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Thermal indices for predicting fruit yield of bitter gourd

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ABSTRACT

Field trials to study the effect of thermal indices on fruit yield of bitter gourd were conducted during kharif, 2001, 2003 and 2004 at the Agronomy farm, college of Agriculture, Dapoli, Maharashtra state, India. Results revealed that during all the three seasons and pooled results sowing of bitter gourd two weeks after commencement of monsoon (26th SMW) produced significantly higher fruit yield over the late sowing (27th SMW) as well as early sowing (24th SMW). Bitter gourd accumulated about 1590.6 GDD, 156754.0 hydrothermal units and 5873.5 heliothermal units for higher yield. The highest HUE (4.21 kg ha^{-1}day^{-1}) recorded for sowing in 26th SMW.

Key words : Bitter gourd, Agroclimatic indices, Fruit yield, Heat use efficiency.

Bitter gourd is one of the most important vegetable crops of Maharashtra. In konkan region of Maharashtra, it is mostly grown on well drained hilly and slopy upland during *kharif* season. Sowing of this crop is done right from the onset of monsoon in June and continued up to August. The crop yield is mostly governed by sowing time, temperature, intensity and duration of monsoon, sunshine hours and incidence of pests and diseases. Temperature is one of the dominant weather parameter affects all developmental processes of bitter gourd. In India, the degree-day concept has been widely adopted relating with growth, phenological development and yield of crops (Chakravarty and Sastry, 1983, Hundal *et. al*,1997 and Hundal *et .al*,2003). In view of this, the present investigation was carried out to assess the relationship between thermal time on different growth phases and fruit yield of bitter gourd.

MATERIALS AND METHODS

Field trials were conducted during *kharif*, 2001, 2003 and 2004 at the Agronomy farm, college of Agriculture, Dapoli. Dist. Ratnagiri, Maharashtra, India. Treatments comprised of four sowing dates based on standard meteorological week (SMW) i.e. sowing during 24th SMW (11.06 to 17.06), 25th SMW (18.6 to 24.6), 26th SMW (25.06 to 01.07) and 27th SMW (02.07 to 08.07) and replicated with five times in randomized block design. Bitter gourd variety *Konkan tara* was sown as per treatment at a distance of 50 cm X 30 cm. FYM @ 15 ton ha^{-1} was well mixed with the soil at the time of land preparation. Fertilizers @ 120 kg N, 60 kg P_2O_5 and 30 kg K_2O ha^{-1} were applied. Fruit yield was periodically recorded and subjected to the statistical analysis. Three years pooled data were also analyzed statistically. The

meteorological data regarding weather parameters were collected from agrometeorological observatory located at experimental site. Three indices viz; Growing degree days (GDD), Hydrothermal units (HYTU) and Heliothermal units (HTU) were calculated. Growing degree days (GDD) were determined as per Nuttonson (1955), with base temperature of 10°C. Heliothermal units (HTU), the product of GDD and corresponding actual bright sunshine hours for that day were calculated on daily basis. Hydrothermal units (HYTU), the product of GDD and corresponding relative humidity for that day were also calculated on daily basis. All heat units were accumulated from the date of sowing to harvesting.

Heat use efficiency (HUE) was computed to compare the relative performance of different sowing dates with respect to utilization of heat using the formula:

$$HUE\ (kgm^{-2}\ day^{-1}) = \frac{\text{Grain or biomass yield (kg ha}^{-1})}{\text{Accumulated heat units (°C day)}}$$

RESULTS AND DISCUSSION

Fruit yield

Data presented in Table 1 revealed that sowing times significantly affected the fruit yield of bitter gourd during 2001 and 2004. During 2004 bitter gourd sowing after two weeks from onset of monsoon (26 SMW) produced significantly higher yield (6.06 t ha^{-1}) over the early sowing in 24 SMW (5.01 t ha^{-1}) as well as late sowing 27 SMW (4.45 t ha^{-1}) and it was at par to sowing one week after onset of monsoon (5.56 t ha^{-1}). Similar trend of result was observed with 2001 and 2003. Pooled mean data indicated that sowing two weeks after onset of monsoon (26 SMW) produced significantly higher fruit yield (6.69 t ha^{-1}) over the late sowings carried one weeks (5.12 t ha^{-1}) and immediately after onset of monsoon (5.57 t ha^{-1}) and it was at par to sowing carried out one week after onset of monsoon (6.05 t ha^{-1}).

Growing degree days accumulated for the bitter gourd were 569 and 1022 during vegetative phase and reproductive stage respectively. It was evident that bitter gourd accumulated about 1590 GDD during entire crop growth period for obtaining higher fruit yield. Out of which 36% and 64% units were accumulated during vegetative and reproductive phase respectively (Table 2).

The total hydrothermal units 156754 were accumulated during entire crop growth period for getting the higher yield. Units 35% during vegetative phase and 65% during reproductive stage (Table 3).

Heliothermal units accumulated 1855 during vegetative stage and 4019 during reproductive stage (Table 4).

Table 1: Fruit yield of bitter gourd as influenced by different sowing times during three crop seasons.

Sowing week	Fruit yield (t ha^{-1})			Pooled mean (t ha^{-1})
	2001	2003	2004	
24 SMW	3.09	8.66	5.01	5.57
25 SMW	3.80	8.78	5.56	6.05
26 SMW	4.23	9.77	6.06	6.69
27 SMW	3.43	7.47	4.45	5.12
S.E.+	0.19	0.25	0.101	0.33
CD at 5%	0.58*	NS	0.311*	1.01*

SMW = Standard Meteorological Standard Week

Table 2: GDD (°C day) required for different phenological phases of bitter gourd

Sowing week	2001			2003			2004			Mean		
	Veg.	Rep.	Total	Veg.	Rep.	Total	Veg.	Rep.	Total	Veg.	Rep.	Total
24 SMW	569	1296	1864	683	1157	1840	412	1358	1770	554	1270	1824
25 SMW	448	1236	1683	751	1007	1758	433	1240	1673	544	1161	1705
26 SMW	470	1115	1585	813	831	1644	425	1119	1543	570	1021	1591
27 SMW	495	1055	1550	720	799	1519	396	1027	1422	537	960	1497

Table 3: HYTU (°C day percent) required for different phenological phases of bitter gourd for different sowing dates

Sowing weeks	2001			2003			2004			Mean		
	Veg.	Rep.	Total	Veg.	Rep.	Total	Veg.	Rep.	Total	Veg.	Rep.	Total
24 SMW	51238	119359	170128	70563	107143	177706	38433	131696	170597	53411	119399	172811
25 SMW	66795	113774	153790	76483	93519	170002	34163	119627	180569	59147	108973	168120
26 SMW	42970	102676	148308	81871	94437	176378	39256	109053	145646	54699	102055	156754
27 SMW	40877	97170	137693	73023	94351	167375	36977	100716	138047	50292	97413	147705

Table 4: HTU (°c day Hour) required for different phenological phases of bitter gourd for different during three crop seasons.

Sowing weeks	2001			2003			2004			Mean		
	Veg.	Rep.	Total	Veg.	Rep.	Total	Veg.	Rep.	Total	Veg.	Rep.	Total
24 SMW	2631	3894	6525	1376	5404	6780	1376	5404	6780	1572	4893	6465
25 SMW	1107	3783	4890	2204	4887	7091	2204	4887	7091	1509	4483	5992
26 SMW	1313	3428	4741	2007	4400	6407	2007	4400	6407	1855	4019	5873
27 SMW	1046	3363	4409	2267	3997	6264	1648	4027	5675	1653	3796	5449

Table 5: Heat use efficiency of bitter gourd under different dates of sowing

Sowing dates	AGDD (°C)	Fruit yield (kg ha^{-1})	Fruit yield HUE (kg ha^{-1} °C day^{-1})
D_1	1824	5570	3.05
D_2	1705	6050	3.55
D_3	1591	6690	4.21
D_4	1497	5120	3.42
Average	1654	5860	3.55

Heat use efficiency (HUE)

Average accumulated GDD and fruit yield of bitter gourd at harvest for different sowing dates are given in Table 5. The HUE was computed to determine the fruit yield produced per unit of growing degree days. In general, fruit yield recorded was the highest in third date of sowing where HUE (4.21 kg ha^{-1} °C day^{-1}) was the highest. The lowest HUE (3.05 kg ha^{-1} °C day^{-1}) recorded in the first date of sowing.

Thus, based on present study it may concluded that under Konkan conditions, the bitter gourd crop should be sown upto 26th SMW for getting higher fruit yield and increasing efficiency.

Relationship between fruit yield and thermal indices

The regression relationship obtained between fruit yield of bitter gourd with thermal indices (AGDD, HTU and HYTU) from sowing to maturity are shown below. Significant (5 %) relationship was obtained.

$Y = -12065.0 + 42.220$ AGDD $+6.681$ HTU $+ 0.298$ HYTU $\quad (R^2 = 0.99^*)$

Where, Y = Bitter gourd yield (kg ha^{-1})

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