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Effect of Temperature, Vapour Pressure and Thermal Time on Population of Cabbage Aphid, *Lipaphis erysimi* Kaltenbach Infesting Cabbage

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ABSTRACT

Field experiments conducted on population build up of cabbage aphid, Lipaphis erysimi kaltenbach revealed that it population at Anand increased when the maximum temperature reached around 30°C during winter months with constant increase in minimum temperature, vapour pressure and sunshine hours but it was reduced with decreased in minimum temperature eventhough, there was a increase in vapour pressure and sunshine hours. The increase in 1°Cd weekly thermal time increased 4 aphids per leaf.

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INTRODUCTION

Lipaphis erysimi is an important pest of cabbage affecting the yield. The pest remains active on cabbage during December to March. However, the severity of infestation varies considerably from year to year due to effect of abiotic factors. Amongst abiotic factors, temperature influences the population of *L.erysimi* the most. Bakhetia and Sidhu (1983) have reported as 20 to 30° C temperature is the most favourable temperature for reproduction and development of *L. erysimi* on mustard in Punjab. Whereas, Atwal *et al.*, (1971) have reported adverse effect of sub-zero winter temperature on the subsequent build up of aphid populations. Since no informations on effect of other abiotic factors viz., vapour pressure and sunshine hours on activity of *L. erysimi* is available, study was undertaken to understand the role of these abiotic factors on the population density of this aphid on cabbage in Gujarat.

MATERIALS AND METHODS

Experiments to study population build up of *L. erysimi* were laid out at Anand (Gujarat) during rabi 1982-83, 1984-85 and 1988-89 in randomised block design with four replications, using cabbage variety sutton Express. The plot size was 9.00 x 3.60 m. The row to row and plant to plant distance of 45 cm was maintained. Crops were transplanted on five different times at 15 days interval during October to December.

The aphid population was recorded at weekly intervals between 8 to 10 h of the day by counting number of nymphs and adults on three leaves from each of the five rendomly selected plants from each plots with the appearance of aphid to the harvesting of the crop. Yield of marketable cabbage heads were recorded plot wise. The data were subjected to analysis of variance and presented in Table-1.

The meteorological parameters were monitored daily in the Agrometeorological observatory which was 100 m away from the

experimental plot. To calculate Thermal Time (Heat Units) for each day the following equation expressed in centigrade thermal time (°Cd) was employed

$$THI = \frac{T\max + T\min}{2} - T \text{ threshold}$$

T max, T min and T threshold are maximum, minimum and threshold temperature. The threshold temperature was considered zero (Atwal *et al.*, 1971). Vapour pressure was calculated with the help of psychrometric equation by using dry and wet bulb temperatures. The simple graphical representations were performed for analysis and statistical tests for determining the appropriateness of thermal time on the γ square of overall equation.

RESULTS AND DISCUSSION

The aphid, *L. erysimi* and yield data (Table 1) revealed that in the year 1984-85 maximum number of aphids per leaf on cabbage transplanted in the 4th week of November and 2nd week of December were during 8th and 6th week of transplanting, respectively. Whereas during 1988-89 on 2nd and 4th week of November as well as 2nd week of December transplanted crops, maximum aphid populations were found during 15th, 13th and 11th week of transplanting respectively. This late transplanted crops were heavily infested with aphids during the study period. The pooled data revealed negative correlation between aphid populations and yield, especially in the crops transplanted in November and December. The high aphid density in the early stage of the late transplanted crops reduced the yield. In view of this finding to study the effect of weather parameters on population build up of aphid, *L. erysimi* data of 2nd week of November and 2nd week of December transplanted crops for the year 1982-83, 1984-1985 and 1988-89 were used for further statistical analysis.

The aphid population build up was comparatively high on 1988-89 cabbage crop as compared to rest of the two years crops (Table 2, 3 and 4). During 1988-89 aphid population increased with increase in minimum (10 to 30° C) and maximum (27.9 to 33.7°C) temperature as well as vapour pressure (3.9 to 5.1 mm of Hg) and sunshine hours (10.4 to 10.7) (Table 4). Whereas, during 1984-85 in the later stage of the crop growth inspite of maximum temperature being more than 30°C and constant increase in the vapour pressure (3.4 to 4.5 mm of Hg) and sunshine hours (10.1 to 10.5) aphid population decreased with decrease in minimum temperature (12.0 to 8.8°C) on 2nd week of November (D_3) as well as 2nd week of December transplanted crops (Table 3). Bakhetia and Sidhu (1983) have also reported rapid development of *L. erysimi* on mustard at 30°C.

Moreover to temperature, thermal time has also effect on aphid population build up. It was found on both the crops (D_3 and D_5) during all the three years that during the week when thermal time was more than 143° Cd, aphid populations remained higher than rest of the period of crop life. The cummulative thermal time since the week of first appearance of aphid to the week when aphid population reached to it's peak were 729 to 1980° Cd. If we consider the period required to have a maximum aphid, *L. erysimi* population on cabbage crop it could be 5 to 6 weeks after the first appearance of aphid (Table 2, 3 and 4).

The cummulative weekly thermal time with their respective aphid population in that week were regressed to obtain the linear regression equation line (1 :1 line). The date-wise relation were significant and the resultant equation was $Y=510.7113 + 3.9024 x$ with $R^2 = 053^*$ for 2nd week of November (D_3) planting and $Y= -550.36 + 4.2966 x$ with $R^2 = 54^*$ for 2nd week of December (D_5) planting. Where 'Y' represent aphid population

TABLE 1

Population build up of cabbage aphid, *L. erysimi* in relation to temperature, vapour pressure and sunshine and its effect on yield of healthy cabbage heads, transplanted in different dates times.

Transplanting time month	Week	1982-93 Popn./ leaf	1982-93 Yield q/ha	1984-85 Popn./ leaf	1984-85 Yield q/ha	1988-89 Popn./ leaf	1988-89 Yield q/ha	Pooled Popn./ leaf	Pooled Yield q/ha	Temp. °C. Max.	Temp. °C. Min.	V.P. mm of Hg	Sun-shine h
October	II	6.7	51.4	18.2	104.6	4.3	97.2	9.7	84.4	27.5	10.7	9.2	10.0
(D_1)		(15)		(14)		(16)							
October	IV	20.4	43.8	38.6	104.9	2.6	148.8	20.5	99.0	27.5	10.7	9.2	10.0
(D_2)		(13)		(12)		(14)							
November	II	69.3	58.6	29.1	83.3	249.1	179.9	115.8	107.3	29.7	11.7	7.9	10.1
(D_3)		(12)		(10)		(15)							
November	IV	30.1	41.5	94.6	97.3	277.0	137.6	133.9	92.1	29.7	11.7	7.9	10.1
(D_4)		(10)		(8)		(13)							
December	II	54.1	10.43	148.2	56.3	218.7	109.4	140.3	58.7	29.7	11.7	7.9	10.1
(D_5)		(8)		(6)		(11)							
S. Em. ±			5.0		7.6		24.8						
C. D. 0.05%			15.4		23.4		NS						
C. V. %			24.3		17.0		36.90						

Figures in parentheses indicate age of the crop in weeks.

TABLE 2

Aphid population build up in relation to weather parameters in cabbage transplanted during different time (1982-83).

Av. No. of aphid per leaf		*Temperature °C*		*Vapour pressure*	*Sunshine*	*Thermal time °Cd*	
D_3*	D_5**	*Min*	*Max*	*mm. of Hg.*	*h*	*Weekly*	*cummulative*
9.20 (6)	0.02 (2)	14.4	29.8	3.3	9.8	154	154
27.60 (7)	1.78 (3)	10.1	28.4	2.9	10.0	134	289
24.47 (8)	6.79 (4)	9.8	26.4	2.9	9.7	127	417
28.72 (9)	6.17 (5)	9.3	27.4	3.0	9.6	128	545
36.40 (10)	41.66 (6)	14.0	30.7	3.3	9.2	156	702
18.49 (11)	29.03 (7)	10.3	27.2	3.5	9.6	131	833
69.29 (12)	54.08 (8)	13.3	28.8	4.2	8.2	147	980

* II week of November ** II week of December

Figures in parentheses indicate age of the crop in weeks.

TABLE 3

Aphid population build up in relation to weather parameters in cabbage transplanted during different time (1984-85).

Av. No. of aphid per leaf		*Temperature °C*		*Vapour pressure*	*Sunshine*	*Thermal time °Cd*	
D_3*	D_5**	*Min*	*Max*	*mm. of Hg.*	*h*	*Weekly*	*cummulative*
2.93 (5)	0.00 (1)	10.4	30.1	3.1	9.9	141	141
3.14 (6)	5.03 (2)	10.8	28.8	2.5	9.7	138	280
20.07 (7)	12.32 (3)	10.6	26.6	3.4	9.8	130	410
14.70 (8)	35.25 (4)	11.0	27.9	3.1	9.7	136	546
19.53 (9)	100.62 (5)	12.2	28.9	3.6	9.5	143	690
29.05 (10)	148.19 (6)	12.0	29.0	3.4	10.1	143	833
18.32 (11)	123.02 (7)	9.9	30.5	4.0	9.6	141	975
7.80 (12)	43.97 (8)	8.8	31.1	4.5	10.5	139	1114

* II week of November ** II week of December

Figures in parentheses indicate age of the crop in weeks.

TABLE 4

Aphid population build up in relation to weather parameters in cabbage transplanted during different time (1988-89).

Av. No. of aphids per leaf		Temperature °C		Vapour pressure	Sunshine	Thermal time °Cd	
D_3*	D_5**	Min.	Max	mm. of Hg.	h	Weekly	cummulative
1.82	3.24	10.0	27.9	3.9	10.4	132	132
(11)	(7)						
2.90	6.10	10.0	27.9	3.9	10.4	132	265
(12)	(8)						
13.77	19.58	10.1	30.4	4.7	10.4	141	407
(13)	(9)						
96.53	104.33	12.7	32.8	5.1	10.7	159	566
(14)	(10)						
249.08	218.75	13.0	33.7	5.1	10.7	163	729
(15)	(11)						

* II week of November ** II week of December

Figures in parentheses indicate age of the crop in weeks.

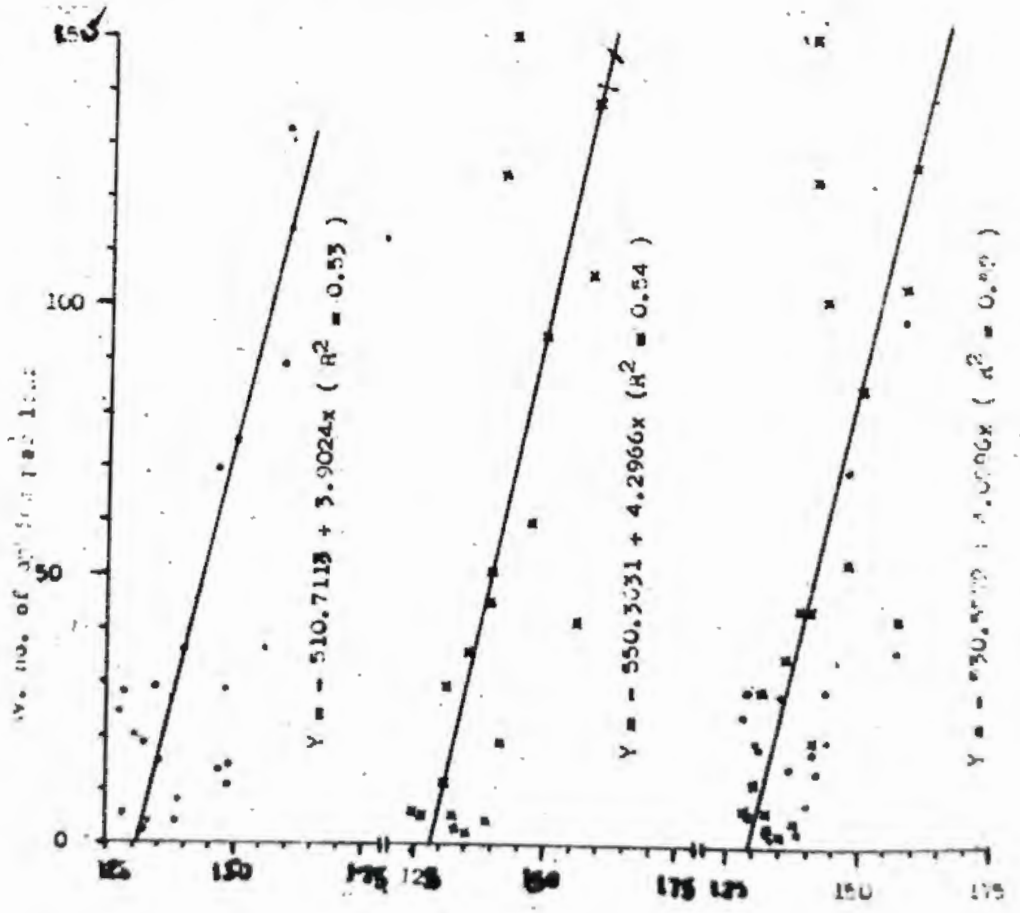


Fig. 1 : Effect of thermal time on aphid, *L. erysimi* populations in cabbage transplanted in the 2nd week of November (D_3) and 2nd week of December (D_5).

and 'x' being thermal time in °Cd (Fig 1). As the value of intercept are significant combined equation were developed for aphid population and thermal time in the form of : Y= -530.5572 + 4.0996 x with R^2 052* which is also highly significant (Fig. 1). It revealed from this study that with increase in 1° Cd weekly thermal time 4 aphids per leaf is increasing.

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