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Phasic development model for cauliflower (*Brasssica oleraceae*) using thermal indices

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ABSTRACT

Cauliflower (*Brasssica oleraceae*) grown during two seasons (2002-03 and 2003-04) at Anand (22°35' N, 72°55'E) required 2174 GDD, 20555 HTU and 23308 PTU to reach its maturity stage. Linear regression models were worked out based on phenophase wise data for predicting the onset of a particular phenophase of the crop using heat units. The R^2 obtained were between 0.94 to 0.97.

Key words : Cauliflower, phenophases, GDD, HTU and PTU

Phenology is an essential component of the crop weather models, which can be used to specify the most appropriate rate and time of specific development process. The duration of each growth phase determines the accumulation and partitioning of dry matter in different organs (Dalton, 1967) as well as crop response to environmental and external factors. The duration of the particular phase of growth was directly related to temperature and this duration for a particular species could be predicted using the sum of daily air temperature (Wang 1960). In view of potential significance of phenological studies on crop weather interactions, a field experiment on cauliflower, cv snowball 16 was planned to develop to agrometeorological indices based model.

MATERIALS AND METHODS

Investigations were carried out at the Agronomy Farm of the B. A. College of Agriculture, Anand Agricultural University, Anand. Anand is located at the latitude of 22°35'N and longitude of 72°55'E and at an elevation of 45.1m above the mean sea level, which falls under the middle Gujarat Agro-climatic Zone-III. The field experiment was laid out in split plot design with three replications. The treatments consists of three dates of planting at 15 days interval (D_1: 1st November, D_2: 15th November and D_3: 30th November) in the main plot, three levels of irrigation (I_1: IW/CPE ratio of 0.6, I_2: IW/CPE ratio of 0.8 and I_3: IW / CPE ratio of 1) in the sub plot and two spacing (S_1 : 60 cm X 45 cm and S_2 : 60 cm X 60 cm) in the sub- sub plots.

The computation of the agrometeorlogical indices like growing degree days (GDD), Heliothermal unit (HTU), Photothermal unit (PTU) were determined as under by using the base

Table 1: Actual and predicted days to attain various phenophases of cauliflower on the basis of accumulated GDD

Phase		D_1		D_2		D_3		Mean	S.D.	CV (%)
		2002-03	2003-04	2002-03	2003-04	2002-03	2003-04			
P_1	A	45.0	42.0	42.0	49.0	48.0	45.0	45.2	2.9	6.5
	P	48.1	47.7	42.9	49.1	45.7	40.6	45.8	3.0	6.6
	D	3.1	5.7	0.9	0.1	-2.3	3.4			
P_2	A	13.0	22.0	22.0	18.0	18.0	22.0	19.2	3.6	18.8
	P	13.0	19.6	20.1	16.5	17.5	19.2	17.6	2.7	15.1
	D	0.0	-2.4	-1.9	-1.5	-0.5	-2.8			
P_3	A	46.0	48.0	37.0	41.0	25.0	27.0	37.3	9.6	25.7
	P	43.2	42.7	36.3	38.1	25.8	27.2	35.5	7.5	21.1
	D	-2.8	-5.3	-0.7	-2.9	0.8	0.2			
For life period	A	104.0	112.0	101.0	108.0	91.0	94.0	101.7	8.1	7.9
	P	104.3	110.0	99.4	103.6	89.0	87.9	99.0	8.9	9.0
	D	0.3	-2.0	-1.6	-4.4	-2.0	-6.1			

A = Actual; P = Predicted; D = Deviation

P_1 Juvenile phase — The period from Transplanting to 16 – 18 leaf stage

P_2 Curd induction Phase—The period between Juvenile and curd initiation

P_3 Curd maturity Phase—The period between curd initiation and last harvest

temperature of 0 ^{0}C (Grevsen and Olesen, 1994 and Wurr *et.al.,* 1990).

RESULTS AND DISCUSSION

The days taken to attain different phenophases of the crop observed during experimentation period is presented in Tables (1 to 3). The number of days taken by the crop for completion of each phenophase varied with the date of planting. The days taken from planting to harvesting ranging from 91.0 to 104 days and 94 to 112 days in 2002-03 and 2003-04, respectively. The number of days taken for the harvest was higher in the crop planted under D_1 date during both the years and consistently decreased with subsequent plantings. The days taken to harvest were much lower in case of D_3 planting in both the years.

GDD required for the completion of the crop growth period of cauliflower from planting to maturity in D_1, D_2 and D_3 were 2291, 2182 and 1950 respectively during the

Table 2: Actual and predicted days to attain various phenophases of cauliflower on the basis of accumulated HTU

Phase		D_1		D_2		D_3		Mean	S.D.	CV (%)
		2002-03	2003-04	2002-03	2003-04	2002-03	2003-04			
P_1	A	45.0	42.0	42.0	49.0	48.0	45.0	45.2	2.9	6.5
	P	45.5	56.2	41.8	46.2	42.9	39.3	45.3	5.9	13.0
	D	0.5	14.2	-0.2	-2.8	-5.1	-5.7			
P_2	A	13.0	22.0	22.0	18.0	18.0	22.0	19.2	3.6	18.8
	P	12.9	18.7	18.1	15.7	17.5	19.3	17.0	2.4	13.9
	D	-0.1	-3.3	-3.9	-2.3	-0.5	-2.7			
P_3	A	46.0	48.0	37.0	41.0	25.0	27.0	37.3	9.6	25.7
	P	41.4	42.1	36.1	39.3	26.4	28.6	35.6	6.7	18.8
	D	-4.8	-5.9	-0.9	-1.7	1.4	1.6			
For life period	A	104.0	112.0	101.0	108.0	91.0	94.0	101.7	8.1	7.9
	P	99.9	117.0	96.0	101.2	86.7	87.1	98.0	11.2	11.4
	D	-4.1	5.0	-5.0	-5.8	-4.3	-6.9			

Table 3: Actual and predicted days to attain various phenophases of cauliflower on the basis of PTU

Phases		D_1		D_2		D_3		Mean	S.D.	CV (%)
		2002-03	2003-04	2002-03	2003-04	2002-03	2003-04			
P_1	A	45.0	42.0	42.0	49.0	48.0	45.0	45.2	2.9	6.5
	P	46.2	47.6	42.7	46.7	44.8	40.6	45.4	3.3	7.3
	D	3.2	5.8	0.7	-0.3	-3.4	-4.4			
P_2	A	13.0	22.0	22.0	18.0	18.0	22.0	19.2	3.6	18.8
	P	12.9	19.4	19.5	15.9	17.2	18.8	17.3	2.6	14.8
	D	-0.9	-2.6	-2.5	-2.1	-0.8	-3.2			
P_3	A	46.0	48.0	37.0	41.0	25.0	27.0	37.3	9.6	25.7
	P	42.5	42.5	36.9	32.8	22.1	28.7	34.2	8.0	23.5
	D	-3.5	-5.5	-0.1	-8.2	-2.9	1.7			
For life period	A	104.0	112.0	101.0	108.0	91.0	94.0	101.7	8.1	7.9
	P	103.6	109.7	99.1	97.4	83.6	88.1	96.9	9.6	9.9
	D	-0.4	-2.3	-1.9	-10.6	-7.2	-5.9			

Table 4: Agrometeorological indices (GDD, HTU and PTU) required to attain various phenophases of cauliflower in different dates of planting during the years 2002-03 and 2003-04

Phase	Date of Planting						Mean	SD	CV%
	D1		D2		D3				
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04			
GDD									
P_1	1061.0	1052.1	945.3	1082.7	1007.9	915.4	1010.7	67.5	6.7
P_2	277.3	426.0	437.3	355.8	378.6	415.3	381.7	59.6	15.6
P_3	952.4	940.2	799.1	837.5	563.6	593.9	781.1	167.7	21.5
Life period	2290.7	2418.3	2181.7	2276.0	1950.1	1924.3	2173.5	198.1	9.1
HTU									
P_1	9638.8	11955.5	8827.9	9787.2	9060.7	8280.9	9591.8	1281.5	13.4
P_2	2564.5	3802.0	3862.1	3148.5	3545.3	3920.0	3475.4	530.0	15.2
P_3	8746.1	8895.4	7582.7	8281.1	5468.7	5951.9	7487.7	1458.7	19.5
Life period	20949.4	24652.9	20272.7	21216.8	18074.7	18162.7	20554.9	2422.4	11.8
PTU									
P_1	11571.6	11490.4	10227.5	10169.4	10694.2	9723.1	10646.0	751.0	7.1
P_2	2966.6	4541.8	4576.9	3700.3	4004.8	4401.4	4032.0	622.8	15.4
P_3	10183.2	10177.1	8817.7	7829.6	6425.0	6813.3	8374.3	1628.0	19.4
Life period	24721.4	28209.2	23622.1	23224.1	21124.1	20937.8	23308.4	2044.9	8.8

first year and they were 2418, 2276 and 1924 respectively during the second year (Table 4). The values of the accumulated GDDs as observed in the D_1, D_2 and D_3 treatments were 1061, 945 and 1008 respectively for the completion of P_1 phase of the crop development in the first year. The corresponding values in the second year were 1052, 1083 and 915 respectively. The average value of the accumulated GDD for P_1 phase over all the dates of planting was 1011 with a C.V. percent of 6.7. The results of the present investigations indicated that the lowest value of the accumulated GDD of 915 was enough to complete the juvenile phase. The average value of accumulated GDD was 382 with the C. V. percent of 15.6 for the completion of the P_2 phase of all the planting dates for both the years. The values of the accumulated GDD observed were 952, 799 and 564 for the completion of the P_3 phase of the crop development in

D_1, D_2 and D_3 treatments, respectively during the first year. Whereas in the second year the values were 940, 838 and 594 respectively.

The average value of accumulated HTU for completion of cauliflower crop growth period was 20555 with C.V. per cent of 11.8 (Table 4). The accumulated values of the HTU were found higher in the year 2003-04 in all the phases of crop development in D_1 and D_2 plantings than those in corresponding treatments in the year 2002-03.

The values of PTU from 11490 to 11572 were found the optimum for completion of juvenile phase of the crop development (Table 4). The optimum values were in the range of 2966 to 4542 for the completion of curd induction phase and 10183 to 10177.0 for the completion of the maturity phase. Among the dates of planting the values of PTU were more in D_1 planting than those in D_2 and D_3 in both the years. The crop planted on D_1 date recorded the higher yield in both the years than the plants planted on the later dates.

Linear regression model based on the phenophasewise data over three dates of planting for two years was derived for predicting the onset of any particular phenophase. The regression model so obtained is given below

$$\hat{y} = 0.5488 + 0.0448 \sum_{i=1}^{n} GDD \quad (R^2 = 0.97)$$

$$\hat{y} = 1.1944 + 0.0046 \sum_{i=1}^{n} HTU \quad (R^2 = 0.94)$$

$$\hat{y} = 0.7367 + 0.0041 \sum_{i=1}^{n} PTU \quad (R^2 = 0.96)$$

where,

$\hat{y}$ = Predicted days

By using this model, the dates required for various phenophases can be predicted. The actual and predicted days for each phenophase as obtained by the model are given in Table 1 to 3 for GDD, HTU and PTU.

REFERENCES

Dalton, L G. 1967. A positive response of yield on maturity of sorghum. *Crop Science*, 7: 721-726

Grevsen, K. and Olesen, J.E. 1994. Modelling cauliflower development from transplanting to curd initiation. *J. Hort. Sci.,* 69 (4) : 755-766.

Wang , J. Y. 1960. A critique of the heat unit approach to plant response studies. *Ecology,* 41: 785 - 790

Wurr, D.C.E., Fellows, J.R., Sutheland, R.A. and Elphinstone, E.D. 1990. A model of cauliflower curd growth to predict when curds reach a specified size. *J. Hort. Sci.,* 65(5) : 555-564.