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Relationships between climatic factors and square, flower and boll production in *Bt* cotton (*Gossypium hirsutum* L.) under rainfed condition

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Abstract
The present field research experiment entitled 'relationships between climatic factors and square, flower and boll production in *Bt* cotton (*Gossypium hirsutum* L.) under rainfed condition' was carried out during *kharif* season 2015-16 at experimental farm, Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani and which was laid out in split plot statistical design with four sowing dates June 16, 2015; June 23, 2015; June 30, 2015; and July 7, 2015 as main plots and three hybrids *viz.*, Mallika, Ajith-155 and Rasi-799 as sub plot with three replications. The flowering stage of cotton was found most sensitive to >30ºC maximum temperature, <20ºC minimum temperature, and its regimes alter the boll development, boll size and the maturity period both decreased as the temperature amplitude increased. And increases the maximum temperature above 32ºC, boll growth decreased significantly and bolls sheds more than 2-3 days after blossoming. The higher temperature coincided with soil moisture stress induced due to midseason and terminal drought, resulted into low conversion mean ratio of flowers (white/yellow + pink/red) to open balls (20%) and squares to open balls (16%). The water stress, higher afternoon relative humidity and daily evaporate rate increase at yield attribute stages, decreased boll retention in plant and decreased seed cotton yield. The significantly highest cotton seed yield was recorded in 24th MW sowing (6.76 q/ha) and which was on par with 25th MW sowing (6.67 q/ha), thereafter, drastically it was reduced by 71.3 and 73.5% in 26th and 27th MW, respectively. The overall mean of all sowing dates recorded lower seed cotton yield observed during this experimental year compared to normal climatic year due to the early, mid season and terminal drought condition.

Keywords: MW, weather factor, cotton, square, flower, ball

Introduction
Cotton is the world's most important fiber crop and the second most oil seed crop. Globally, India is a one of the most important country for natural climatic suitability to grow cotton crop, especially, Central India, comprising the Marathwada and Vidarbha region of Maharashtra, and hence the cotton is a one of the major cash crops of India. Therefore, India having a first position in the world regarding area under cultivation (12.469 M ha), which contributes around 39% of world area (31.88 M ha). Approximately 67% of Indian's cotton is produced from rain-fed cultivation and 33% from irrigated, and 99% area covered by the *Bt* cotton. Though, the India having a top most country in terms of cultivated area in the world, but in terms of productivity, it is on 33rd rank (441 kg/ha) with very low production (around 24%) of the total global cotton production and production (Anonymous, 2024a and Anonymous, 2024b) [4, 5]. It is because of the cotton is a very weather-sensitive in nature due to its C_3 photosynthetic pathway on one side, and another side, the weather of cotton growing belt of India is ever changing during growing season and changing climatic condition (Sawan, 2009, 2013a & 2013b; Jaybhaye *et al.*, 2016) [25, 27, 28, 10]. Cotton plays a major role in sustaining the livelihood of an estimated 6 million cotton farmers and 40-50 million people engaged in related activity such as cotton processing and trade. Thus India's cultivation under *Bt* cotton increased by 3 M ha and 1 M farming families (Anonymous, 2022) [3].
Concern to the Indian climate, the quantity and distribution of rainfall is very erratic and having less predictable, because of the geographic location of the India. Climate extremes like droughts,

cold/heat waves, dust storm, hailstorm, strong and cyclonic winds, heavy and uneven distribution of rainfall, and lesser number of rainy days are increasing day by day (Jaybhaye, 2022) [11]. By the end of the 20th century, global mean annual temperatures had increased by over 0.7 °C from the end of the 19th century and there is at least a greater than 50% likelihood that global warming will reach or exceed 1.5 °C in the near-term, even for the very low greenhouse gas emissions scenario (IPCC, 2021) [9].

In view of the above facts and climatic limitations of decreasing water availability for agricultural crop production, increasing temperature, increasing cyclonic activity and heavy rainfall events in coming days is big challenge to increase productivity of *Bt* cotton under rainfed cultivation. Considering the above facts, the present field experimental study was undertaken and findings of the experiment are discussed in this paper.

Materials and Methods

A field experiment was conducted during *kharif* season 2015-2016 at experimental farm of Department of Agricultural Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to study the correlation between weather parameters and square formation, flowering and boll development in *Bt* cotton. The experiment was laid out in split plot design with four sowing dates (June 16, 2015 - 24thMW (standard meteorological week), June 23, 2015 - 25thMW, June 30, 2015 - 26th MW and July7, 2015 - 27th MW) in main plot and three hybrids i.e. Mallika, Ajit-155 and Rasi-779 in sub plot with three replications. Land preparation was done as per package of practices. Fertilizer were applied to the crop as per recommended dose (80:40:40 kg per ha N:P:K respectively) and half dose of N and entire full dose of P and K was given as basal dose at the time of sowing, while remaining N was given at 45 and 60 DAS as a top dressing in equal quantities. Standard intercultural operations (i.e., weeding, plant protection etc.) were done as per the need.

The emergence count was recorded by counting all emerged plants from each plot on 7 days after emergence. The days required to attain different growth stages; growth and yield attributes were taken from the randomly selected 5 plants of each plot from the all sowing dates and *Bt* hybrid. The plant height and width, number of sympodial branches per plant were recorded form randomly selected each plant (5 plants from each plot) weekly interval w.e.f. 30 DAS, and number of squares, flowers (white + pink/red), bolls per plant of randomly selected each plant (5 plants from each plot) were recorded daily. Squares and flowers on all the selected plants were tagged in order to count and record the number of open flowers, and set bolls, retained number bolls on plant on daily basis.

The total number of 4 pickings were done in all the sowing dates, the seed cotton yield was taken at each picking and which was summarized after last (4th) picking, and biological yield was taken at last picking from each plot of all sowing dates and *Bt* hybrids. The harvest index was calculated as follows: Harvest index (HI) = Yield/DMA, where Yield is seed cotton production (q/ha), and DMA is aboveground biomass dry matter accumulation (q/ha) (Yang *et al*., 2025) [10].

The daily weather (rainfall- RF, rainy days - RD, air maximum temperature - Tmax, minimum temperature-Tmin, morning relative humidity-RH-I, afternoon relative humidity-RH-II, evaporation-Evp, bright sunshine hours- BSS and wind velocity-WV etc.) was obtained during for whole crop grown season of kharif 2015-16from the agrometeorological observatory, which was located 30 m away from the experimental field. The data was recorded at IST, as per prescribed norms by IMD and obtained weather parameters data was converted in the form of mean to growth stages and sowing dates (Table 1).

The whole crop data was taken and processed after 45 DAS for comparison of all parameters amongst the sowing dates, due to there was delay in the germination of 26th and 27th sowing because of not received sufficient rainfall (i.e. dry spell), which would have been non-beneficial for germination and initial growth just after germination.

The recorded data were statistically analyzed by using technique of ANOVA i.e. analysis of variance and significance was determined as given by Panse and Sukhatme (1967) [18]. The statistical analysis correlation coefficient was worked out with the help of computerized designed programme by MS Office Excel Windows 10.

Results and Discussion

Weather observed during experimentation crop growth period

The seasonal and growth phase wise mean weather (*viz.*, RF, RD, Tmax, Tmin, RH-I, RH-II, Evp, BSS and WV etc.) during crop growing season of *kharif* 2015-16 (Table1) shows deficit rainfall 40% during whole crop growing period and 92% during the period of 26th to 30th meteorological week (MW) (i.e. experienced severe early season drought) (Jaybhaye *et al*., 2024) [12].

The sowing of cotton was undertaken as per the experimental preceded sowing dates, during 24th, 25th, 26th, and 27th MW. However, the total rainfall received during crop growth period (i.e. 24th MW to 52th MW) was 381.1 mm in 24 rainy days. The first rain shower of monsoon was received 27.0 mm in 23rd MW and 61.0 mm in 24th MW, and 88.0 mm rainfall was received during a span of 15 days. Which was sufficient to undertake sowing operation in 24th and 25th sowing. While, after 25th MW, the dry spell was experienced during 26th to 30th MW, which was significantly delayed the germination of 26th and 27th MW sowing. Thereafter, good amount of rainfall (267.1 mm) was received during 31st to 38th MW, which was sufficient for germination of sown seed in 26th and 27th MW, and for initial growth of 24th and 25th sowing. However, the severe drought condition was experienced during the reproductive stage and it was continued up to harvest of crop after 38th MW, called as early withdrawal of monsoon. It was directly affected to the seed yield in all the sowing dates, prominently in 26th and 27th MW sowing. In general, during crop growing period, the average weather condition at different phenophases under all the sowings (Table1) was observed favorable, except rainfall and its distribution (RD), and Tmax at square formation to flowering in 24th MW and Tmax and Tmin under 26th and 27th MW sowing at flowering to boll bursting (Jaybhaye *et al*., 2024) [12].

1. Growth attributes

Plant height

Irrespective of the sowing dates and *Bt* hybrids, the mean plant height of cotton crop increased continuously from sowing to harvest of the crop and highest mean height was recorded 56.70 cm at harvest (Table 2a). The similar trend was observed in all the sowing dates and *Bt* hybrids (Fig. 1a and b). The rate of increasing plant height was observed more up to 115 DAS and thereafter it was decreased up to harvest. The continuously increasing height was observed in all the sowing dates because of its indeterminant nature.

Amongst the sowing date, significantly highest plant height (62.75 cm) at harvest and all the growth stages was recorded under 24th MW sowing date, and it was found at par with 25th MW at all the stages, except 66 to 101 DAS, and with 26th MW sowing at 122 DAS to harvest. It was recorded significantly lowest (48.62 cm) at harvest and at all growth stages in 27th MW sowing (Table 2a and Fig1a). The highest plant height was recorded in early sowing dates and decreases as delayed sowing (Fig. 1a), because of observed moisture stress and may be due to recorded Tmax above thermal kinetic window (TKW) during flowering to ball bursting stage under delayed sowing dates. The biomass production is directly related to the amount of time that foliage temperature is within the TKW (Sawan *et al*., 2002) [23], and hence, delayed sowings showed stunted growth and development of plants. On the similar line, results were reported by Awan *et al.* (2011) [6], They found that the cotton plant height was affected significantly by different sowing times.

Alike sowing dates, trend was observed, and exactly similar trend under different *Bt* hybrids was noted (Figure 1b). The significant difference was observed within the *Bt* hybrids (Table 2a) and Ajit-155 recorded significantly highest mean plant height, and at all the growth stages over all the rest of hybrids, except 44 and 51 DAS in Mallika. However, it was found at par with each other at all the growth stages, except at 94 and 101 DAS. The significant difference was recorded in plant height within the *Bt* hybrids due to the difference in genetic characteristics and growing environment. The final plant height is a function of main stem nodes and the seasonal total number of main stem nodes, strongly influenced by determinacy and growing environment. The number of nodes and the length of the internodes are influenced by the genetics and environmental factors such as climate, soil moisture, nutrients, disease and insects. The development rate of a new node is significantly slower when the plant is water stressed. Typically, this produced shorter stature plants (Awan *et al*., 2016). This is in close agreement with the findings of Kerby *et al*. (1986) [13] and Ali *et al.* (2016) [1].

Plant width

The trend of mean plant width is more or less similar to plant height and it was increased continuously from sowing to harvest, and mean width was recorded highest (46.30 cm) at harvest (Table 2b). The similar trend was observed in all the sowing dates and *Bt* hybrids. The rate of increasing plant width was observed more up to 136 DAS, and thereafter it was slightly decreasing up to harvest. The plant width was significantly influenced by different sowing dates, and the highest plant width (60.43 cm) was recorded in 24th MW sowing at harvest and decreases as delayed sowing dates (Figure 2a). Under different sowing dates, the mean and at all growth stages plant width was significantly recorded highest in 24th MW sowing and the lowest in 27th MW sowing (Table 2b and Figure 2a). The significant differences within the sowing dates was recorded may be due to the earlier stated reason (Kerby *et al*., 1986; Ali *et al*., 2016; Jaybhaye *et al*., 2016) [13, 1, 10].

Amongst the hybrids, the trend was found exactly similar and Ajit-155 recorded significantly highest mean plant width and at all the growth stages over all the rest of hybrids except at 45 and 52 DAS. It was found at par with Mallika at all the growth stages except 150 DAS and at harvest (Table 2b and Fig. 2b). Lowest plant width was observed in Rashi-779. The significant differences in plant width was observed may be because of varietal characters of *Bt* cotton. These results are similar with those earlier reported by Kerby *et al*. (1986) [13], Jaybhaye *et al*. (2016) [10].

Sympodial branches per plant

Irrespective of sowing dates and *Bt* hybrids, the mean number of sympodial branches per plant was continuously increased from 45 to 143 DAS, and similar trend seen under date of sowings and *Bt*. Hybrids. The highest mean number of sympodial branches (12.84 per plant) was recorded at 143 DAS. The rate of increasing number of sympodial branches was found more up to 136 DAS, thereafter, decreased up to 143 DAS, and after that, it was constant up to harvest (Table 3a and Figure 3). It might be due to the prevailed varied weather condition, especially temperature, cloud cover and scarcity of soil moisture due to early and mid season drought condition during crop growing period, and which was affected on growth and development of crop. These results are inconformity to the results of earlier researchers (Anonyms, 2016; Wright *et al.*, 2015; Freeland *et al.*, 2004; Jaybhaye *et al*., 2016) [2, 29, 7, 16].

Among the sowing dates, significantly highest mean number of sympodial branches at 143 DAS (15.94 per plant) and at all growth stages were found under 24th MW sowing, and it was found at par with 25th MW sowing at 45, 52 and 129 DAS. The lowest (9.52 per plant) number of branches were recorded under 27th MW sowing (Table 3a and Figure 3a). It was might be due to the fact that the early sown crop has higher growth rate and branching pattern due to availability of soil moisture, congenial temperature and humidity for its vegetative growth. However, in late sown crop the vegetative growth was restricted due to non-congenial weather parameters conditions as stated earlier under the weather prevailed during crop growing season. The results are in conformity with those reported by Patil *et al*. (2009) [20], Wright *et al.* (2015) [29] and Munk (2001) [17].

Alike plant height and width, the trend of number sympodial branches was observed exactly similar in between different *Bt* hybrids (Figure 3b). The significant difference was observed at 80 DAS to harvest of crop, and it was recorded highest number of sympodial branches (12.76 per plant) in Ajit-155 and it was found at par with Mallika at 80 DAS to at harvest (Table 3a and Figure 3b). Significantly lowest number of sympodial branches (12.25 per plant) was recorded in Rashi-779. It may be due to the vari*et al* characters of the *Bt* hybrids and because of the number of sympodial branches, which are influenced by the genetics and environmental factors such as climate, soil moisture, nutrients, disease and insects (Patil *et al*. (2009) [20].

2. Yield attributes

Number of squares per plant

Irrespective of sowing dates and *Bt* hybrids, the general mean number of squares per plant showed continuously increasing from 45 up to 115 DAS and thereafter, it was reduced up to harvest. The highest number of squares per plant (11.13) at 115 DAS and lowest (0.17) i.e. almost not recorded at harvest (last picking) (Table 3b and Figure 4).

Among the sowing dates, the pattern of flowers was not observed similar to general mean (Figure 4a). It may be because of the prevailed varied weather conditions (especially monsoon initiation time and uneven distribution of rainfall during the crop growth period), which was influenced on the number of squares. The 24th MW sowing recorded significantly highest mean number of squares per plant (24) at 65 DAS and at all the growth stages over other date of sowing except 87 to 136 and at harvest. It was found at par with 26th MW at 87, 122, 129, 136 DAS. However, from 45 to 66 DAS, there was not observed squares on plant under 26th and 27th MW sowing due to prevailed severe drought condition just after 26th and 27th MW sowing, and because of this reason, lowest mean number of squares per plant was observed under 27th MW sowing (Table 3b and Figure 4a). It may be due to the experienced the dry spell during the 35th MW and it was coincided with the higher Tmax and Tmin (>30.0^0 C and >20.0 ^{0}C). The temperature range in whole crop growth period was 33.3 ^{0}C (maximum) and 20.4 ^{0}C (minimum). The most of the squares were abort and shed under prevailing temperature above30 ^{0}C (maximum) and 20 ^{0}C (minimum), and cloudy weather also causes temporary increase in rate of square shedding. The recorded low BSS at square formation to ball formation was influenced negatively with number of squares per plant (Table 1 and 4a), it signifies the above assumed facts that the drought stress causes severe shedding of small squares, resulting decreasing number of flowers. This is in close agreement with the results of Freeland *et al*. (2004) [7], they reported that the water stress during the first 14 days after anthesis also leads to ball abscission. Similar results were reported by Mc Michael and Hesketh (1982) [16], Guinn (1982) [8], Reddy *et al.* (1991) [21], Anonyms (2016) and Jaybhaye *et al*. (2024) [12].

Among the *Bt* hybrids, Ajit-155 was found to be significantly highest number of squares per plant over all other remaining hybrids except 45 to 52 DAS. It was found at par with Mallika at 66, 73 and 115 DAS and also at par with Rashi-779 at 66, 136 and 143 DAS (Table 3b and Figure 4b). The lowest mean number of squares per plant was observed in Rashi-779. On the similar line, Sarwar *et al*. (2012) [22] and Jaybhaye *et al*. (2024) [12] reported that the initiation of first square and development squares on plant are temperature and cultivar dependant.

Flowers per plant

The trend of mean number of flowers (white + pink + red) per plant of sowing dates was not observed similar to the *Bt* hybrids (Table 3c and Figure 5). Irrespective of sowing dates and *Bt*. hybrids, it was recorded highest (1.20 per plant) at 59 DAS (Table 3c). The 24th MW sowing showed significantly highest mean number of flowers per plant over all remaining sowings except 59 to 94 DAS, and it was found at par with 25th MW sowing at 122, 143 and 150 DAS. The germination was delayed due to the dry spell (abiotic stress) observed during 26th and 27th MW sowing and hence, squares was not observed in plants at 45 to 66 DAS, and which was expressed in absence of flowers on plant from 45 DAS to 73 DAS (Table 1 and 3c and Figure 5a).

The lowest mean number of flowers per plant was observed at all the growth stages under 27th MW sowing. The lower mean number of flowers per plant was observed at all the growth stages under 26th MW sowing and lowest in 27th MW sowing. It may be due to observed high Tmax (>34.0 ºC) at flowering to boll bursting and low Tmin (<20.0 ºC) during ball formation to boll bursting and low to very low rainfall along with high daily evaporation rate. High evaporation rate could result in water stress would show growth and increase shedding rate of flowers and boll production. This is in close agreement with those reported earlier by Reddy *et al.* (1991) [21], Sawan *et al*. (2002) [23], Freeland *et al*. (2004) [7], Wright *et al*. (2015) [29] and Jaybhaye *et al*. (2024) [12].

Amongst the *Bt* hybrids, mean number of flowers trend was observed exactly similar and the effect of all three *Bt* hybrids on mean number of flowers per plant was not found statistically significant, it may be because of the conversion percentage of total squares number to number of flowers per plant was similar (data is not presented) (Table 3c and Figure 5b).

Bolls per plant

In general, to attain the ball formation stage in *Bt* cotton requires >50 DAS (Jaybhaye *et al*., 2016) [10] and hence, the mean number of bolls per plant was recorded from 59 DAS at weekly interval (Table 3d and Figure 6). The timely germination and initial growth were not observed under 26th and 27th MW sowing, because of dry spell experienced during sowing time, and due to this reason, there was not observed balls on plants up to 87 DAS, hence data was reported 59 to 87 DAS. Compared to congenial environmental condition, under dry spell and soil moisture stress condition, the period required to attain balls in cotton are shorted by one to one and half week (Freeland *et al*., 2004; Jaybhaye *et al*., 2016 and Jaybhaye *et al*., 2024) [7, 10, 12].

The general mean number of bolls per plant was recorded 11 and it showed continuously increasing trend from 59 to 136 DAS, and thereafter decreasing up to harvest (Table 3d and figure 6). The increase in number of bolls rate was decreased after 136 DAS to harvest, it may be due to the exactly similar pattern was noted in number of sympodial branches, and more or less similar to number of squares and flowers per plant (Figure 6a). Amongst the sowing dates, similar pattern was not observed except 26th and 27th MW sowing. In general, the conversion period of square to developed ball is more than 80 days (i.e. >120 DAS) and hence, mean number of bolls per plant reduced after 136 DAS related to reduces no. of squares and flowers per plant after 115 DAS. The sowing dates not followed the similar pattern of general mean, because of the prevailed weather condition during different dates of sowings, which was showed more influence on the number of bolls per plant. The significantly highest no. of balls per plant (15) at 151 DAS and at all crop growth stages was recorded in 24th MW sowing, except, it was found at par with 25th MW sowing at 144, 151 DAS and at harvest; at 130 DAS and harvest with 26th MW sowing (Table 3d). The lowest number of bolls were observed in 27th MW except at 116, 123 and 130 DAS. The number of bolls per plant was significantly decreased as delaying the sowing (Table 3d and Figure 6a). The lower no. of balls retained in 26th and 27th MW sowing. This might be due to the fact that the early sown crop has higher growth rate and branching pattern due to availability of longer soil moisture, temperature and humidity for its vegetative growth. However, in late sown crop the vegetative growth was restricted due to shorter period of soil moisture, higher temperature and lower humidity.

These results agree with reported in past that the high temperature causes male sterility in cotton flowers and increased boll shedding in the late fruiting season and cool temperature (<20.0 ºC) at night slowed boll development (Sawan *et al.*, 2002) [23], Water stress during first 14 days after anthesis leads to ball abscission and it may be due to Tmax observed above TKW during the flowering to boll formation and boll formation to boll bursting stages. It was due to observed dry spell, high ambient Tmax and Tmin below 20.0 ºC. which as may be responsible to hinder ball development under 26th and 27th MW sowings (Guinn, 1998; Mahmood-ul-Hassan, 2003; Freeland *et al*., 2004; Sawan *et al*., 2005; Wright *et al*., 2015; Jaybhaye *et al*., 2016 and Jaybhaye *et al*., 2024) [8, 14, 7, 24, 29, 10, 12].

The number of bolls per plants was influenced significantly by different *Bt* hybrids at all stages of crop growth except from 60 to 74 DAS and it was found significantly highest (14) at 136 DAS in Ajit-155 over the rest of the *Bt*. hybrids except 101 and 108 DAS, and lowest (10) in Rashi-779 at 130 (Table 3d and Figure 6b). It may be due to the initiation of first square and development, its conversion in to flower and ball are weather (*viz.*, RF, RD, Tmax, Tmin, RH-I, RH-II, Evp, BSS) and cultivar dependent (Patil *et al.*, 2009; Freeland *et al*., 2004; Wright *et al*., 2015; Sarwar *et al*., 2012 and Jaybhaye *et al*., 2024) [20, 7, 29, 22, 12].

Yield attributes and its conversion

As delaying the sowing dates decreasing number of sympodial branches, squares, flowers and open bolls, it may due to the mid season and terminal drought condition which was coincided with more temperature than TKW, the Tmax (>30 ºC) and Tmin (<20 ºC) recorded during flowering to boll bursting and boll formation to boll bursting, respectively under 26th and 27th MW sowing (Sawan *et al.*, 2002) [23]. The number of total harvested bolls depends on conversion of one yield attributes in other attributes and its ratio (Table 4) is clearly shows that count of yield attributes mostly affecting on seed yield of the *Bt* cotton and the number of total harvested bolls depends on conversion ratio of squares to flowers to open bolls or squares to open bolls. The conversion ratio explains the retention of number of flowers/bolls and which ultimately reflects into seed cotton seed yield, because, if the conversion ratio of squares to flowers to bolls are higher, than harvest a greater number of bolls.

Irrespective of *Bt* hybrids, as delayed sowings, decreased total mean number of sympodial branches (13), squares (69), flowers (white + pink + red) (57) and bolls per plant (11) and increased conversion ratio with reduction in number of open bolls per plant, but there was found significant difference between conversion ratio of squares to flowers, flowers to open bolls and squares to open bolls under different sowing dates. Highest number of total sympodial branches (16), squares (99), flowers (77) and bolls (15) were recorded under 24th MW sowing and lowest in 27th MW sowings. The highest conversion ratio of square to open bolls and flowers to open bolls was recorded under 24th MW sowing (Table 4). Though the number of squares, flowers and bolls was observed more under 24th MW sowing, the conversion ratio of squares to flowers and square to open bolls was observed lowest, and lower in flowers to open bolls, due to the Tmax was recorded 34.7 ºC at square formation to flowering stage. The conversion ratio of squares to open bolls and flowers to open bolls was observed lowest under 26th and 27th MW, it may due to the Tmax recorded >34.0ºC at flowering to boll bursting stage and Tmin <20ºC boll formation to boll bursting stage. The similar results were repoeted by Sawan *et al*. (2002) [23], Reddy *et al.* (1991) [21], Guinn (1998) [8], Sawan *et al*. (2002) [23], Mahmood-ul-Hassan (2003) [14], Freeland (2004) [7], Sawan *et al*. (2005) [24], Wright *et al*. (2015) [29], Jaybhaye *et al*. (2016) [10] and Jaybhaye *et al*. (2024) [12].

3. Post-harvest studies

The yield attributing characters *viz*., seed cotton yield, stalk yield, biological yield or above ground biomass dry matter and harvest index are taken for post-harvest studies and there was noted almost similar trend under sowing dates in studied all post-harvest parameters.

Seed cotton yield (q ha^{-1})

The seed cotton yield was influenced significantly by different sowing dates and *Bt* hybrids and general mean was observed 4.29 q ha^{-1}. Amongst sowing dates, the significantly highest seed cotton yield was recorded in 24th MW sowing (6.76 q ha^{-1}) and it was found at par with 25th MW sowing. As delay sowings decreases seed cotton yield by 71 and 74 percent under 26th and 27th MW sowing compared to 24th MW sowing (Table 5), it may be because of the recorded lower growth and yield attributes per plant and especially due to reduced number of bolls per plant in delayed sowing time. While, the seed cotton yield depends on boll numbers per plant as well as boll weight. This is in close agreement with the results of Sawan *et al*. (2010) [26] stated that the water stress at pre-flowering, boll formation and at boll bursting reduced yield by 48% compared to the normal rainfall condition. On similar lines, Sawan (2013b) [28] reported in cotton that seed cotton yield was decreased by 50% when water stress was present at flowering stage, slightly decreased by stress at boll formation stage and not significant affected by stress in the vegetative stage. These results are similar with those reported earlier by Mahmood-ul-Hassan (2003) [14], Patil *et al.* (2009) [20], Jaybhaye *et al*. (2016) [10] and Jaybhaye *et al*. (2024) [12].

Among the different hybrids Ajit-155 was found to be significantly highest seed cotton yield (4.87 q ha^{-1}) over rest of hybrids and it was found statistically at par with Mallika, and reduced by 12 percent under Rashi-779 compared to Ajit-155 (Table 5). The highest seed cotton yield observed in Ajit-155 hybrid due to recorded higher growth and yield attributes per plant and its genetically performance may be showed more retention of bolls under such weather condition (i.e. drought condition). These results were found on similar line to reported earlier by Patil *et al.* (2009) [20], Sawan (2013b) [28], Jaybhaye *et al*. (2016) [10] and Jaybhaye *et al*. (2024) [12].

Stalk yield (q ha^{-1})

The stalk yield was influenced significantly by different sowing dates and *Bt* hybrids and general mean was observed 8.69 q ha^{-1}. Amongst sowing dates, the significantly highest stalk yield was recorded in 24th MW sowing (10.56 q ha^{-1}) and it was found at par with 25th MW. Delaying sowing decreases stalk yield by 36 and 34 percent under 26th and 27th MW sowing, compared to 24th MW sowing (Table 5), because of the recorded lower growth and yield attributes per plant. These results are similar with those reported by Mahmood-ul-Hassan (2003) [14], Patil *et al.* (2009) [20], Jaybhaye *et al*. (2016) [10] and Jaybhaye *et al*. (2024) [12].

Among the different *Bt* hybrids Mallika was found to be significantly highest stalk yield (9.8 q ha^{-1}) over rest of hybrids and it was found statistically at par with Ajit-155 and it reduced by 25 percent in Rashi-779, compared to Mallika (Table 5). The highest stalk yield observed in Mallika *Bt* hybrid may be due to recorded low yield attributes and genetical performance of more stalk yield under such weather condition (i.e. drought condition). These results were found on similar line to reported earlier by Sawan *et al.* (2002) [23], Freeland *et al.* (2004) [7], Patil *et al.* (2009) [20], Jaybhaye *et al*. (2016) [10] and Jaybhaye *et al*. (2024) [12].

Biological yield (q ha^{-1})

The biological yield or above ground biomass dry matter was influenced significantly by different sowing dates and *Bt* hybrids and general mean was observed 12.97 q ha^{-1}. Amongst sowing dates, the significantly highest biological yield was recorded in 24th MW sowing (17.32 q ha^{-1})and it was found at par with 25th MW, and lowest biological yield was recorded in 27th MW sowing. Delaying sowing decreases biological yield by 50 percent under 26th and 27th MW sowing compared to 24th MW sowing (Table 5), it was because of the recorded lower growth and yield attributes per plant (Mahmood-ul-Hassan, 2003; Patil *et al.*, 2009; Jaybhaye *et al*., 2016 and Jaybhaye *et al*., 2024) [14, 20, 10, 12].

Among the different *Bt* hybrids Mallika was found to be significantly highest biological yield (14.07 q ha^{-1}) over rest of hybrids and it was found statistically at par with Ajit-155 and reduction by 21 percent in Rashi-779 (Table 5). The highest biological yield observed in Mallika *Bt* hybrid may be due to genetical performance showed more stalk yield under specific weather condition (i.e. drought condition). The results are found on similar line to reported by Patil *et al.* (2009) [20], Jaybhaye *et al*. (2016) [10] and Jaybhaye *et al*. (2024) [12].

Harvest Index (HI)

The HI was influenced significantly by different sowing dates and *Bt* hybrids and general mean was observed 34. Amongst sowing dates, significantly highest HI (39)was recorded in 24th and 25th MW sowing. Delaying sowing decreases HI by 43 and 46 percent under 26th and 27th MW sowing, respectively, and lowest HI was recorded in 27th MW sowing (Table 5). It is because of HI is the product of seed cotton yield and biological yield and it follows the similar trend to the seed cotton yield and biological yield.

Among the different hybrids Ajit-155 was found to be significantly highest HI (35%) over rest of hybrids and it was reduced by 3 and 14 percent in Rashi-779 and Mallika, respectively (Table 5). The highest HI observed in Ajit-155 hybrid due to genetical influence, by which highest seed yield and lower biological yield per plant was obtained (Patil *et al.*, 2009; Jaybhaye *et al*., 2016 and Jaybhaye *et al.*, 2024) [20, 10, 12].

4. Correlation study

In general, the germination of cotton seed observed 4-5 days after sowing (DAS) (i.e. it depends on the sowing method and depth) and square formation attained 30-35 days after emergence (DAE) under ideal weather and soil condition. The present investigation showed that the time required for attaining square formation was ranged between 25-33 and 43-45 DAE (Jaybhaye *et al*., 2016) [10] and hence, the data of squares, flowers and bolls was taken for correlation study w.e.f. 45 DAS (Table 6-8). Significant simple correlation coefficients were estimated between weather parameters and number of squares, flowers (white + pink + red) and bolls for weekly intervals (Table 6-8).

Almost all the weather parameters at 45-66 DAS shows positively significant or highly significant correlation with number squares per plant and negatively significant or negatively highly significant at 73 DAS to at harvest, except rainfall at 101 DAS; rainy days at 80 DAS; maximum temperature at 94 and 129 DAS; mean temperature at 101 DAS and 129 DAS; morning relative humidity at 136 DAS; afternoon relative humidity at harvest; mean RH at 136 DAS evaporation at 94, 108, 129 and 150 DAS; bright sunshine hours at 94 and 108 DAS, which was found positively significant or highly significant correlation (Table 6). Negative correlation may be observed due the received higher rain consecutively in three weeks 36 MW (88.1mm), 37 MW (38.4 mm) and 38 MW (57.4 mm). And which was coincided with cloudy weather or no rain after 38 MW, with higher maximum temperature, morning humidity, wind speed and more evaporation etc., it might be enhanced the more squares sheading than the natural. The similar results are reported by Sawan *et al*. (2010) [26], Sawan (2013a) [27] and Jaybhaye *et al.* (2016) [10].

Alike, squares, all the weather parameters at 45-73 DAS shows positively significant or highly significant correlation with number flowers per plant and negatively significant at 80 DAS except BSS. Thereafter, it was found negatively significant of highly significant Tmin at 94 DAS, RH-I at 108 and 136 DAS, RH-II at 94,136 and 143 DAS, Evp at 122 and 129 and WV at 108 to 129 DAS except Evp and BSS at 87 and 108 DAS; thereafter w.e.f. 115 DAS shows positively significant or highly significant correlation unto harvest except relative humidity (morning afternoon and mean) at 136 DAS, evaporation at 122 and 129 DAS, wind speed at115-129 DAS (Table 7). Negative correlation may be observed due the not received rainfall, higher evaporation, coupled with partially cloudy weather and low wind speed immediate after heavy rainfall (164.5 mm during the period of 36 to 38 MW). Which may be enhanced the more flowers sheading or abortion than the natural. It may be due the reasons stated above and similar correlation coefficients were reported by Sawan *et al*., 2002 [23], Sawan *et al*. (2005) [24], Sawan *et al*. (2009) [25], Sawan *et al*. (2013a) [27] and Jaybhaye *et al*. (2016) [10].

Alike, squares, all the weather parameters Showed more or less similar correlation coefficients at different interval of days and at 59-80 DAS shows highly positive significant correlation with number bolls per plant, and thereafter, it shows highly negative correlation at 87 DAS with all the weather parameters except RH-I, RH-II and BSS, at 94 DAS with Tmax, at 87 to 101 DAS with Evp (Table 8). It may be due to received more rainfall at boll formation to boll bursting stage, which induced higher Evp, more day temperature; after that it shows negative correlation with RH-I, RH-II, Evp and WV, it means that more Evp, higher temperature and lower RH caused reduction in boll numbers (Sawan *et al*., 2010; Sawan, 2013a and Jaybhaye *et al*., 2016) [26, 27, 10]. It means that the negative correlation in between weather parameters and number of balls retained by the plants may observed mostly due to the retained lower number of squares and flowers on plant, it was due to more aborted or dropped balls. And it may be observed due high rainfall was recorded during 36 to 38 MW and their after not received rainfall, higher evaporation, coupled with partially cloudy weather and low wind speed immediate after rainfall and more difference in diurnal temperature.

Table 1: Mean weather condition prevailed during different phenophses of *Bt* cotton (*Gossypium hirsutum* L.) growing season under various sowing dates

Weather Parameters	Sowing Dates	Emergence to square formation	Square formation to flowering stage	Flowering to boll formation	Boll formation to boll bursting	Mean
Rainfall (mm)	24th MW	13.5	22.7	21.8	237.8	295.8
	25th MW	6.8	46.2	12.8	222.0	287.8
	26th MW	148.0	85.8	0.0	1.8	235.6
	27th MW	143.0	91.6	0.6	21.6	256.8
Rainy days (No's)	24th MW	1.0	3.0	2.0	11.0	17.0
	25th MW	1.0	5.0	2.0	12.0	20.0
	26th MW	10.0	4.0	0.0	0.0	14.0
	27th MW	9.0	4.0	0.0	1.0	14.0
Maximum temperature	24th MW	34.8	34.7	30.5	32.1	33.8

(^{0}C)	25th MW	35.8	32.3	30.4	32.2	32.7
	26th MW	32.2	31.9	34.0	34.3	33.1
	27th MW	32.2	32.2	34.1	34.3	33.2
Minimum temperature (^{0}C)	24th MW	24.4	23.8	23.0	22.8	23.5
	25th MW	24.8	23.3	23.7	22.7	23.6
	26th MW	22.9	22.0	20.7	18.4	21.0
	27th MW	22.9	22.0	21.0	18.7	21.2
Relative humidity (morning) (%)	24th MW	75.7	69.4	84.6	83.8	78.4
	25th MW	73.8	79.9	82.1	83.6	79.9
	26th MW	83.8	81.6	73.4	72.3	77.8
	27th MW	83.4	81.5	74.0	72.7	77.9
Relative humidity (afternoon) (%)	24th MW	44.2	51.3	66.0	56.0	54.4
	25th MW	40.5	57.2	63.5	56.3	54.4
	26th MW	55.5	57.3	41.8	31.8	46.6
	27th MW	54.8	56.7	44.7	32.9	47.3
Evaporation (mm day^{-1})	24th MW	8.4	7.6	5.1	5.4	6.6
	25th MW	9.7	6.4	4.2	5.3	6.4
	26th MW	5.4	5.0	7.2	6.7	6.1
	27th MW	5.5	5.2	7.0	6.6	6.1
Bright sunshine hours (hrs. day^{-1})	24th MW	6.2	4.9	3.2	8.2	5.6
	25th MW	7.6	4.5	3.7	6.3	5.5
	26th MW	6.2	5.8	8.3	8.3	7.2
	27th MW	6.3	6.1	8.0	8.3	7.2
Wind velocity (km hr^{-1})	24th MW	8.3	8.3	5.9	5.4	6.9
	25th MW	9.1	7.6	5.9	5.1	6.9
	26th MW	5.5	4.1	4.0	3.9	4.4
	27th MW	5.6	4.1	3.8	3.7	4.3

Table 4: *Bt* Hybrids mean number of yield attributing parameters under different sowing dates

Sowing dates	No. of Sympodial branches plant^{-1}	No. of squares plant^{-1}	No. of flowers (white+pink/red) plant^{-1}	No. of open bolls plant^{-1}	squares to flowers (white+pink/red) (%)	Flowers (white+ pink/red) to open balls (%)	Square to open balls (%)
24th MW	16	99	77	15	78	20	15
25th MW	14	64	54	12	84	22	19
26th MW	12	63	52	10	83	19	16
27th MW	10	51	43	8	84	18	16
Mean	13	69	57	11	82	20	16

Table 5: Seed, Stalk and Biological yield recorded of *Bt* cotton (*Gossypium hirsutum* L.) under various sowing dates and *Bt* hybrids

Treatments	Seed Cotton Yield (q ha^{-1})	Stalk Yield (q ha^{-1})	Biological Yield (q ha^{-1})	Harvest Index
Date of Sowing				
24th MW	6.76	10.56	17.32	39
25th MW	6.67	10.52	17.19	39
26th MW	1.94	6.72	8.66	22
27th MW	1.79	6.93	8.72	21
S.E. ±	0.40	0.71	0.77	1.73
C.D. at 5%	1.39	2.47	2.66	5.15
***Bt* hybrids**				
Mallika	4.26	9.80	14.07	30
Ajit-155	4.87	8.89	13.76	35
Rashi-779	3.73	7.36	11.09	33
S.E. ±	0.21	0.59	0.51	1.12
C.D. at 5%	0.64	1.76	1.53	2.67
D x V Interaction				
S.E. ±	0.42	1.17	1.02	0.45
C.D. at 5%	NS	NS	NS	NS
G.M.	4.29	8.69	12.97	34

Table 2: Mean plant height, Plant width, and number of sympodial branches

Treatments	Days After Sowing															
	45	52	59	66	73	80	87	94	101	108	115	122	129	136	143	150	HT
a) Plant height (cm)																	
Date of sowing																	
S. E.	0.94	0.99	0.67	0.46	1.16	1.94	1.49	2.23	2.36	2.1	2.55	2.43	2.39	1.95	1.93	1.93	1.91
C. D. at 5%	3.25	3.45	2.33	1.61	4.04	6.74	5.18	7.73	8.19	7.3	8.85	8.41	8.28	6.76	6.64	6.64	6.62
***Bt* hybrids**																	
S. E.	0.75	0.72	0.41	0.53	0.58	0.59	0.68	1.09	1.07	1.22	0.97	1.09	1.1	1.02	1.12	1.1	1.09

C. D. at 5%	NS	NS	1.24	1.6	1.74	1.78	2.04	3.29	3.23	3.68	2.91	3.28	3.31	3.06	3.23	3.21	3.20
G. Mean	19.77	23.15	26.27	30.36	34.23	37.19	41.13	44.81	48.26	50.9	52.51	54.05	55.13	56.04	56.65	56.68	56.70
b) Plant width (cm)																	
Date of sowing																	
S. E.	0.73	0.62	1.02	1.18	0.89	1.38	1.42	1.58	1.66	1.99	1.59	1.78	2.06	1.54	1.28	1.36	1.28
C. D. at 5%	2.53	2.14	3.55	4.08	3.11	4.79	4.93	5.47	5.75	6.92	5.52	6.16	7.15	5.34	4.43	4.72	4.45
***Bt* hybrids**																	
S. E.	0.77	0.65	0.64	0.72	0.56	0.64	0.73	1.35	0.61	0.60	0.76	0.60	0.86	1.04	1.13	1.02	1.33
C. D. at 5%	NS	NS	1.92	2.18	1.70	1.92	2.21	4.07	1.85	1.82	2.28	1.82	2.59	3.14	3.41	3.06	3.99
G. Mean	15.97	18.45	21.33	25.14	27.85	30.52	32.52	34.95	36.71	38.75	40.28	41.42	42.70	44.13	44.97	45.70	46.30

Table 3: Number of mean sympodial branches, squares, flowers and bolls per plant under different sowing dates and *Bt*. Hybrids.

Treatments	Days After Sowing															
	45	52	59	66	73	80	87	94	101	108	115	122	129	136	143	150	At Harvest
a) No. sympodial branches per plant																	
Sowing dates																	
S. E.	0.33	0.32	0.38	0.55	0.48	0.36	0.46	0.24	0.40	0.47	0.50	0.47	0.55	0.54	0.53	0.53	0.53
C. D. at 5%	1.16	1.11	1.34	1.93	1.69	1.26	1.59	0.85	1.40	1.63	1.74	1.65	1.90	1.89	1.64	1.64	1.64
***Bt* hybrids**																	
S. E.	0.39	0.29	0.28	0.27	0.31	0.27	0.25	0.29	0.22	0.29	0.30	0.31	0.31	0.37	0.34	0.34	0.34
C. D. at 5%	NS	NS	NS	NS	NS	0.83	0.77	0.87	0.68	0.89	0.90	0.95	0.93	1.11	1.09	1.09	1.09
G. Mean	2.47	2.92	4.94	5.97	6.98	7.79	9.41	10.34	11.14	11.62	12.13	12.32	12.70	12.73	12.84	12.84	12.84
b) Mean Number of squares per plant																	
Sowing dates																	
S. E.	0.10	0.75	0.99	0.53	0.34	0.59	0.84	0.47	1.00	0.73	0.76	0.70	1.31	0.77	0.62	0.69	0.24
C. D. at 5%	0.36	2.6	3.45	1.84	1.19	2.06	2.91	1.65	3.46	2.53	2.65	2.43	4.55	2.68	2.15	2.39	NS
***Bt* hybrids:**																	
S. E.	0.16	0.53	0.55	0.34	0.61	0.90	0.78	0.58	0.76	1.06	1.08	0.9	0.94	0.85	0.71	0.33	0.16
C. D. at 5%	NS	NS	1.07	1.02	1.84	2.71	2.34	1.74	2.29	3.2	3.26	2.72	2.84	2.42	2.13	1.01	0.52
G. Mean	3.3	5.22	6.32	6.92	6.96	6.42	6.32	7.27	9.49	10.35	11.13	10.51	9.52	8.07	5.77	3.09	0.17
c) Mean number of flowers per plant																	
Sowing dates																	
S. E.	0.07	0.16	0.10	0.05	0.18	0.13	0.12	0.23	0.44	0.55	0.01	0.06	0.09	0.09	0.16	0.16	0.0
C. D. at 5%	0.25	0.57	0.36	0.17	0.62	0.46	0.44	0.36	0.25	0.19	0.06	0.23	0.32	0.32	0.55	0.58	0.0
***Bt* hybrids**																	
S. E.	0.07	0.12	0.16	0.14	0.16	0.18	0.16	0.16	0.08	0.07	0.08	0.06	0.08	0.08	0.11	0.1	0.0
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
G. Mean	0.46	1.10	1.20	0.45	1.13	0.87	0.79	0.53	0.41	0.20	0.23	0.25	0.29	0.54	0.35	0.27	0.0
d) Periodical mean number of bolls per plant																	
Sowing dates																	
S. E.			-	-	-	-	-	0.28	0.38	0.64	0.38	0.49	0.90	0.90	0.91	0.85	0.41
C. D. at 5%			-	-	-	-	-	0.98	1.32	2.24	1.34	1.72	3.11	3.12	3.15	2.94	1.43
***Bt* hybrids**																	
S. E.			0.21	0.26	0.29	0.38	0.22	0.25	0.48	0.58	0.42	0.87	0.58	0.70	0.61	0.40	0.52
C. D. at 5%			NS	NS	NS	1.14	0.67	0.76	1.46	1.74	1.28	2.6	1.76	2.12	1.83	1.21	1.57
G. M.			1.36	2.64	3.75	4.36	5.73	7.01	7.94	8.54	9.16	10.65	11.05	11.10	10.84	10.89	8.81

Table 6: Correlation between weather parameters and number of squares per plant

Days after sowing (DAS)	Weather Parameters									
	Rainfall (mm)	Rainy days	Tmax (°C)	Tmin (°C)	T Mean(°C)	RH-I (%)	RH-II (%)	RH Mean	Evp (mm day^{-1})	B.S.S (h day^{-1})	WV (km h^{-1})
45	0.488	0.452	0.991**	0.989**	0.990**	0.982**	0.941**	0.966**	0.986**	0.979**	0.989**
52	0.961**	0.912**	0.969**	0.971**	0.970**	0.968**	0.964**	0.967**	0.939**	0.904**	0.942**
59	0.849**	0.888**	0.889**	0.866**	0.880**	0.877**	0.823**	0.856**	0.886**	0.96	0.817**
66	0.314	0.334	0.698*	0.693*	0.696*	0.664*	0.665*	0.661*	0.747**	0.895**	0.812**
73	-0.598*	-0.593*	-0.577*	-0.141	-0.396	-0.29	-0.926**	-0.946**	-0.072	0.076	-0.353
80	0.529	0.637*	-0.029	-0.841**	-0.427	0.408	0.183	0.256	-0.287	0.125	-0.915**
87	-0.474	-0.536	-0.394	-0.148	-0.779**	-0.464	-0.056	-0.233	0.208	-0.26	0.073
94	-0.703	-0.648*	0.892**	-0.899**	0.704	-0.743**	-0.825**	-0.803**	0.868**	0.784**	-0.384
101	0.763**	0	0.542	-0.477	0.740**	0.105	-0.402	-0.325	0.398	0.02	-0.550
108	-0.726**	0	0.544	-0.439	-0.277	-0.764**	-0.594*	-0.653*	0.801**	0.759**	-0.380
115	0.353	0	-0.354	-0.055	-0.681*	0.344	0.066	0.194	-0.332	-0.412	0.389
122	0	0	0.191	0.088	0.277	-0.223	0.253	0.115	0.392	0.435	-0.465
129	0	0	0.694*	0.216	0.586*	-0.349	-0.737**	-0.749**	0.806**	0.543	-0.566
136	0	0	0.023	0.56	0.545	0.635*	0.575	0.597*	-0.553	0.445	-0.594*
143	0	0	0.538	0.1	0.238	-0.246	-0.151	-0.294	-0.013	-0.690*	0.086
150	0	0	-0.218	-0.532	-0.709**	-0.08	-0.324	-0.213	0.597*	0.562	0.478
At Harvest	0	0	0.197	0.515	0.331	0.285	0.583*	0.42	0.097	-0.192	-0.059

*Significant at 5% level (0.576), **Significant at 1% level (0.708)

Table 7: Correlation between weather parameters and no. of flowers per plant

Days after sowing (DAS)	Weather Parameters									
	Rainfall (mm)	Rainy days	Tmax (°C)	Tmin (°C)	T Mean(°C)	RH-I (%)	RH-II (%)	RH Mean	Evp (mm day^{-1})	B.S.S (h day^{-1})	WV (km h^{-1})
45	0.682*	0.701*	0.531	0.596*	0.560	0.585*	0.667*	0.622*	0.461	0.200	0.663*
52	0.878**	0.793**	0.899**	0.899**	0.899**	0.901**	0.899**	0.900**	0.887**	0.838**	0.886**
59	0.928**	0.928**	0.916**	0.921**	0.918**	0.924**	0.913**	0.920**	0.917**	0.915**	0.938**
66	0.676*	0.748**	0.887**	0.879**	0.883**	0.896**	0.895**	0.897**	0.869**	0.869**	0.816**
73	0.192	0.367	0.578*	0.594*	0.585*	0.557	0.583*	0.568	0.573	0.533	0.672*
80	-0.281	-0.616*	0.437	-0.614*	-0.095	-0.599*	-0.632*	-0.622*	0.575	0.636*	-0.595*
87	-0.476	-0.336	0.520	-0.542	0.286	-0.514	-0.528	-0.527	0.577*	0.417	-0.077
94	0.163	0	0.701*	-0.711**	-0.097	-0.428	-0.655*	-0.623*	0.524	0.458	-0.258
101	-0.361	0	0.324	-0.327	-0.308	-0.340	-0.323	-0.330	-0.318	0.270	0.017
108	0	0	0.503	0.272	0.520	-0.576*	-0.106	-0.332	0.807**	0.797**	-0.715**
115	0	0	0.865**	0.265	0.813**	-0.100	-0.396	-0.321	0.855**	0.749**	-0.703*
122	0	0	0.281	0.712**	0.650*	0.267	0.815**	0.773**	-0.769**	0.125	-0.648*
129	0	0	0.167	0.530	0.597*	-0.441	0.429	0.156	-0.764**	0.047	-0.815**
136	0	0	0.716**	-0.338	-0.018	-0.758**	-0.638*	-0.720**	0.548	0.206	0.480
143	0	0	0.342	-0.495	-0.432	-0.061	-0.636*	-0.497	0.876**	0.003	0.888**
150	0	0	-0.327	0.428	0.319	0.663*	0.392	0.523	0.658*	-0.514	0.616*
Harvest	0	0	0	0	0	0	0	0	0	0	0

*Significant at 5% level (0.576), **Significant at 1% level (0.708)

Table 8: Correlation between weather parameters and no. of bolls per plant

Days after sowing (DAS)	Weather Parameters									
	Rainfall (mm)	Rainy days	Tmax (°C)	Tmin (°C)	T Mean(°C)	RH-I (%)	RH-II (%)	RH Mean	Evp (mm day^{-1})	B.S.S (h day^{-1})	WV (km h^{-1})
59	0.931**	0.971**	0.988**	0.989**	0.988**	0.988**	0.989**	0.989**	0.988**	0.987**	0.988**
66	0.932**	0.900**	0.945**	0.936**	0.941**	0.937**	0.911**	0.927**	0.952**	0.983**	0.910**
73	0.887**	0.766**	0.937**	0.934**	0.936**	0.928**	0.928**	0.928**	0.943**	0.975**	0.955**
80	0.718**	0.738**	0.897**	0.892**	0.895**	0.890**	0.893**	0.892**	0.928**	0.890**	0.891**
87	-0.720**	-0.754**	-0.782**	-0.915**	-0.963**	0.961**	0.938**	0.974**	-0.926**	0.468	-0.983**
94	0.737**	0.688*	-0.844**	0.723**	-0.723**	0.746**	0.856**	0.825**	-0.811**	-0.911**	0.903**
101	0.293	0.175	-0.625*	0.691*	-0.343	0.349	0.514	0.468	-0.567**	-0.52	0.334
108	-0.084	-0.102	-0.504	0.626*	0.492	0.726**	0.618*	0.646*	-0.072	-0.492	0.704**
115	0.558	0	0.369	0.321	0.484	0.494	0.229	0.305	0.782**	-0.158	-0.641*
122	-0.109	0	0.730**	0.497	0.677*	-0.283	-0.006	-0.114	0.680*	0.685*	-0.651*
129	0	0	0.791**	0.698*	0.767**	0.098	0.504	0.454	0.545	0.586*	-0.691*
136	0	0	0.465	0.730**	0.655*	-0.462	0.876**	0.763**	-0.753**	-0.216	-0.632*
143	0	0	0.592*	0.352	0.472	-0.766**	-0.188	-0.599**	-0.608*	0.760**	-0.579
150	0	0	0.816**	-0.481	-0.009	-0.719**	-0.846**	-0.791**	0.878**	-0.267	0.926**
At Harvest	0	0	0.716**	0.736**	0.736**	0.778**	0.764**	0.780**	0.317	-0.531	-0.705*

*Significant at 5% level (0.576), **Significant at 1% level (0.708)

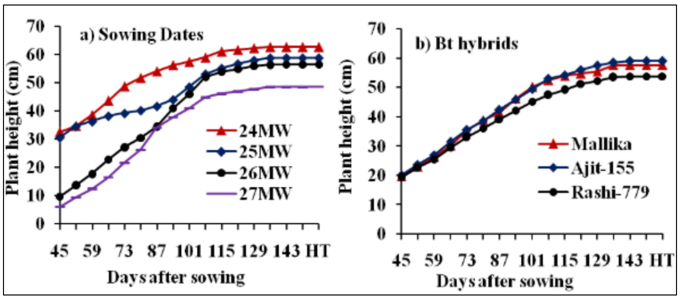

Fig 1: Weekly plant height (cm) of cotton (*Gossypium hirsutum* L.) during plant growth period (a) under different sowing dates and (b) under different *Bt* hybrids

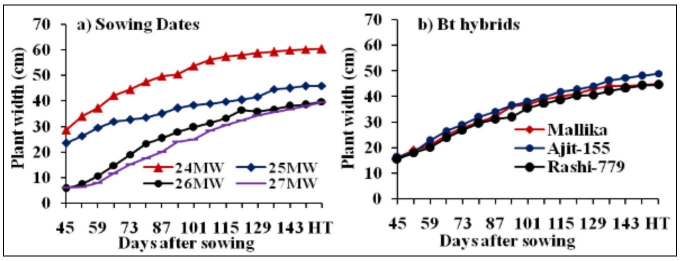

Fig 2: Weekly plant width (cm) of cotton (*Gossypium hirsutum* L.) during plant growth period (a) under different sowing dates and (b) under different *Bt* hybrids

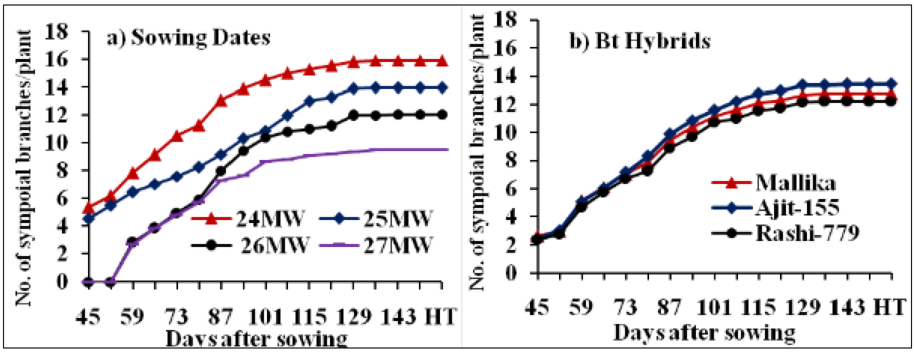

Fig 3: Weekly number of sympodial branches per plant of cotton (*Gossypium hirsutum* L.) during plant growth period (a) under different sowing dates and (b) under different *Bt* hybrids.

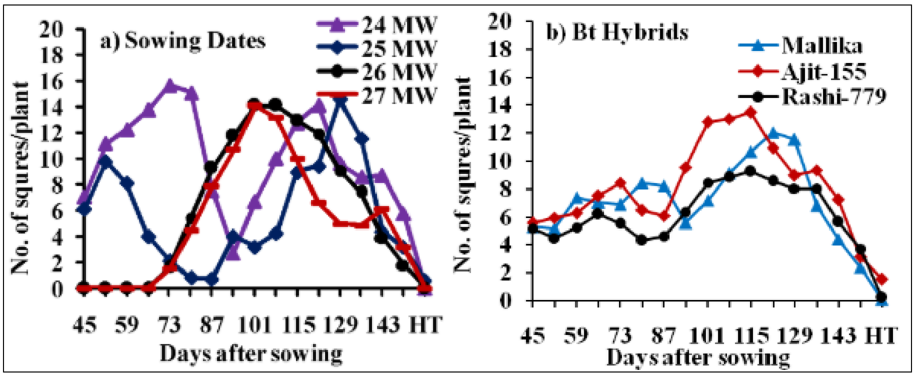

Fig 4: Weekly number of squares per plant of cotton (*Gossypium hirsutum* L.) during plant growth period (a) under different sowing dates and (b) under different *Bt* hybrids.

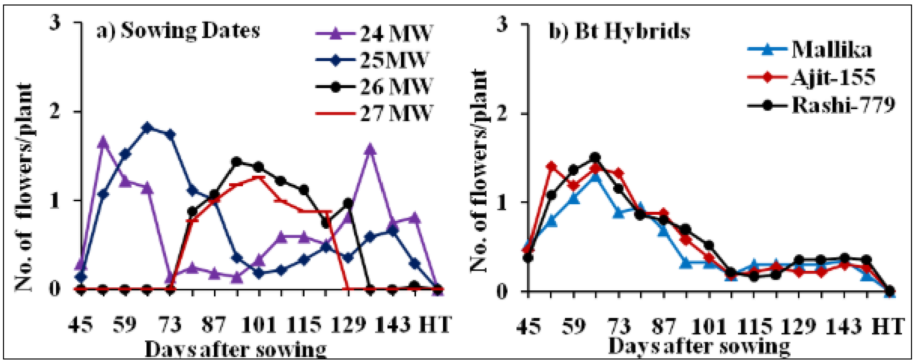

Fig 5: Weekly number of flowers (Yellow+Pink+Red) per plant of cotton (*Gossypium hirsutum* L.) during plant growth period (a) under different sowing dates and (b) under different *Bt* hybrids.

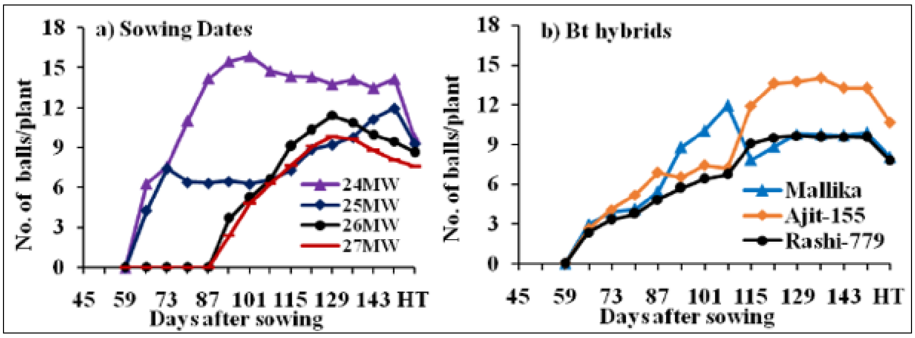

Fig 6: Weekly number of balls per plant of cotton (*Gossypium hirsutum* L.) during plant growth period (a) under different sowing dates and (b) under different *Bt* hybrids

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