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Heat Unit Requirement of Rainfed Cotton Under South Gujarat Condition

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ABSTRACT

Field experiments was conducted to study the heat unit requirement for rainfed American cotton cultivars at Regional Cotton Research Station of, NAU, Maktampur, Gujarat, during *kharif* season of 2016. The experiment consisted of three cultivars*viz.*,(GBHV-180, GBHV-183, GBHV-164) sown on oneset of monsoon was laid out in randomised block design replicated thrice. The results revealed that an overall day from sowing to physical maturity in different cultivars varies between 182 to 191. Similarly thetotal heat unit (GDD, HTU PTUand PTI) accumulated during life period of crop up to maturitybetween (2929 to 3011^{0}C day, 16536 to 17135^{0}C hrs, 35184 to36091^{0}C hrs) and (84.4 to 86.7^{o}C days day^{-1}) respectively.

Key words *Cotton, phenology, temperature, GDD, HTU and PTU, PTI*

Weather variability is considered one of the major factors of inter-annual variability of crop growth and yield in all environments besides rainfall, temperature and bright sun shine hours also have been bearing on crop growth and development as well as yield response of different species to different environments can be quite different (Mote, et al. 2015), also plants require a specific amount of heat to develop from one point in their life cycle to another. Research has shown that measuring theheat accumulated over time provides a more accuratephysiological estimate than counting calendar days. Temperature based heat units such as growing degree days (GDD), helio thermal units (HTU) and photo thermalunits (PTU) are based on the concept that real time to attainthe phenological stage is linearly related to temperature inthe range between base temperature and optimum temperature (Monteith, 1981).Basically three climatic parameters *viz.,* temperature, rainfall and light are most important for optimum crop growth and development there by exploits the potentiality of a crop. Growingdegree days are based on the concept that the real time toattain a phenological stage is linearly related to temperaturein the range between base temperature and optimum temperature (Monteith, 1981). The duration of each phenophases determines the accumulation and partitioning of dry matter in differentparts as well as crop responses to environmental and external factors. The duration of each phenophases determines the accumulation and partitioning of dry matter in different parts as well as crop responses to environmental and external factors (Dalton, 1967). In the present paper thermal indices of cotton have been carried out by using weathervariables.

MATERIAL AND METHODS

Field experiments were carried out at the research farm of Regional Cotton Research Station, (22' N latitude and 73.5' E longitude withan altitude of 16.5 m above mean sea level) in Maktampur, Navsari Agricultural University, Bharuch, Gujarat State.The treatment combinations of the experiment comprised of three cultivars (V_1) GBHV-183, (V_2) GBHV-180 and (V_3) GSHV-164 replicated three times in randomised block design during *kharif* seasons of 2016 under rainfed conditions. The spacing for all three cultivars of cotton was 120 x 45 cm was maintained and recommended agronomic practises and plant protection measures were taken as and when necessary. The mean meteorological data on maximum and minimum temperature, and sunshine hours during investigation was recorded at Agro-meteorological Observatory, Regional Cotton Research Station, Maktampur, NAU, Bharuch and used for computation of agrometeorological indices. For recording days required for a phenophase two middle lines in each plot were selected and daily observations were made when 50 per cent of the population showed germination, square formation, boll opening and maturity. Days between

Table 1. Number of days required for completion of different stages of rainfed cotton cultivars

	Phenological stages					
Cultivars	Sowing to germination	Germination to square formation	Square formation to flowering	Flowering to boll opening	Boll opening to phy. maturity	Total
GBHV-180	6	39	14	61	65	185
GBHV-183	6	39	18	61	67	191
GSHV-164	6	37	13	60	66	182

Table 2. Stage wise requirement of growing degree daysfor different rainfed cotton cultivars

Cultivars	Phenological stages					
	Sowing to germination	Germination to square formation	Square formation to flowering	Flowering to boll opening	Boll opening to phy. maturity	Total
GBHV-180	111	716	255	1043	813	2938
GBHV-183	111	716	330	1034	820	3011
GSHV-164	111	679	256	1051	832	2929

Table 3. Stage wise requirement of heliothermal units for different rainfed cotton cultivars

Cultivars	Phenological stages					
	Sowing to germination	Germination to square formation	Square formation to flowering	Flowering to boll opening	Boll opening to phy. maturity	Total
GBHV-180	219	1531	1150	6582	7132	16614
GBHV-183	219	1531	1732	6572	7081	17135
GSHV-164	219	1489	1035	6534	7259	16536

emergences to different event were taken. The agrometeorological indices were computedduring different growth phases of Cotton by adopting theprocedure laid out by (Jones and Wells 1998).

Growing degree days (GDD)= {(Tmax + Tmin)/2}-Tb

Where,

Tmax-Daily maximum temperature (^{0}C)

Tmin-Daily minimum temperature (^{0}C)

Heliothermal units HTU (^{0}C day hr) = GDD × Duration ofsunshine hour.

Photothermal units PTU (^{0}C day hr) = GDD X Day length (hrs.)

Photothermal IndexPTI (^{0}C days day^{-1}) = (Degree days/ No. of days)

RESULTS AND DISCUSSIONS

Phenological calendar

The calendar days taken from sowing tophysiological maturity in cultivars (GBHV-183, GBHV-180 and GSHV-164) between 182 to 191. Among the different cultivars more number of calendar days 191 days taken by cultivar V_2 (GBHV-180) as compared to V_1 (GBHV-183) and V_3(GSHV-164), 185 and 182 days respectively Table 1. Whereas, from square formation to flowering stage lesser as compared to number of days to reachdifferent phenological stages. This might be due to higher temperature after square formation stage which fulfilledgrowing degree days requirement and thermal units of cultivars. Similar findings were reported by (Hokmalipour, *et al.* 2011).

Table 4. Stage wise requirement of photothermal unitsfor different rainfed cotton cultivars

Cultivars	Phenological stages					
	Sowing to germination	Germination to square formation	Square formation to flowering	Flowering to boll opening	Boll opening to phy. maturity	Total
GBHV-180	1469	9264	3189	12384	8973	35280
GBHV-183	1469	9264	4113	12200	9046	36091
GSHV-164	1469	8799	3214	12520	9182	35184

Table 5. Stage wise requirement of photothermal index for different rainfed cotton cultivars

Cultivars	Phenological stages					
	Sowing to germination	Germination to square formation	Square formation to flowering	Flowering to boll opening	Boll opening to phy. maturity	Total
GBHV-180	18.5	18.4	18.2	17.1	12.5	84.7
GBHV-183	18.5	18.4	18.3	17.0	12.2	84.4
GSHV-164	18.5	18.4	19.7	17.5	12.6	86.7

Growing degree day

The maximum growing degree day of 3011degree days from sowing to physiological maturity were recorded in cultivars V_2 (GBHV-183) followed by cultivars GBHV-180 and V_3GSHV-164(2938 degree days) and (2929 degree days)Table-2. In case of different phenological phases higher GDD consumed from flowering to boll opening phase in all cultivars. Growing degree day coincides with the study of (Gudadh, *e t al.* 2013)

Heliothermal units

Among different cultivars higher helio thermal units of 17135^{0}C hrs from sowing to physiological maturity were recorded in cultivars V_2 (GBHV-183) followed by cultivars GBHV-180 and V_3 GSHV-164 (16614^{0}C hrs) and (16536 ^{0}C hrs) respectively table-3. In case of different phenological phases higher HTU consumed from flowering to boll opening phase in all cultivars.

Photothermal thermal units

Among different cultivars more number of Photothermal thermal units36091^{0}C hrs from sowing to physiological maturity were recorded in cultivars V_2 (GBHV-183) followed by cultivars GBHV-180 and V_3 GSHV-164 (35280 ^{0}C hrs) and (35184^{0}C hrs) respectively table-4. In case of different phenological phases higher PTU consumed from flowering to boll opening phase in all cultivars.

Photothermal thermal index

Among different cultivars higher photothermal thermal index 86.7^{0}C days day^{-1} from sowing to physiological maturity were recorded in cultivars V_3 GSHV-164followed by cultivars V_1 GBHV-180 and V_2 GBHV-183 (84.7 and 84.4 ^{0}C days day^{-1}) respectively table-5. In case of different phenological phases higher PTU consumed from sowing to germination phase in cultivars V_1 and V_2 and in cultivars GSHV-164 from square formation to flowering.

CONCLUSION

It may be concluded cotton phenological stages extremely regulated by prevailing weatherconditions. Higher consumption of GDD, HTU and PTU in all cultivars from flowering to boll opening phase. Calculation of thermal indices may be useful in crop management decisions, insect and disease management, fertilizer application.

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