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Study of agrometeorological indices in different cotton genotypes

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Abstract

A field investigation entitled “Study of Agrometeorological indices in different cotton genotypes” was conducted at Research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* season of 2024-2025. Six treatments (cotton genotypes) such as V₁ (Yugank Bt), V₂ (Suraj Bt), V₃ (PKV 081 Bt), V₄ (NH 615), V₅ (AKH 9916) and V₆ (AKH 09-5) were laid out in randomised block design with four replications. Among the six genotypes studied, growing degree days, photothermal units, heliothermal units, thermal use efficiency and canopy temperature depression were found to be higher with Suraj Bt and followed by PKV 081 Bt and AKH 09-5. Suraj Bt recorded lowest canopy temperature, indicating comparatively lower degree of field-scale plant water stress in this genotype compared to other genotypes.

Keywords: Cotton genotypes, agrometeorological indices, growing degree days

Introduction

Cotton (*Gossypium* spp.) stands as one of the most important commercial crops in India, with substantial economic significance. In India area under cotton during 2024-25 was 112.94 lakh ha as against 123.70 lakh ha in 2023-24 during the previous year. Among the states, Maharashtra is leading in cotton acreage with 40.86 lakh ha followed by Gujarat (23.66 lakh ha), Telangana (17.70 lakh ha), Karnataka (6.84 lakh ha) and Madhya Pradesh (6.14 lakh ha). (Anonymous, 2025) ^[1]. Cotton crop is estimated at 299.26 lakh bales as compared to 325.22 lakh tonnes in 2023-24. Among the states, Maharashtra is leading in cotton production with 84.80 lakh bales followed by Gujarat (80.01 lakh bales), Telangana (48.95 lakh bales), Rajasthan (20.42 lakh bales) and Karnataka (18.56 lakh bales). (Anonymous, 2025) ^[1]. Its growth and development are highly sensitive to temperature, which plays a critical role in regulating physiological processes and determining the timing of phenological events. To evaluate the influence of thermal conditions on crop growth and yield, agrometeorological indices such as accumulated heat units are commonly employed. In Maharashtra, where cotton is cultivated under both *rainfed* and irrigated conditions, productivity is often affected by climatic variability, soil characteristics, and management practices (Kadam and Dakhore., 2019) ^[5]. The current study was undertaken to evaluate the performance of Bt and non-Bt cotton genotypes in response to climatic factors, particularly in terms of yield outcomes. Canopy temperature, a key physiological indicator, serves as a useful tool in identifying genotypic tolerance to drought stress. It is influenced by transpiration driven cooling and provides insight into plant water status. A lower canopy temperature relative to ambient air temperature quantified as canopy temperature depression (CTD) is generally associated with better hydration and greater stress resilience (Karunakar *et al.*, 2018) ^[6]. Understanding how climatic parameters such as temperature, growing degree days (GDD), heliothermal units (HTU), photothermal units (PTU), and canopy temperature affect the performance of different cotton genotypes can enhance selection for thermal use efficiency, particularly under dryland farming systems.

Materials and Methods

A field investigation was carried out at Research field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *kharif* season of 2024-25. Six

treatments (cotton genotypes) such as V₁ (Yugank Bt), V₂ (Suraj Bt), V₃ (PKV 081 Bt), V₄ (NH 615), V₅ (AKH 9916) and V₆ (AKH 09-5) were laid out in randomised block design with four replications. The soil of experiment site was clayey in texture. Cotton crop was sown on 3rd July, 2024. Total rainfall of 881.4 mm was recorded during the crop growing season. Meteorological data viz, rainfall, maximum and minimum temperature, bright sunshine hours and day length were recorded from Agrometeorological observatory, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The Agrometeorological indices such as growing degree days (GDD), photothermal units (PTU), heliothermal units (HTU), thermal use efficiency (TUE) were calculated using following formula:

Agrometeorological indices

Growing degree days (°C day)

GDD across each phenophase were added together so as to obtain GDD i.e. thermal requirement in °C day during that phenophase in each treatment. Further total GDD or thermal unit requirement over crop period under each treatment was calculated by summation (Waghmare and Singh., 2017).^[13]

The GDD was computed by summing the daily mean temperature recorded during period of crop growth stages by following formula,

$$\text{GDD} = \frac{(T_{\text{max}} + T_{\text{min}})}{2} - \text{Base temp.}$$

Base temperature is the temperature below which the physiological activities in the plant practically ceases and as a result plant does not show any growth. It is considered as 15 °C for cotton crop (Kadam and Dakhore., 2019)^[5].

Photothermal unit (°C day hrs)

Photothermal units were accumulated from date of sowing to particular date of phenophase and from that accumulated PTU for each phenophase and total PTU over crop period in each treatment were computed. Photothermal unit required was computed by formula, (Deshmane *et al.*, 2022)^[2].

Photothermal unit = GDD x day length (hrs)

Heliothermal unit (°C day hrs)

Heliothermal units were accumulated from date of sowing to particular date of phenophase and from that accumulated HTU

for each phenophase and total HTU over crop period in each treatment were computed. Heliothermal unit required was computed by formula, (Prakash *et al.*, 2015)^[11].

Heliothermal unit = GDD x bright sunshine hours (hrs)

Thermal use efficiency (kg ha⁻¹ °C day⁻¹)

Thermal use efficiency (kg ha⁻¹ °C day⁻¹) of crops in terms of seed cotton yield and biological yield was computed treatment wise by dividing seed cotton yield and biomass yield by corresponding accumulated thermal units of the treatment (Karunakar *et al.*, 2018)^[6].

$$\text{Thermal use efficiency} = \frac{\text{Seed cotton yield or Biological yield (kg ha}^{-1}\text{)}}{\text{Accumulated thermal units (}^{\circ}\text{C day}^{-1}\text{)}} \times 100$$

Canopy temperature (°C) and canopy temperature depression

Infrared thermometer was used to record the canopy temperature (CT) of crop. The observations were recorded at different phenophases of crop. Canopy temperature depression (CTD) is difference between air temperature and canopy temperature and it is positive (more) when the canopy is cooler than the air (Karunakar *et al.*, 2018)^[6].

Results and Discussion

Growing degree days (GDD)

The data presented in Table 1 indicate that cotton genotypes accumulated an average of 1499 °C days (GDD) during their life cycle, calculated at a base temperature of 15.0 °C. The accumulation of GDD for each phase varied among different genotypes, reflecting genotypic differences in thermal time requirements. Among the different cotton genotypes evaluated, the maximum thermal units were accumulated by Suraj Bt (V₂) (1532 °C day) to complete all phenophases, indicating a longer growth duration compared to other cotton genotypes and this is followed by PKV 081 Bt (V₃) (1525 °C day) and AKH 09-5 (V₆) (1525 °C day). Genotype Yugank Bt (V₁) accumulated the least growing degree days. These differences suggest that Suraj Bt (V₂) had relatively longer developmental durations or slower physiological progress under similar temperature regimes, possibly contributing to differences in growth and yield outcomes. Genotypic differences in GDD also reported by Waghmare and Singh (2017)^[13] and Deshmane *et al.* (2022)^[2].

Table 1: Accumulated growing degree days (°C day) across various phenophases as influenced by different treatments

Treatments	Growing degree days (°C day)						
	Emergence	First Square	First Flower	First Boll Burst	First Picking	Last Picking	Total GDD
V ₁ -Yugank Bt	84	343	194	446	174	203	1443
V ₂ -Suraj Bt	74	454	197	506	105	195	1532
V ₃ -PKV 081 Bt	74	419	203	507	118	204	1525
V ₄ -NH 615	74	363	200	473	137	246	1494
V ₅ -AKH 9916	84	377	188	439	162	226	1476
V ₆ -AKH 09-5	74	442	201	497	108	204	1525
GM	77	400	197	478	134	213	1499

These results reinforce the influence of genotype on thermal time use and the importance of genotype selection for optimizing crop development under specific growing conditions.

Photothermal Units (PTU)

Photothermal Units (PTU), expressed in °C day hours, represent the cumulative heat energy utilized by a crop during daylight

hours. The PTU accumulated by different cotton genotypes throughout their life cycle varied, reflecting genotypic differences in thermal and photoperiodic responses.

The data presented in Table 2 shows that the mean PTU accumulation among the genotypes was 18051 °C day hours. Among the genotypes studied, Suraj Bt (V₂) recorded the highest PTU accumulation (18387 °C day hours), indicating a

longer duration or greater heat energy utilization during development. It was followed by PKV 081 Bt (V₃) (18318 °C day hrs) and AKH 09-5 (V₆) (18318 °C day hrs). In contrast, genotype Yugank Bt (V₁) recorded lower PTU values (17452 °C day hours), suggesting a comparatively shorter or less energy

demanding growth cycle. Waghmare *et al.* (2016) ^[12], Waghmare and Madho Singh (2017) ^[13] and Kadam and Dakhore (2019) ^[5] reported that the photothermal units were significantly influenced by different Bt hybrids.

Table 2: Accumulated photothermal unit (°C day hrs) across various phenophases as influenced by different treatments

Treatments	Photothermal unit (°C day hrs)						
	Emergence	First Square	First Flower	First Boll Burst	First Picking	Last Picking	Total PTU
V ₁ -Yugank Bt	1100	4435	2400	5294	1972	2250	17452
V ₂ -Suraj Bt	975	5826	2423	5885	1177	2101	18387
V ₃ -PKV 081 Bt	975	5394	2505	5921	1317	2206	18318
V ₄ -NH 615	975	4695	2510	5558	1567	2732	18037
V ₅ -AKH 9916	1100	4856	2326	5193	1830	2486	17791
V ₆ -AKH 09-5	975	5672	2467	5794	1204	2206	18318
GM	1017	5146	2438	5608	1511	2330	18051

These results indicate that Suraj Bt (V₂) may require more photothermal energy for completing their phenological stages, which could be associated with extended growth duration, possibly supporting higher biomass accumulation or yield under favorable conditions. The differences in PTU accumulation among the genotypes also reflect their adaptability to specific environments and provide insights for genotype selection based on thermal and light energy use efficiency.

Heliothermal unit (HTU)

Heliothermal units (HTU) required to attain different

phenological stages presented in Table 3. Among genotypes, Suraj Bt (V₂) required more heliothermal units (7068 °C day hrs) for the entire crop growth period. It was followed by PKV 081 Bt (V₃) (7028 °C day hrs) and AKH 09-5 (V₆) (7028 °C day hrs). Comparatively longer growth duration of crop coupled with greater sunshine hours for the respective genotype caused higher accumulation of HTU. Genotype Yugank Bt (V₁) accumulated the least heliothermal units. This result is in line with Prakash *et al.* (2017) ^[8] and Premdeep *et al.* (2017) ^[9].

Table 3: Accumulated heliothermal unit (°C day hrs) across various phenophases as influenced by different treatments

Treatments	Heliothermal unit (°C day hrs)						
	Emergence	First Square	First Flower	First Boll Burst	First Picking	Last Picking	Total HTU
V ₁ -Yugank Bt	309	572	638	2311	745	1974	6550
V ₂ -Suraj Bt	273	1027	544	3127	835	1262	7068
V ₃ -PKV 081 Bt	273	879	598	2993	951	1335	7028
V ₄ -NH 615	273	699	553	2643	949	1697	6814
V ₅ -AKH 9916	309	772	444	2454	1138	1616	6733
V ₆ -AKH 09-5	273	939	632	2975	875	1335	7028
GM	285	815	568	2750	915	1537	6870

Thermal use efficiency

Thermal use efficiency was computed with respect to seed cotton yield and biological yield production. Thermal use efficiency (TUE), is the conversion of heat energy into dry matter and economic yield (e.g., seed cotton yield or lint yield) and depends on crop type and genetic factors. Relevant data presented in Table 4. The mean thermal use efficiency was 1.06 and 2.82 (kg ha⁻¹ °C day⁻¹), respectively in terms of seed cotton yield and biological yield.

Thermal use efficiency was found to be higher in genotype Suraj Bt (V₂) with respect to both seed cotton yield and biological yield. It was followed by genotype PKV 081 Bt (V₃) and AKH 09-5 (V₆). Thermal use efficiency was found to be least in genotype Yugank Bt (V₁). This result is in line with Prakash *et al.* (2017) ^[8], Nandini and Sridhara (2019) ^[7] and Engonopoulos *et al.* (2025) ^[4].

Different cotton genotypes exhibit varying abilities to utilize thermal time. High TUE indicates superior physiological efficiency and better adaptation to the thermal environment. This efficiency is critical for understanding the genotypic adaptability and yield potential of cotton under diverse agroclimatic conditions.

Table 4: Thermal use efficiency in terms of seed cotton yield and biological yield (kg ha⁻¹ °C day⁻¹) as influenced by different treatments

Treatments	Thermal use efficiency (kg ha ⁻¹ °C day ⁻¹)		
	Seed Cotton Yield	Biological yield	Mean
V ₁ -Yugank Bt	0.84	2.33	1.58
V ₂ -Suraj Bt	1.23	3.20	2.22
V ₃ -PKV 081 Bt	1.17	3.05	2.11
V ₄ -NH 615	1.06	2.80	1.93
V ₅ -AKH 9916	0.92	2.55	1.74
V ₆ -AKH 09-5	1.13	2.96	2.04
GM	1.06	2.82	

The use of thermal use efficiency indices offers a foundation for assessing the combined impact of temperature, radiation, and photoperiod on the phenological development of crops. These indices help to determine how efficiently crops utilize heat energy under varying environmental conditions. Total heat energy available to any crop is never completely converted to dry matter even under most favourable agro climatic conditions.

Canopy temperature and Canopy temperature depression

Canopy temperature measurements have been widely used in

recent years to study genotypic response to drought. The disparity between canopy and ambient air temperatures can serve as an indirect indicator of plant hydration levels. Cooler CT is favourable for higher yield and this association is stronger and more consistent under heat/moisture stress. Data on canopy temperature (CT) recorded periodically are presented in Table 5. Among the genotypes studied, Suraj Bt (V₂) consistently exhibited the lowest canopy temperature (CT) and the highest canopy temperature depression (CTD) across all stages of observation. This indicates a comparatively lower degree of plant water stress at the field scale, suggesting greater environmental stress tolerance in Suraj Bt (V₂) compared to other genotypes. These findings align with Karunakar *et al.* (2018) ^[6], who reported that crop varieties with lower canopy temperatures tend to have higher yields.

Table 5: Canopy temperature (°C) and canopy temperature depression as influence by different treatments

Treatments	60 DAE		90 DAE		120 DAE	
	CT	CTD	CT	CTD	CT	CTD
V ₁ -Yugank Bt	28.1	3.1	31.2	2.6	33.1	0.1
V ₂ -Suraj Bt	25.9	3.9	30.3	3.3	32.4	1.8
V ₃ -PKV 081 Bt	26.1	3.7	30.4	3.2	32.5	1.7
V ₄ -NH 615	26.5	3.3	30.8	2.8	32.8	1.4
V ₅ -AKH 9916	27.9	3.3	31.1	2.7	33.0	0.2
V ₆ -AKH 09-5	26.3	3.5	30.6	3.0	32.6	1.6
GM	26.8	3.5	30.7	2.9	32.7	1.1

The superior performance of Suraj Bt (V₂) in maintaining cooler canopies under stress conditions highlights its potential for improved adaptation and productivity in challenging environments. Saeed *et al.* (2025) ^[10] reported significant differences among genotypes for CTD at all three stages.

Conclusion

Among the genotypes, genotype Suraj Bt took highest GDD, PTU, HTU and Thermal use efficiency for maturity and lowest canopy temperature with high canopy temperature depression and greater tolerance to environment stress with comparative to genotypes PKV 081 Bt and AKH 09-5.

References

1. Anonymous. Agricultural Market Intelligence Centre, PJTAU. 2025.
2. Deshmane AB, Khargakharate VK, Rathod NS, Kedar PB. Agro-meteorological studies on Bt. cotton hybrids with different sowing dates under high-density planting in Parbhani (Maharashtra). *Pharma Innov J.* 2022;11(12):6079-83.
3. Dhakate AA. Studies of agrometeorological indices of cotton (*Gossypium hirsutum* L.) genotypes under different sowing times and plant density [MSc thesis]. Akola: Dr. Panjabrao Deshmukh Krishi Vidyapeeth; 2020. xv, 125 p. (Unpublished).
4. Engonopoulos V, Papastylianou P, Kakabouki I, Bilalis D. Agro-meteorological indices in relation to cotton yield in a Mediterranean environment. *Not Sci Biol.* 2025;17(1):12330.
5. Kadam YE, Dakhore KK. Study the phenology growth and yield of kharif cotton in relation to agrometeorological indices under different sowing dates. *Bull Environ Pharmacol Life Sci.* 2019;8(5):9-14.
6. Karunakar AP, Kumar A, Turkhede AB, Nagdeve MB, Mali RS. Agro meteorological studies in different cotton species

under HDPS. *Int J Curr Microbiol Appl Sci.* 2018;7(8):604-605.

7. Nandini KM, Sridhara S. Heat use efficiency, helio thermal use efficiency and photo thermal use efficiency of foxtail millet (*Setaria italica* L.) genotypes as influenced by sowing dates under southern transition zone of Karnataka. *J Pharmacogn Phytochem.* 2019;8(2S):284-90.
8. Prakash V, Mishra JS, Kumar R, Ravikant K, Kumar S, Dwivedi SK, *et al.* Thermal utilization and heat use efficiency of sorghum cultivars in middle Indo-Gangetic. *J Agrometeorol.* 2017;19(1):29-33.
9. Premdeep, Ram Niwas, Khichar ML, Abhilash, Sharma A. Quantification of energy indices requirement of cotton varieties under different growing environments. *Int J Curr Microbiol Appl Sci.* 2017;6(3):809-17.
10. Saeed I, Khattak GSS, Jehan A, Ahmad S, Wahid A. Association of canopy temperature depression and membrane relative injury with seed and biological yield in chickpea (*Cicer arietinum* L.) genotypes under field conditions. *Int J Appl Exp Biol.* 2025;4(1):139-47.
11. Prakash V, Ram Niwas, Khichar ML, Sharma D, Manmohan, Singh B. Agrometeorological indices and intercepted photosynthetically active radiation in cotton crop under different growing environments. *J Cotton Res Dev.* 2015;29(2):268-72.
12. Waghmare SV, Vishwas DH, Singh M. Effect of weather parameters on growth and yield of Bt cotton hybrids at different sowing dates. *Adv Life Sci.* 2016;5(12):4910-13.
13. Waghmare SV, Singh M. Agrometeorological indices and correlation coefficient of Bt cotton under different growing environment. *Int J Curr Microbiol Appl Sci.* 2017;6(10):551-57.