and yield attributes :** The data presented in Table 1 revealed that various cotton cultivars varied in terms of growth related characters like, plant height, monopods, sympods/plant and leaf area index. Non-*Bt* cultivars *i.e.* F 2228 and F 1861 recorded higher plant height (153.0-155.1 cm), leaf area index (4.27-4.37) and monopods / plant (2.0-2.2) over *Bt* cultivars. However, sympods/ plant was higher in *Bt* cultivars (26.7-27.6) than non *Bt* cultivars (22.1– 22.4). Other yield contributing characters like, boll/plant and boll weight were also significantly higher in *Bt* cultivars by 18.0 and 21.2 per cent than non *Bt* cultivars in conformity with Gangaiah *et al.,* (2013) who reported higher boll/plant and boll weight and lower plant height and leaf area index in *Bt* cultivars in comparison to non *Bt* varieties. *Bt* cultivar NCS 855 BGII recorded highest seed cotton yield *i.e.* 2997 kg/ha though statistically *at par* with RCH 650 BGII (2884 kg/ha) but significantly higher than F 2228 (2295 kg/ha) and F 1861 (2177 kg/ha). In our investigations, *Bt* cultivars recorded 24.0 per cent higher seed cotton yield over non *Bt* cultivars in line with Nagender *et al.,* (2017) who also observed 27.0 per cent higher seed cotton yield in *Bt* cultivar (MRC 7202 BGII) over non *Bt* hybrid (WGCV 48). Similarly, lint yield (967-1009 kg/ha), seed yield (1917-1989 kg/ha) and ginning outturn (33.4-33.5 per cent) were also higher in *Bt* cultivars over non *Bt* cultivars (Table 2). GOT was also found to be significantly better for *Bt* hybrids as compared to non *Bt* cultivars. Contrarily, Nagender *et al.,* (2017) reported non significant differences with respect to ginning outturn between *Bt* and non *Bt* cultivars.In contrast to our results, Buttar *et al.,* (2010) observed non significant differences for monopods, sympods and bolls/plant and seed cotton yield among tested *Bt* and non *Bt* cultivars. Sankaranarayanan *et al.,* (2011) observed that under normal/timely planting, there was non significant difference between *Bt* and non *Bt* cultivars but with delay in planting there was significant reduction in performance of non *Bt* genotypes. Contrarily Singh *et al.,* (2011) found significant difference in terms of seed cotton yield among tested *G. arboreum* and *G. hirsutum* cultivars mainly due to improved number of sympods, bolls/plant and plant population even if sown on the same dates. Our findings established that *Bt* hybrids outperformed the non *Bt* cultivars in terms of seed cotton yield as well as quality parameters such as GOT, which established their superiority for higher productivity realization.

## CONCLUSION

Results of the present studies confirmed that for better seed cotton yield,second fortnight of April was most suitable sowing time as delayed sowing reduced yield by 7.5 per cent (May 10) and 29.1 per cent (May 30). However, under compelling conditions sowing can be dragged to May10, as there was no significant difference with respect to seed cotton yield. Among tested cultivars, NCS 855 BGII and RCH 650 BGII should be preferred for higher (24.0%) seed cotton yield

**Table 1.** Effect of sowing dates and cultivars on growth parameters of cotton

| Treatments | Plant height (cm) | | | Monopods/ plant | | | Sympods/ plant | | | Leaf area index (120DAS) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FDK | BTI | **Pooled** | FDK | BTI | **Pooled** | FDK | BTI | **Pooled** | FDK | BTI | **Pooled** |
| **Sowing dates** | | | | | | | | | | | | |
| April 20 | 163.3 | 167.1 | **165.2** | 2.2 | 2.2 | **2.2** | 31.1 | 28.1 | **29.6** | 4.70 | 4.47 | **4.58** |
| May 10 | 151.4 | 150.9 | **151.2** | 2.0 | 2.0 | **2.0** | 27.6 | 24 | **25.8** | 4.42 | 4.16 | **4.28** |
| May 30 | 130.2 | 130.8 | **130.5** | 1.7 | 1.8 | **1.7** | 18.4 | 19.1 | **18.7** | 3.76 | 3.75 | **3.75** |
| CD (p=0.05) | 16.2 | 20.1 | **10.7** | 0.3 | NS | **0.2** | 1.9 | 3.1 | **1.5** | 0.18 | 0.19 | **0.10** |
| **Cultivars** | | | | | | | | | | | | |
| F 2228 | 151.8 | 154.1 | **153.0** | 2.5 | 2.6 | **2.5** | 23.1 | 21.8 | **22.4** | 4.35 | 4.17 | **4.27** |
| F 1861 | 156.2 | 154.0 | **155.1** | 2.2 | 2.2 | **2.2** | 23.1 | 21.2 | **22.1** | 4.40 | 4.34 | **4.37** |
| NCS 855 BGII | 144.3 | 144.8 | **144.6** | 1.8 | 1.6 | **1.7** | 28.8 | 26.4 | **27.6** | 4.24 | 4.04 | **4.10** |
| RCH 650 BG II | 140.8 | 145.6 | **143.2** | 1.4 | 1.5 | **1.5** | 27.7 | 25.6 | **26.7** | 4.15 | 3.93 | **4.05** |
| CD (p=0.05) | NS | NS | **NS** | 0.2 | 0.2 | **0.1** | 0.9 | 2.2 | **1.2** | NS | 0.26 | **0.21** |

**Table 2.** Effect of sowing datesand cultivars on yield attributing parameters and seed cotton yield

| Treatments | Bolls/plant | | | Boll weight (g) | | | Seed cotton yield (kg/ha) | | | Lint yield (kg/ha) | | | Seed yield (kg/ha) | | | GOT (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FDK | BTI | **Pooled** | FDK | BTI | **Pooled** | FDK | BTI | **Pooled** | FDK | BTI | **Pooled** | FDK | BTI | **Pooled** | FDK | BTI | **Pooled** |
| **Sowing dares** | | | | | | | | | | | | | | | | | | |
| April 20 | 58.9 | 57.8 | **58.3** | 3.65 | 3.53 | **3.59** | 3006 | 2887 | **2947** | 1020 | 975 | **998** | 1986 | 1912 | **1949** | 33.9 | 33.6 | **33.7** |
| May 10 | 47.3 | 49.8 | **48.5** | 3.43 | 3.47 | **3.45** | 2783 | 2671 | **2727** | 932 | 896 | **914** | 1851 | 1775 | **1813** | 33.4 | 33.5 | **33.5** |
| May 30 | 28.4 | 29.1 | **28.8** | 3.05 | 3.08 | **3.07** | 2130 | 2052 | **2091** | 657 | 623 | **640** | 1472 | 1429 | **1451** | 30.7 | 30.2 | **30.4** |
| CD (p=0.05) | 5.4 | 6.9 | **3.6** | 0.23 | 0.31 | **0.16** | 426 | 319 | **221** | 133 | 117 | **74** | 295 | 203 | **149** | 0.9 | 0.6 | **0.5** |
| **Cultivars** | | | | | | | | | | | | | | | | | | |
| F 2228 | 39.8 | 41.3 | **40.6** | 3.13 | 3.07 | **3.1** | 2376 | 2214 | **2295** | 782 | 719 | **750** | 1595 | 1496 | **1545** | 32.6 | 32.2 | **32.4** |
| F 1861 | 41.0 | 40.9 | **40.9** | 2.86 | 2.82 | **2.84** | 2226 | 2127 | **2177** | 695 | 658 | **676** | 1531 | 1469 | **1500** | 31 | 30.7 | **30.9** |
| NCS 855 BGII | 49.2 | 50.6 | **49.9** | 3.82 | 3.82 | **3.82** | 3027 | 2968 | **2997** | 1012 | 1005 | **1009** | 2015 | 1963 | **1989** | 33.4 | 33.7 | **33.5** |
| RCH 650 BGII | 49.5 | 49.4 | **49.5** | 3.71 | 3.73 | **3.72** | 2930 | 2837 | **2884** | 991 | 943 | **967** | 1939 | 1894 | **1917** | 33.7 | 33.1 | **33.4** |
| CD (p=0.05) | 5.0 | 4.0 | **3.1** | 0.27 | 0.17 | **0.15** | 183 | 224 | **140** | 50 | 79 | **45** | 137 | 146 | **97** | 0.7 | 0.3 | **0.4** |

Where, FDK: Faridkot, BTI: Bathinda and P: Pooled

over non *Bt* cultivars owing to better yield attributes and quality parameters.April sowing of cotton using *Bt* hybrids was found to be best option for higher seed cotton yield for both studied agro climatic zones of Punjab.

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