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***Short Communication***

# A comparative assessment of crop phenology, agrometeorological indices and yield of Bt and non-Bt cotton in Akola, Maharashtra

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Cotton production has influenced the economic development of many nations throughout the world. The area under Bt cotton increased from a mere 0.05 million hectare during 2002-03 to 11.6 million hectare in 2013-14 which account 94.6 per cent of cotton area (Choudhary and Gaur, 2015).The agronomic performance of Bt cultivars may vary substantially from their non-Bt counterparts (Jenkins *et al*., 1997).Taking into consideration the above aspects, it was felt necessary to conduct the experiment to evaluate the Bt cotton hybrid for its morpho-phenological event, agrometeorological indices and yield in relation to agronomical intervention over its non-Bt version.

The field experiment was conducted at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *kharif* seasons of 2008-2009 and 2009-2010.The experimental site was situated at 307.4 meters above the mean sea level at 22°42' N latitude and 77°02' E longitude and has subtropical continental climate. The weather data was recorded from meteorological observatory of the university.The observations on number of days to attain various morpho-phenological events *viz*. appearance of first true leaf, appearance of first bud, appearance of first flower and first boll split were recorded once the50 per cent plants have attained that particular phenophase in each replication. Whereas, mean maturity dates were computed according to method given by Christides and Harrison (1955). Seed cotton from each net plot was weighed separately as per treatments at each picking and added to obtain the total yield. Biological yield was obtained by summing up seed cotton and stalk yield after the last picking. The various heat units were calculated as follow.

$$\text{Growing degree days (GDD)} = \sum_{a}^{b} \left[\left(T_{\max} + T_{\min}\right)/2\right] - T_b$$

$$\text{Helio thermal unit (HTU)} = \sum_{a}^{b} \left( GDD \times b\text{right sunshine hours} \right)$$

$$\text{Phenothermal Index (PTI)} = \frac{\text{Degree day consumed}}{\text{Number of days}}$$

$$\text{Heat use efficiency (HUE)} = \frac{\text{Seed yield or biological yield}}{\text{Accumulated heat units}}$$

***Crop phenology and heat units***

Perusal of data (Table 1) showed that, cotton hybrids had significant differences in calendar days and GDD to attain a particular phenological stage, except appearance of first true leaf. Bt cotton hybrid was significantly earlier in respect of appearance of first bud, appearance of first flower, days to first boll split and to attain mean maturity than the non-Bt.

Bt cotton hybrid required significantly less degree days to attain a definite stage of growth and development, except appearance of first true leaf compared to non-Bt (Table 1).The changes in morphological, phenological and physiological characteristics of Bt cultivar in comparison to their non-Bt counterpart was earlier reported by Chen *et al*., (2002) and Nawalkar *et al*., (2015).

Cotton hybrids differed significantly in accumulation of heliothermal units to attain a definite stage of growth and development (Table 1). Bt cotton hybrid required significantly lesser heliothermal unit for the appearance of first bud, appearance of first flower, first boll to split and to reach mean maturity than the non-Bt. Bt cotton accumulated 8591 HTUs from sowing to attain mean maturity as compared to non-Bt (9273HTUs).

***Phenothermal index***

The phenothermal index (PTI) which gives an account of degree days accumulated per growth day for consecutive phenophases is presented in Table 1. The Bt cotton recorded significantly higher PTI value for appearance of first bud, boll split and to attain mean maturity, whereas, for appearance

**Table 1:** Days taken to attain different phenophases, GDD accumulation, heliothermal units (HTU) and phenothermal index (PTI) as influenced by Bt and non-Bt cotton hybrids (pooled data: 2008-09 and 2009-10)

| Cotton hybrids | Appearance of first true leaf | Appearance of first bud | Appearance of first flower | First boll split | Mean maturity |
|---|---|---|---|---|---|
| | | | **Days taken** | | |
| $V_1$ Bt Cotton | 13.4 | 32.6 | 45.4 | 91.8 | 163.6 |
| $V_2$ Non-Bt Cotton | 13.5 | 35.8 | 48.7 | 104.6 | 180.5 |
| S. E. (m) ± | 0.10 | 0.12 | 0.16 | 0.61 | 2.03 |
| C. D. at 5% | NS | 0.39 | 0.50 | 1.95 | 6.48 |
| | | | **GDD (°C day)** | | |
| V1 Bt Cotton | 170 | 404 | 557 | 1116 | 1733 |
| V2 Non-Bt Cotton | 171 | 439 | 597 | 1263 | 1850 |
| S. E. (m) ± | 1.30 | 1.4 | 1.7 | 6.7 | 12.2 |
| C. D. at 5% | NS | 4.6 | 5.7 | 21.5 | 39.1 |
| | | | **HTU (°C day hour)** | | |
| $V_1$ Bt Cotton | 560 | 1275 | 1678 | 4416 | 8591 |
| $V_2$ Non-Bt Cotton | 560 | 1338 | 1809 | 5523 | 9273 |
| S. E. (m) ± | 3.9 | 4.0 | 5.9 | 52.6 | 70.3 |
| C. D. at 5% | NS | 12.9 | 18.8 | 168.4 | 225.0 |
| | | | **PTI** | | |
| V1 Bt Cotton | 12.6 | 12.2 | 11.8 | 12.0 | 8.8 |
| V2 Non-Bt Cotton | 12.6 | 12.0 | 12.0 | 11.9 | 7.7 |
| S. E. (m) ± | 0.00 | 0.01 | 0.01 | 0.01 | 0.07 |
| C. D. at 5% | NS | 0.02 | 0.03 | 0.03 | 0.24 |

**Table 2 :** Seed cotton yield, biological yield, heat use efficiency and production rate index of Bt and non-Bt cotton(pooled data: 2008-09 and 2009-10)

| Treatments | Seed cotton yield (kg ha$^{-1}$) | Biological yield (kg ha$^{-1}$) | HUE on seed cotton yield basis (kg ha$^{-1}$°C day$^{-1}$) | HUE on biological yield basis (kg ha$^{-1}$°C day$^{-1}$) |
|---|---|---|---|---|
| $V_1$ Bt Cotton | 1019.6 | 2208.0 | 0.591 | 1.281 |
| $V_2$ Non-Bt Cotton | 900.3 | 2433.8 | 0.487 | 1.316 |
| S. E. (m) ± | 13.2 | 33.2 | 0.008 | 0.023 |
| C. D. at 5% | 42.22 | 106.43 | 0.026 | NS |

of first flower non-Bt cotton recorded higher PTI. The higher PTI value in case of Bt cotton hybrid for appearance of first bud, boll split and to attain mean maturity could be ascribed to the least number of days taken to attain particular phenophase.

***Yield and heat use efficiency***

The Bt cotton recorded significantly highest seed cotton yield than the non-Bt cotton (Table 2). The increased seed cotton yield in Bt cotton might be attributed to better fruiting efficiency, efficient source-sink relationship, early maturity and in-built resistance to bollworms. The higher yield advantage in majority of Bt cotton hybrids over non-Bt cotton were observed by Buttar and Singh (2006) and Patil *et al*. (2009). On the contrary, non-Bt cotton recoded significantly higher biological yield which may happen owing to loss of fruiting bodies due to bollworm which

**Table 3 :** Correlation coefficient between seed cotton yield and agro-meteorological indices at different morpho-phenological events

| Parameters | Seed cotton yield |
|---|---|
| GDD at appearance of first bud | -0.474** |
| GDD at appearance of first flower | -0.486** |
| GDD at first boll split | -0.527** |
| GDD at mean maturity | -0.478** |
| HTU at appearance of first bud | -0.431** |
| HTU at appearance of first flower | -0.472** |
| HTU at first boll split | -0.526** |
| HTU at mean maturity | -0.482** |

(** Correlation is significant at 0.01 level)

impart indeterminateness in non-Bt cotton. As regard HUE on seed cotton yield basis Bt cotton recorded higher value for this over non-Bt cotton. This was due to the significantly higher seed cotton yield and early maturity in Bt cotton over the non-Bt. However HUE on biological yield basis remained unaffected.

***Correlation analysis***

The correlation between seed cotton yield and different agro-meteorological indices (Table 3) shows that seed cotton yield significantly but negatively correlated with accumulation of GDD and HTU at different phenophases. This indicates that under rainfed condition where moisture is the limiting factor during later stages of growth and development, the lesser GDD and HTU accumulations to attain particular phenophase and earlier the maturity more will be the contribution towards seed cotton yield.

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