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RESEARCH PAPER

Response of cotton to temperature, rainfall and sunshine hours at Kovilpatti, Tamil Nadu, India

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Abstract : Three date of sowing with four levels of spacing were tried to know growing degree days (GDD), heliothermal units (HTU) photo thermal units (PTU) requirement of crop and heat use efficiency (HUE) for prediction of phenophases, growth and yield of cotton. Field experiments was conducted during 2010-11 in *Rabi* season (October - December) at Agricultural Research station, Kovilpatti (Latitude 9.17'N, Longitude 77.88'E and elevation (AMSL) 90 m), Tamil Nadu, India, using cotton (NCS 145). The treatment combinations comprised of three dates of sowing *viz.*, D_1- 39th, D_2- 41st and D_3- 43rd standard weeks (pre monsoon, monsoon and post monsoon sowing, respectively) in main plot with four different spacing of S_1- 90 x 60, S_2-90 x 45, S_3- 75 x 60, S_4- 75 x 45 in the sub plot. The highest HUE of 0.815 g m^{-2} per °C day for cotton kapas yield was recorded by pre monsoon sown crop and GDD directly reflected in cotton kapas yield. The maximum and minimum temperature, sun shine hours and rainfall had positive correlation with yield of the crops. Higher cotton kapas yield was recorded by pre monsoon sown crop due to favourable weather factors.

Key Words : Cotton, Temperature, Rainfall, GDD, HTU, HUE

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INTRODUCTION

Bt cotton occupies 40 per cent area in India and 82 per cent area in Tamil Nadu. High levels of cotton production require favourable combinations of climate, soil and cultural practices. Cotton requires four to five months of warm temperature (about 32°C) during the growing season. Planting geometry has greater role in optimizing yield of Bt cotton (Bhalerao *et al*., 2008). Some earlier workers reported different results with regards to plant spacing and date of sowing *i.e.* Soomro *et al.* (2000) recorded 15th May as optimum sowing time with 30 cm spacing, Arian *et al.* (2001) reported that maximum seed cotton yield was produced when cotton was sown on first May followed by April 15th. It is essential to find out suitable plant density and time of sowing for recently released Bt cotton hybrid to realize the maximum yield potential under rainfed vertisol condition. Hence, the present study was undertaken to find out the effect of spacing and sowing date on productivity of Bt cotton hybrid (NCS 145).

MATERIAL AND METHODS

A field experiment was conducted during *Rabi* season of 2010-11 at the Agricultural Research Station, Tamil Nadu Agricultural University, Kovilpatti, Tamil Nadu. Experiment was laid out in split plot design and replicated thrice with dates of sowing in main plots and spacing in sub plots. The treatment combinations comprised of three dates of sowing *viz.*, 39th, 41st and 43rd standard weeks (pre monsoon, monsoon and post monsoon sowing, respectively) in main plot with four different spacing of 90 x 60, 90 x 45, 75 x 60, 75 x 45 in the sub plot. Base temperature for cotton crop is 10°C. The sum of the degree days for the completion of each phenophase were obtained by using the following formula:

$$\text{Accumulated GDD } (^{\circ}\text{C day}) = \sum_{i=dh}^{i=ds} (\bar{T} - Tb)$$

where,

$\bar{T}$ (Daily mean air temperature in ^{o}C)= $^{(Tmax+Tmin)/2}$

The Helio-Thermal Unit for a given day represents the product of GDD and the actual hours of bright sunshine for that day. The sum of the HTU for the duration of each phenophase was determined by using the following formula:

$$\text{Accumulated HTU } (^{\circ}\text{Cday}) = \sum_{i=ds}^{i=dh} \left[\left(\bar{T} - Tb\right) i \times Di\right]$$

The photo thermal unit for a day represents the product of GDD and the possible sunshine hours calculated for Anand, Gujarat, India latitude (22°35'N). The accumulated of PTU for each phenophase was determined by the following formula:

$$\text{Accumulated PTU } (^{\circ}\text{C day}) = \sum_{i=ds}^{i=dh} \left[\left(\bar{T} - Tbi\right) \times N\right]$$

Heat use efficiency (Hue):

In the similar way that of the APAR use efficiency computation, the heat use efficiency (HUE) was also computed in which periodically measured values of the dry matter data were regressed over the accumulated growing degree days (GDD) and the slope of straight line was termed as heat use efficiency.

$$\text{HUE}(\text{kg ha}^{-1} \text{per } ^{\circ}\text{C day}) = \text{BY/GDD}$$

where,

BY= Biological yield (seed yield or total biomass),

GDD= Growing degree day.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Phenological phases:

In the present investigation, the whole life cycle of the cotton crop (from the germination to physiological maturity) was sub-divided into 6 distinct phenological

Table 1 : Number of days (DAS) taken in the different phenophases during the life cycle of cotton in 2010 at Kovilpatti

Sr. No.	Phenophases	D_1 (DAS)		D_2 (DAS)		D_3 (DAS)	
		Days required	Acc. days	Days required	Acc. days	Days required	Acc.days
1.	P_1	4	4	4	4	4	4
2.	P_2	44	48	45	49	45	49
3.	P_3	15	63	16	65	15	64
4.	P_4	2	65	2	67	2	66
5.	P_5	28	93	26	93	26	92
6.	P_6	29	122	29	122	31	123

P_1- Germination, P_2-50% Square formation, P_3-50% Flowering, P_4-50% Boll initiation, P_5-50% Boll development, P_6- Boll bursting

Table 2: Agroclimatic indices (from sowing to 50% boll bursting) of the cotton for different treatments during the *Rabi* 2010

Phenophases	Accumulated GDD (^{0}Cday)			Accumulated HTU (^{0}Cday)			Accumulated PTU (^{0}Cday)		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
P_1	75	78	73	495	619	609	911	922	861
P_2	848	794	723	5266	4947	3482	10012	9287	8415
P_3	1054	1016	919	6412	5839	4787	12398	11842	10659
P_4	1080	1043	941	6462	5979	4815	12705	12151	10918
P_5	1441	1339	1229	8014	7432	6304	16860	15566	14257
P_6	1758	1677	1648	9677	9497	9377	20529	19515	19169

stages, which is shown in the Table 1. The number of days taken for physiological maturity was 122,122 and 123 days when crop sown on 24th September, 10th October and 22nd October, 2010, respectively.

The result revealed that there was no much difference in the total number of days taken by crop sown in different dates but, the days required to complete particular phenophases varies with different time of sowing. For completing boll development stage from boll initiation, pre monsoon sown crop required 28 days while other two dates of sown crop required 26 days only. These result is in close agreement with the findings of Dhingra *et al*. (1981). The shortening of the duration of various growth phases in the late sown crop (monsoon and post monsoon) might be the probable reason of the reduction in the total biomass (leaves, stem, kapas and roots combined effect). In contrast post monsoon sown crop required more number of days for completing boll development to boll bursting stage *i.e.* 31 days while early sown crop required 29 days due to prevailing of lower values of maximum and minimum temperature in post monsoon as compared to pre monsoon was balanced by the extending of the following period (Kumar *et al.*, 2008).

The growing degree days was determined on the basis of base temperature of 10°C for the cotton crop for the different phenophases of crop growth. Accumulated GDD value was higher, which recorded in the pre monsoon sowing crop as compared to monsoon and post monsoon sowing. The value of accumulated GDD was observed in the pre monsoon, monsoon and post monsoon sown crop as 848, 794 and 723 °C day for the completion of P_2 phenophases respectively in cotton (Table 2).

The photo thermal unit (PTU) was also determined for cotton, it revealed that the accumulated PTU ranged

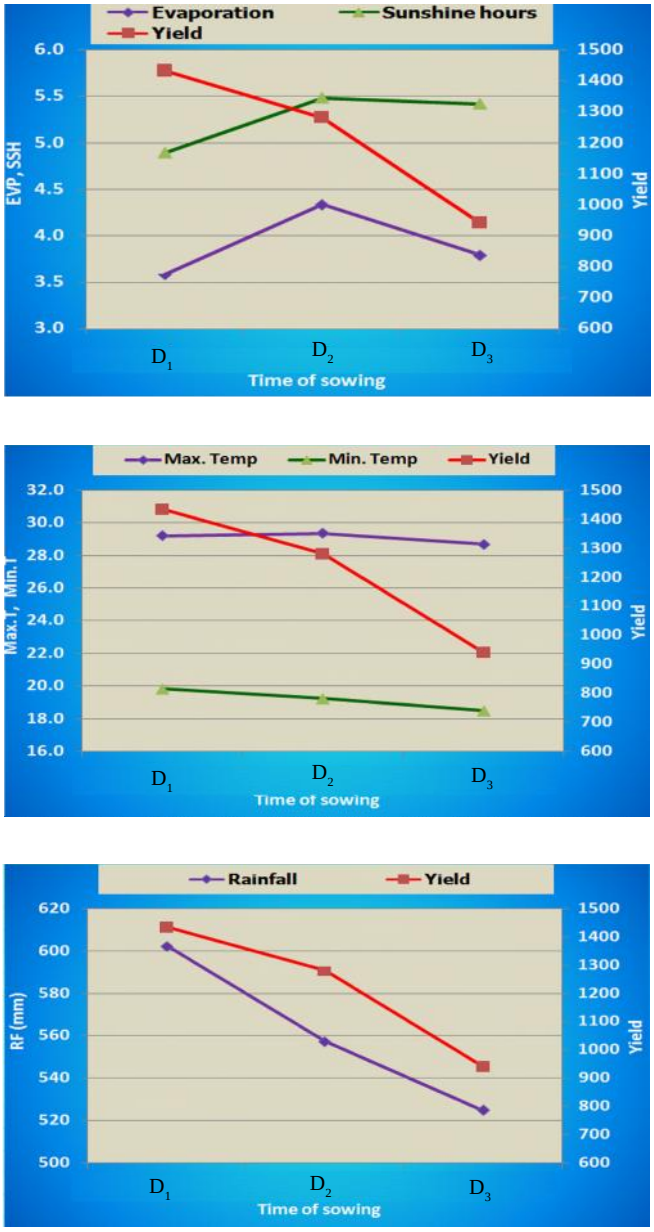

Fig. 1 : Effect of weather variables on the yield of cotton (2010-11)

Table 3: Heat use efficiency (HUE) of cotton NCS 145 for the different treatment using the GDD in the year 2010

Treatments	Seed yield (kg ha^{-1})	Acc. GDD (^{0}C day)	HUE of seed with GDD (kg ha^{-1} per ^{0}C day)
Date of sowing			
D_1	1433	1758	0.815
D_2	1254	1677	0.747
D_3	946	1648	0.574
Spacing			
S_1	1117	1694	0.659
S_2	1278	1694	0.752
S_3	1015	1694	0.597
S_4	1434	1694	0.841

from 861 to 20529 °C days in the completion of different phenophases (P_1 to P_6). The higher value of accumulated HTU was recorded (9677 °C days) in the pre monsoon treatment as compared to the post monsoon (9377 °C days) treatment for completion of different phenophases (P_1 to P_6). Pre monsoon sown crop produced higher cotton kapas yield than the late sown crop as they availed more growing degree days, rainfall, PTU and HTU. Heat use efficiency was decreased with delay in sowing (Table 3). The correlation studies shows that, the maximum and minimum temperature, sun shine hours and rainfall had positive correlation with yield of the crops (Fig. 1).

From the result of the study it is concluded that, premonsoon sowing of cotton during 39th standard week found to be best time of sowing for getting higher kapas yield.

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