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Effect of Weather Factors on the Host-Predators Relationship in the Aleyrodid, *Siphoninus phillyreae finitimus* Goux on Pomegranate*

by

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SYNOPSIS : Three species of insects viz., *Sticholotis* sp., *Chrysopa* sp. and *Aclctoxenus indica* Malloch are recorded for the first time to be predaceous on the white-fly, *Siphoninus phillyreae finitimus* Goux, of which the Drosophilid fly, *A. indica* Malloch, was found to be the predominant one. The general population trend of the predators was found to follow a more or less similar trend to that of the host.

Among the weather factors minimum temperature and evening humidity showed a positively significant association with the aleyrodid infestation. Minimum temperature and morning humidity were found to have positive and negative associations respectively with the population of predators at a significant level. Population fluctuations of both the predators and the pest (prey) were found to be more or less interdependent. The aleyrodid infestation was decidedly governed by the weather elements morning humidity and evening humidity in addition to the biological factor viz., population of predators.

Introduction : During recent years studies on the relationship of environmental factors in population dynamics of insects has assumed considerable importance in economic entomology. It has come to be believed that fundamental studies along ecological lines must form the basis of further advances, and that biological control and other concepts of ecological control which have been badly neglected should be revived. Further more, insects are closely associated with their environment in many ways characteristic of and sometimes peculiar to each of them. Some insect populations are kept in check by the action of their natural enemies which may operate as density — dependent factors and others are often abundant inspite of natural enemies. These in turn depend on ecological conditions.

So far, studies on the fundamental nature of predators — prey interaction in particular and the interrelation of this coaction with other important parameters of population changes in general have been few. Fluctuations in predators and how they are related in time and place to prey populations have been investigated by a number of workers mostly in aphids, scales, mealy bugs and mites with reference to their predatory Coccinellid beetles and mites respectively. Very little attention has been

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paid to the study of the influence of weather factors on the occurrence of aleyrodids (white-flies) in India. Observations have so far been made on *Bemisia tabaci* Gennad. on cotton (Afzal Husain 1930) and on tobacco (Pruthi & Samuel 1942, Samuel 1950), *Aleurolobus barodensis* Mask. on sugarcane (Mahmood 1955, Basheer 1956), *Neomaskellia bergii* S. on sugarcane (Prasad 1954) and *Siphoninus phillyreae finitimus* Goux on three varieties of pomegranate and *Aleurocanthus spiniferus* Q. on rose by the author (1961). However, similar studies on predator — prey relationship with emphasis on weather factors have not so far been investigated in aleyrodids. In view of the lack of information on this subject in aleyrodids, the author investigated the effect of weather factors on the host—predators relationship in the aleyrodid, *Siphoninus phillyreae finitimus* Goux on two varieties of pomegranate (*Punica granatum* Linn.) and the results are furnished in this paper. In this connection, it would be of interest to note that the chief predator noted is a Drosophilid fly, *Acletoxenus indica* Malloch and this is the first time that an ecological study is undertaken on this fly predator of aleyrodids.

Review of Literature: Studies on the fundamental nature of predator – prey interaction and the interrelations with other factors on population changes with particular reference to the roll of predation have been investigated by a number of workers (Uvarov 1931; Errington 1937, 1946; Leopold 1954). Huffaker and Kennett (1956) made a study of predation under field conditions for the control of the Cyclamen mite, *Tarsonemus pallidus* Banks, in older plantings of strawberries in California by use of a native predatory mite, *Typhlodromus* sp. Huffaker (1958) conducted studies on the role of dispersion in predator–prey relations under controlled laboratory conditions using the phytophagous mite, *Eotetranychus sexmaculatus* as prey, and the mite *Typhlodromus occidentalis* as predator. Dunn (1951) reported the effect of temperature on the pea aphid — ladybird relationship. Changes in the numbers of adult Coccinellid beetles *Adalia bipunctata* (L.), *Coccinella septempunctata* L. and *Propylea quatuordecimpunctata* (L.) on nettles infested with *Microlophium evansi* (Theo.) and on three experimental bean plots infested with *Aphis fabae* Scop. are described by Banks (1956). The effect of temperature on the Coccinellid *Coccinella undecimpunctata aegyptiaca* Rche. has been investigated by Ibrahim (1955). Kenneth (1962) has reviewed the biology and ecology of predaceous Coccinellidae.

Materials & Methods: The present study was undertaken at Coimbatore during 1960 — '61 and the observations were made in the Orchard attached to the Agricultural College & Research Institute.

(i) *Materials*: For observations two varieties of pomegranate viz., *Vellodu* and *Kashmiri* situated in one and the same plot and infested with the white-fly, *Siphoninus phillyreae finitimus* Goux were selected.

(ii) *Methods*: The infestation of the white-fly and the population of predators on *Kashmiri* and *Vellodu* varieties of pomegranate were recorded at weekly intervals on two trees in each variety. The counts were taken at three different heights i.e., 0 to 2', 2 to 4' and 4' and above, and the number of leaves infested and uninfested (free) as also the predators encountered were recorded from three branches selected at random and the overall percentage of infestation and predatism arrived at. The observations were recorded between 8 and 9 a. m. at weekly intervals.

The meteorological data included in the study were obtained from the Agricultural Meteorologist, Coimbatore. Since the Meteorological Observatory is situated very close to the observation plot of the Orchard the readings formed a fair representation of the weather conditions in the Orchard.

The following meteorological observations viz., 1. absolute maximum temperature, 2. absolute minimum temperature, 3. absolute morning humidity (recorded at 7–10 A. M.), 4. absolute evening humidity (recorded at 2–10 P. M.) and 5. rainfall (recorded at 8 A. M.) recorded during the week were taken into consideration. Since the fluctuations in the day to day observations were normally high the absolute values were taken and the average values not considered.

The data were subjected to statistical analysis. Methods described by Fisher (1938) were followed for the calculation of simple correlations. The procedures given by Goulden (1952) were followed for working out multiple correlations and multiple regressions.

Experimental Results: The percentage of infestation of the white-fly and the percentage of population of the predators and also the meteorological data for the period from May 1960 to March 1961 during which the observations were made are furnished in tables I and II. The weather phenomena are plotted against the population trend of white-fly (Fig. 1) and its predators (Fig. 2) on two varieties of pomegranate (Figs. 3 & 4). The correlation coefficients (r) for the different weather factors and the infestation, the weather factors and the predators and the infestation and predators are presented in table III. The multiple correlation coefficients and the regression equations worked out are given in tables IV and V. The significant correlations established have been illustrated by diagrams (Figs. 5, 6, 7 & 8).

TABLE I

Percentage of infestation of aleyrodid and its predators

S. No. (1)	Date of observation (2)	Vellodu variety		Kashmiri variety	
		White-fly (3)	Predators (4)	White-fly (5)	Predators (6)
1.	13—5—1960	71·5	6·0	80·9	...
2.	2—6—1960	71·0	20·0	76·0	6·0
3.	9—6—1960	79·0	17·0	77·0	6·0
4.	16—6—1960	63·0	16·0*	70·0	11·0
5.	23—6—1960	25·5	12·0	59·0	9·0
6.	30—6—1960	37·0	22·0	49·0	11·0
7.	7—7—1960	62·5	24·0	54·0	10·0@
8.	14—7—1960	30·0	3·0	41·5	8·0
9.	21—7—1960	52·5	...	...	...
10.	28—7—1960	31·0	16·0	19·0	10·0
11.	4—8—1960	34·5	18·0	29·0	...
12.	11—8—1960	54·0	2·0	31·5	...
13.	25—8—1960	77·0	17·0	58·0	2·0
14.	1—9—1960	55·0	5·0	75·0	11·0
15.	8—9—1960	66·5	6·0	61·5	7·0
16.	15—9—1960	66·0	...	61·0	...
17.	22—9—1960	41·0	...	60·0	4·0
18.	29—9—1960	68·0	17·0	53·5	1·0
19.	22-10—1960	70·0	3·0	77·5	...
20.	29-10—1960	35·5	...	28·0	...
21.	5-11—1960	69·0	4·0	61·0	2·0
22.	12-11—1960	73·0	5·5	79·5	5·0£
23.	19-11—1960	79·0	5·0†	82·5	10·0‡
24.	26-11—1960	30·0	...	15·5	...
25.	6-12—1960	8·0	...	4·0	...
26.	13-12—1960	...	...	4·0	...
27.	20-12—1960	...	...	...	...
28.	27-12—1960	3·0	...	7·0	...
29.	3—1—1961	3·0	...	6·0	...
30.	10—1—1961	4·0	...	5·0	...
31.	19—1—1961	9·5	20·0	10·0	2·0
32.	31—1—1961	9·5	10·0	16·0	4·0
33.	7—2—1961	16·0	...	26·0	8·0
34.	17—2—1961	36·0	...	31·0	4·0
35.	23—2—1961	37·0	10·0	35·5	17·0
36.	8—3—1961	61·5	5·0	55·0	2·0
37.	15—3—1961	53·5	2·0	61·0	...

* 4% *Chrysopa* sp. — larvae.

@ 1·5% do. do.

£ 1% *Sticholotis* sp. — Grubs & adults.

† 2% do. do.

‡ 4% *Sticholotis* sp. and 4% *Chrysopa* sp.

TABLE II

Meteorological Data

S. No.	Date of observation	Maximum temperature	Minimum temperature	Morning humidity	Evening humidity	Rainfall
		°F	°F	%	%	cents
1.	13—5—1960	95·5	66·7	97	40	198
2.	2—6—1960	90·3	69·5	87	46	70
3.	9—6—1960	91·9	70·8	95	45	...
4.	16—6—1960	91·9	72·2	79	38	...
5.	23—6—1960	92·3	71·4	89	44	...
6.	30—6—1960	89·2	70·3	78	44	7
7.	7—7—1960	86·8	69·8	96	50	208
8.	14—7—1960	89·4	69·7	97	51	23
9.	21—7—1960	90·8	70·7	100	48	71
10.	28—7—1960	85·7	70·7	85	59	23
11.	4—8—1960	85·7	70·9	95	55	36
12.	11—8—1960	88·0	70·2	95	51	61
13.	25—8—1960	91·5	70·2	88	43	...
14.	1—9—1960	91·7	69·3	94	41	...
15.	8—9—1960	91·0	70·1	90	42	...
16.	15—9—1960	91·0	71·3	100	46	41
17.	22—9—1960	90·2	70·2	92	47	7
18.	29—9—1960	88·5	71·4	88	49	6
19.	22-10—1960	94·2	66·4	99	37	121
20.	29-10—1960	89·1	69·3	100	46	448
21.	5-11—1960	86·0	68·9	100	68	264
22.	12-11—1960	83·6	67·0	100	67	268
23.	19-11—1960	81·2	63·2	98	63	49
24.	26-11—1960	86·9	65·3	100	42	171
25.	6-12—1960	87·0	60·2	98	29	...
26.	13-12—1960	88·3	68·1	100	44	2
27.	20-12—1960	88·5	63·4	95	44	2
28.	27-12—1960	87·6	55·2	95	22	...
29.	3—1—1961	89·0	57·4	94	37	...
30.	10—1—1961	89·5	62·3	94	22	79
31.	19—1—1961	83·0	63·3	99	39	40
32.	31—1—1961	86·2	52·0	94	36	...
33.	7—2—1961	92·1	64·0	98	38	...
34.	17—2—1961	93·2	67·0	92	46	47
35.	23—2—1961	89·2	59·4	92	30	...
36.	8—3—1961	95·6	68·2	93	40	...
37.	15—3—1961	94·6	60·0	91	17	...

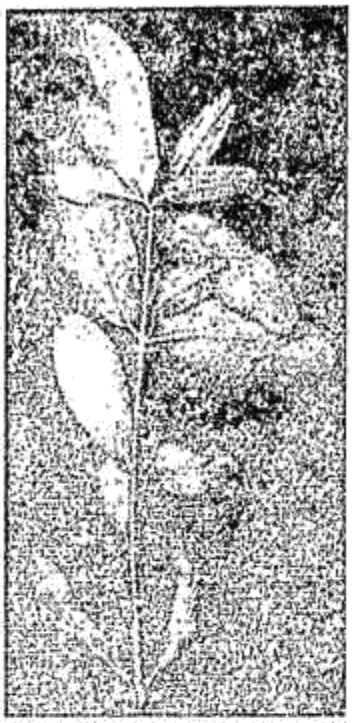


FIG. 1.
Pomegranate leaves infested with the Aleyrodid

HOST

Infestation trend of aleyrodid on pomegranate: The general trend of infestation of the white-fly was more or less the same in both the varieties of pomegranate considered in the studies. The peak infestation occurs during five definite periods during a year viz., from the second fortnight of May to first week of June, last week of August, third week of October, middle of November and the last week of March. A sudden fall in the infestation count was noticed by the last week of November which continues till the end of January. The intensity of infestation was generally higher in *Kashmiri* variety when compared to the intensity in *Vellodu* variety.

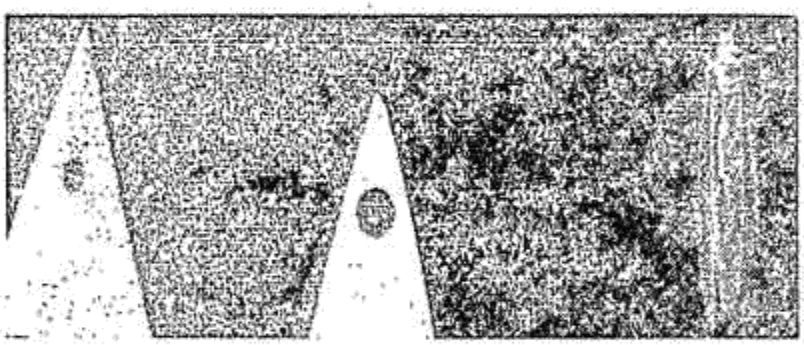
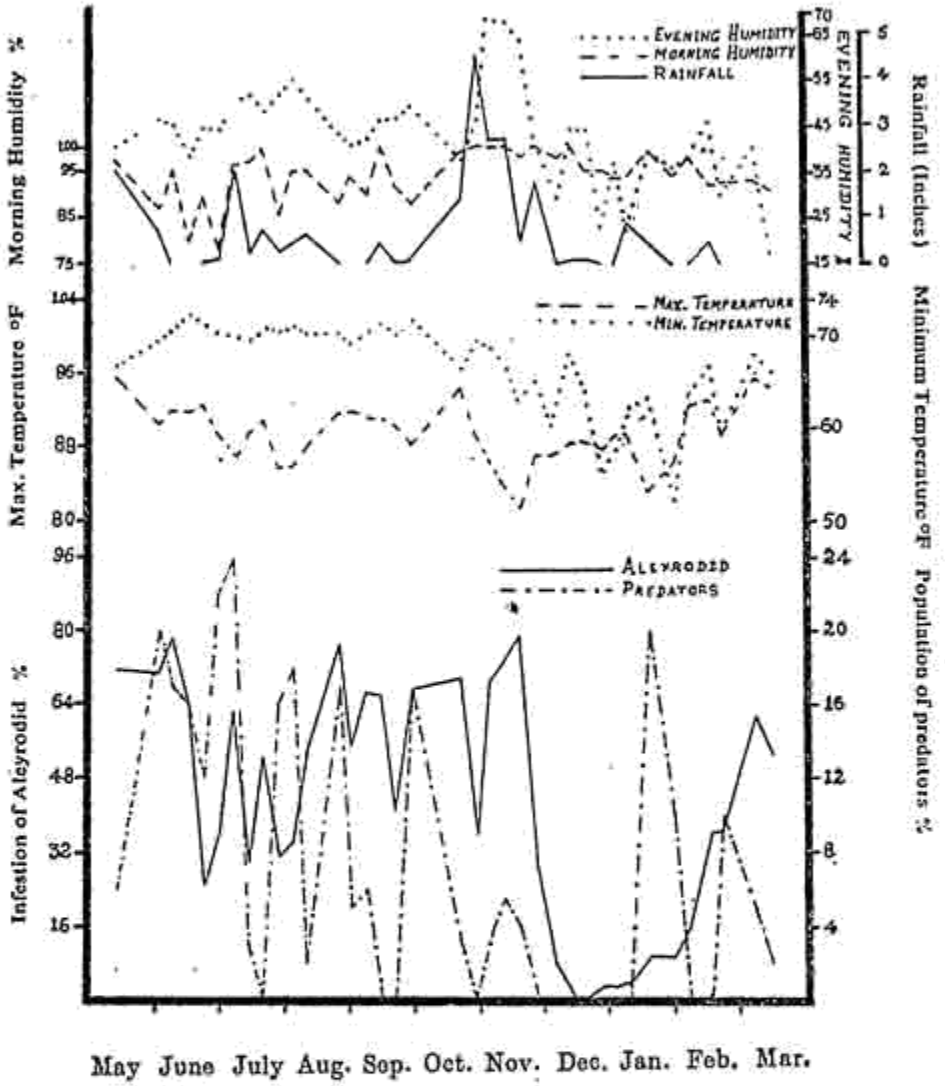


FIG. 2.
Predators of the Aleyrodid
L. to R. *Acletoxenus indica* M., *Sticholotis* sp. & *Chrysopa* sp.

Influence of weather factors on the trend of infestation: (a) *Simple correlation studies:* Simple correlations were worked out between the infestation of white-fly and the different weather factors. Among these weather factors minimum temperature and evening humidity showed a positively significant association at a probability of 0·01, when the *Vellodu* and *Kashmiri* varieties were considered individually and in combination. Though the other meteorological factors did not show any significant trend towards aleyrodid infestation maximum temperature and rainfall exerted a positive trend of association while morning humidity exhibited a negative trend.

FIG. 3.

Trend of Infestation of Aleyrodid, Predators and Weather factors
(Vellodu variety)

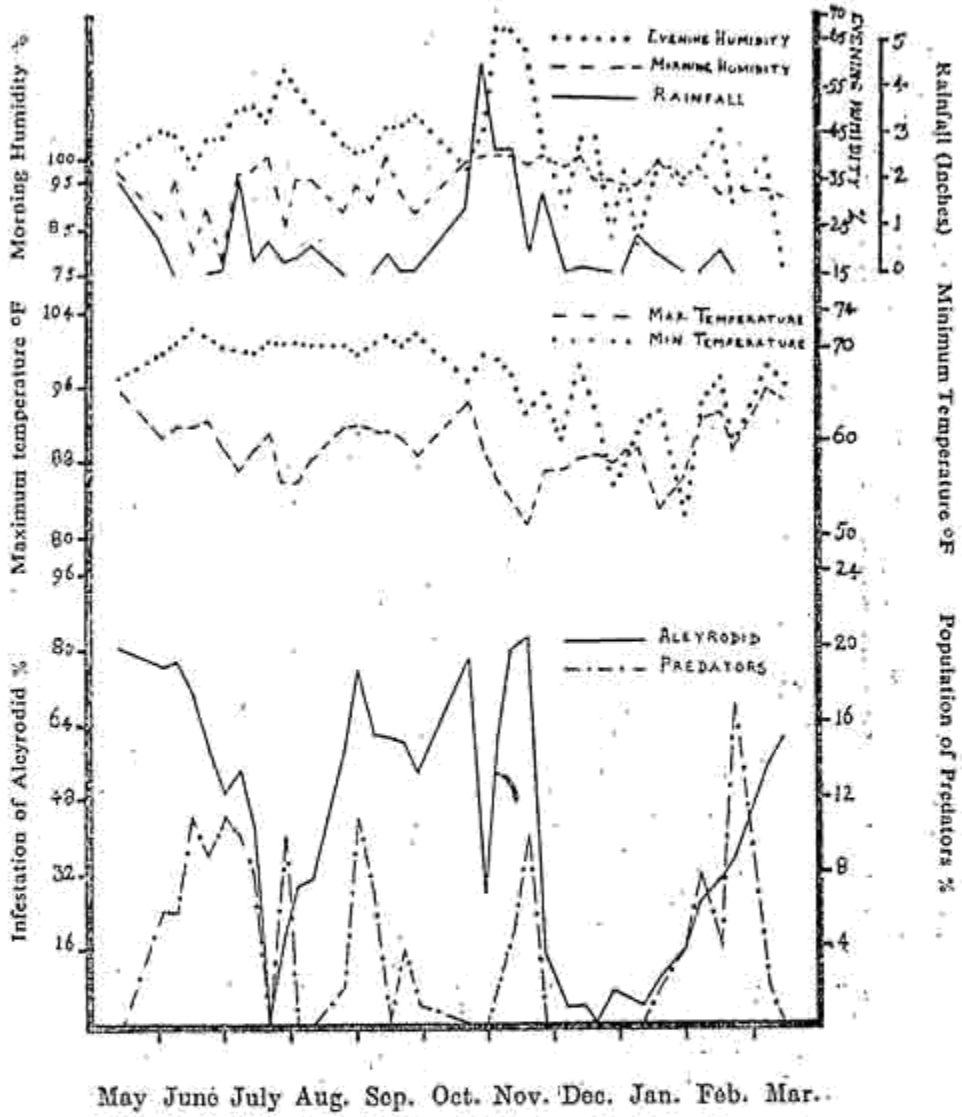


(b) *Multiple correlation studies:* With a view to estimate the influence of two or more independent factors on the infestation trend of aleyrodid multiple correlations were worked out and regression equations constructed.

For studying the combined association of two of the weather factors with the aleyrodid infestation, minimum temperature and evening humidity which had shown a significant trend were taken into consideration. A third factor viz., morning humidity which showed a negative but non-significant trend was also included in the multiple correlation studies since this factor has been found to have significant correlation with minimum temperature ($r = -0.3783^{**}$). While morning humidity showed a negative association with minimum temperature a significantly positive correlation

FIG. 4.

Trend of Infestation of Aleyrodid, Predators and Weather factors
(Kashmiri variety)



($r = 0{\cdot}4327^{**}$) was observed between minimum temperature and evening humidity. It is obvious, therefore, that among the very many weather factors, minimum temperature, morning humidity and evening humidity are interrelated and hence, in working out the multiple correlations they were taken into consideration.

Among the two varieties of pomegranate, in *Vellodu* variety no influence was observed to be exerted by any two of the meteorological factors on the infestation. A similar non-significant association was observed with regard to the combined effect of all the three meteorological factors considered. In the *Kashmiri* variety, though the combination of all the three factors did not show a significant trend, the combined effect of morning humidity and evening humidity exhibited a positive significant

TABLE III

Results of Simple Correlation Studies

Particulars	Correlation coefficient (r)		
	Vellodu variety	Kashmiri variety	Combined analysis
i. *Weather factors & Infestation of Aleyrodid on Pomegranate:*			
Infestation X Maximum temperature:	0·1846	0·2303	0·2077
,, X Minimum temperature:	0·6468**	0·5108**	0·5830**
,, X Morning humidity:	−0·1400	−0·2176	−0·1790
,, X Evening humidity:	0·4400**	0·8417**	0·6909**
,, X Rainfall:	0·2616	0·1428	0·2030
ii. *Weather factors & Predators:*			
Predators X Maximum temperature:	−0·1468	−0·0652	−0·1062
,, X Minimum temperature:	0·5532**	0·1376	0·3688*
,, X Morning humidity:	−0·5596**	−0·4748**	−0·5185**
,, X Evening humidity:	0·2089	0·1661	0·1875
,, X Rainfall:	−0·1904	−0·1903	−0·1904
iii. *Aleyrodid infestation & Predators:*			
Infestation X Predators:	0·3058	0·3678*	0·3372*

− Negative correlation.

* Significant at 5% level.

** Significant at 1% level.

association (R = 0·8810**). Also, minimum temperature in combination with morning humidity exerts a similar positive association (R = 0·5857*) with aleyrodid infestation.

PREDATORS

During the course of investigation three species of insects viz., grubs and adults of a Coccinellid beetle, *Sticholotis* sp., larvae and adults of a Chrysopid, *Chrysopa* sp. and maggots of a Drosophilid fly, *Aclctoxenus indica* Malloch were found to be predaceous on the different stages of the white-fly. This is the first time that all the above species are recorded as predaceous on the insect. The activities of the predators were evident throughout the year except during the period from the second fortnight of November to the first half of January. Among the predators only *A. indica* Malloch was noted in abundance throughout the period of its occurrence and the predatism reached a maximum of 24% during July. *Chrysopa* sp. was noted to be predaceous on the aleyrodid during June-July and the predator population recorded a maximum of 4% only. *Sticholotis* sp. was found active during November and the population of the predator did not exceed beyond 4%.

TABLE IV

Results of Multiple Correlation Studies

Particulars	Correlation coefficient (R)	
	Vellodu variety	Kashmiri variety
Aleyrodid infestation:		
Infestation X Minimum temperature & Evening humidity:	0·6711	0·8576
,, X Morning humidity & Evening humidity:	0·4650	0·8810**
,, X Minimum temperature & Morning humidity:	0·6092	0·5857*
,, X Minimum temperature, Morning humidity & Evening humidity:	0·6811	0·8576
,, X Minimum temperature, Evening humidity & Predators:	0·6676	0·8861
,, X Morning humidity, Evening humidity & Predators:	0·5079	0·8999**
,, X Minimum temperature, Morning humidity & Predators:	Not worked Out	0·6050
Predators:		
Predators X Minimum temperature & Evening humidity:	0·5543	0·1814
,, X Morning humidity & Evening humidity:	0·5759	0·4995
,, X Minimum temperature & Morning humidity:	0·6702**	0·4769
,, X Minimum temperature, Morning humidity & Evening humidity:	0 6703	0·4875
,, X Minimum temperature, Evening humidity & Aleyrodid:	0·5578	0·4573
,, X Morning humidity, Evening humidity & Aleyrodid:	0·6116	0·5453
,, X Minimum temperature, Morning humidity & Aleyrodid:	0·6285	Not worked out

* Significant at 5% level.

** Significant at 1% level.

TABLE V

Multiple Regression Equations

Particulars	Equation	R
i. Aleyrodid infestation on Kashmiri variety of pomegranate with Mini. temperature & Morning humidity as independent variates.	$Y = 129{\cdot}31 - (1{\cdot}998 \text{ X } X\text{-}1) + (-2{\cdot}348 \text{ X } X\text{-}2)$	0·5857 *
ii. Aleyrodid infestation on Kashmiri variety of pomegranate with Mor. humidity and Evening humidity as independent variates.	$Y = 103{\cdot}78 - (-1{\cdot}61 \text{ X } X\text{-}2) + (2{\cdot}067 \text{ X } X\text{-}3)$	0·8810 **
iii. Population of predators with Minimum temperature and Morning humidity as independent variates (Vellodu variety)	$Y = 14{\cdot}88 - (0{\cdot}6937 \text{ X } X\text{-}1) + (-0{\cdot}5752 \text{ X } X\text{-}2)$	0·6702 **

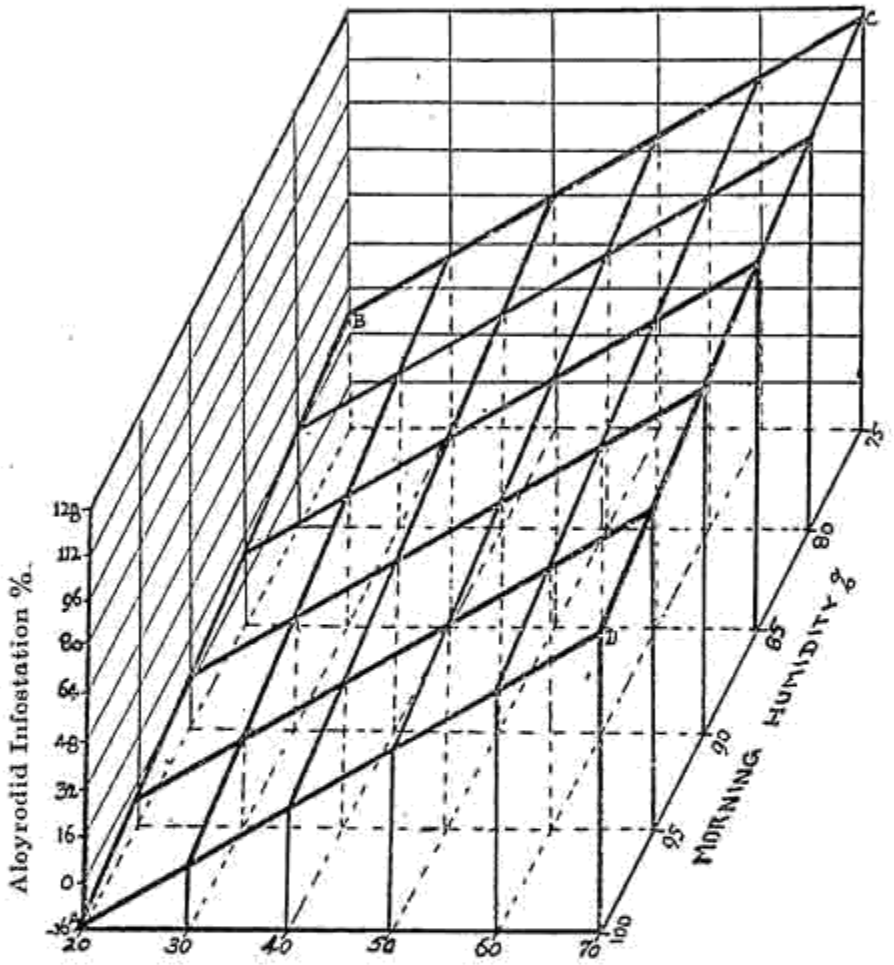
X-1 Minimum temperature

X-2 Morning humidity

X-3 Evening humidity

FIG. 5.

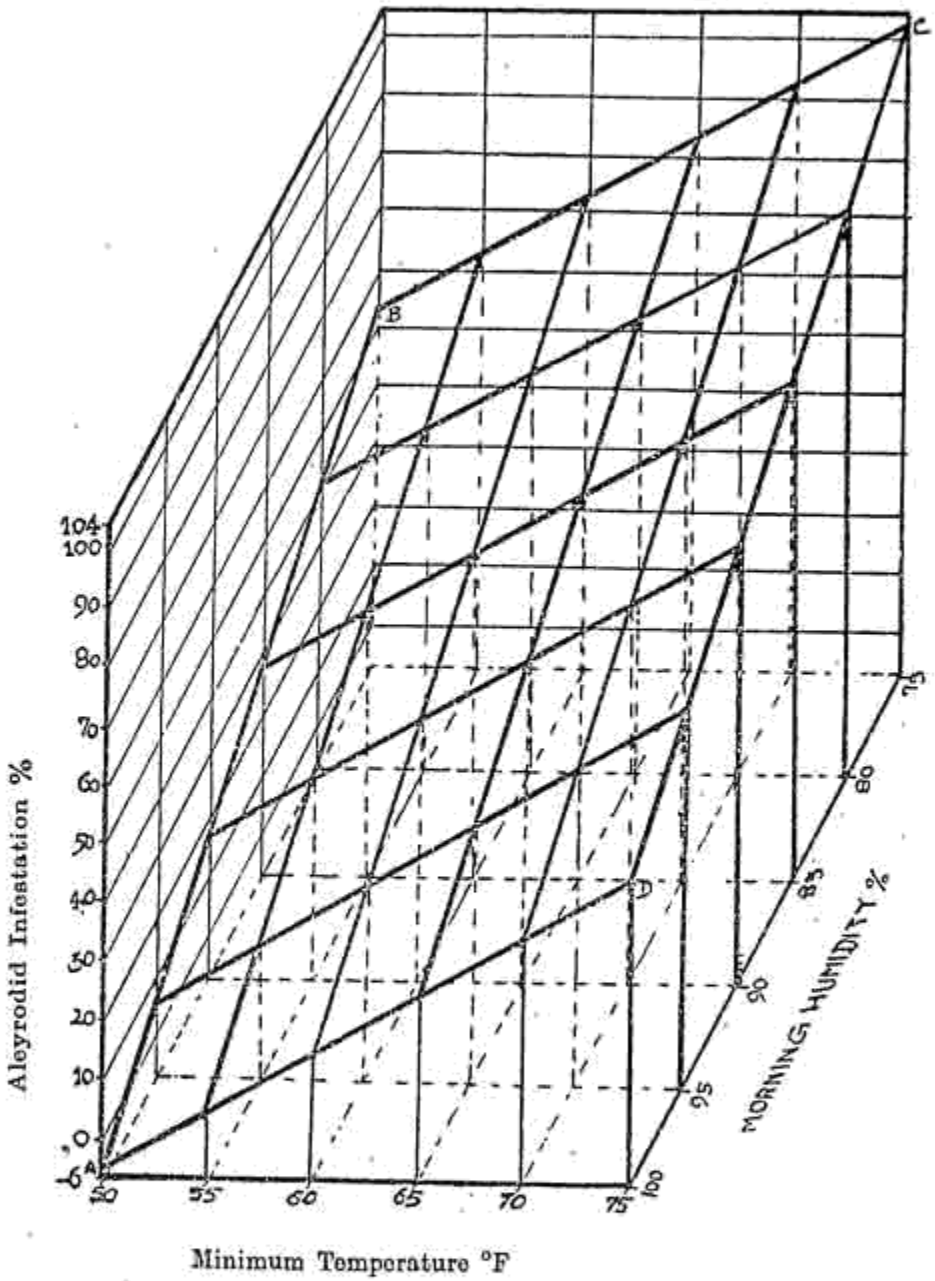
Influence of Evening Humidity and Morning Humidity on Aleyrodid Infestation (Kashmiri variety)



Population trend of predators: The general population trend of predators follows a more or less similar pattern to that of the host. In the *Vellodu* variety the maximum population of predators is noticed during the first week of June, second week of July and the third week of January though increase in population was observed by the first and last weeks of August and last week of September. In the *Kashmiri* variety the percentage of predator population is markedly lower when compared to that on the *Vellodu* variety and in the former the maximum population is recorded between 23rd February and 8th March. A peak occurrence of 24% of predators is recorded in the *Vellodu* variety on the 14th July while in the *Kashmiri* variety the maximum occurrence was only 17% on 23rd February. In both the varieties there was complete absence of predators between 26th November to 10th January.

FIG. 6.

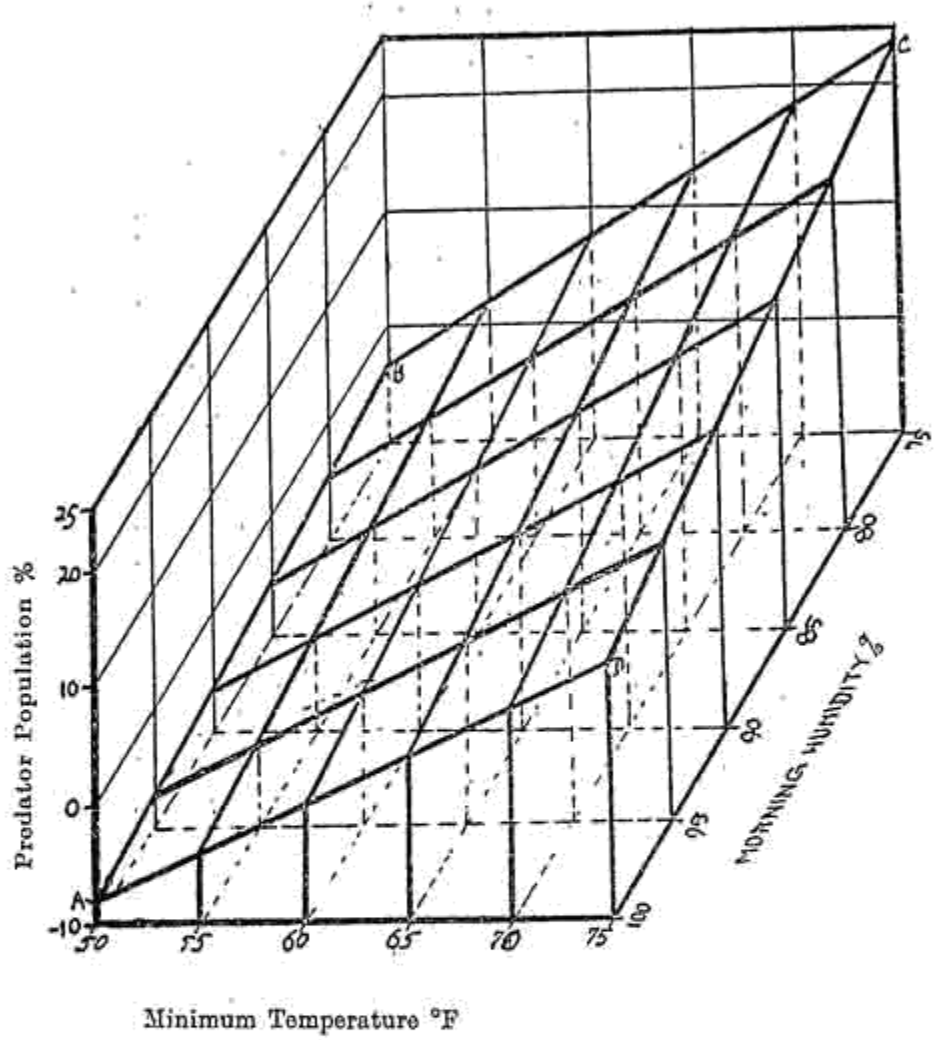
Influence of Minimum Temperature and Morning Humidity on Aleyrodid Infestation (Kashmiri Variety)



Influence of weather factors on the population trend of predators: (a) *Simple correlation studies :—* Among the weather factors, maximum temperature, morning humidity and rainfall possess a negative trend of association while minimum temperature and evening humidity exhibit a positive trend with the percentage of population of predators. Minimum temperature has a positively significant relationship with predators ($r = 0{\cdot}5532^{**}$) in *Vellodu* variety whereas no significant correlation exists in the *Kashmiri* variety. Yet the prevalence of a significant association between minimum

FIG. 7.

Influence of Minimum Temperature and Morning Humidity on Population of Predators (Vellodu variety)

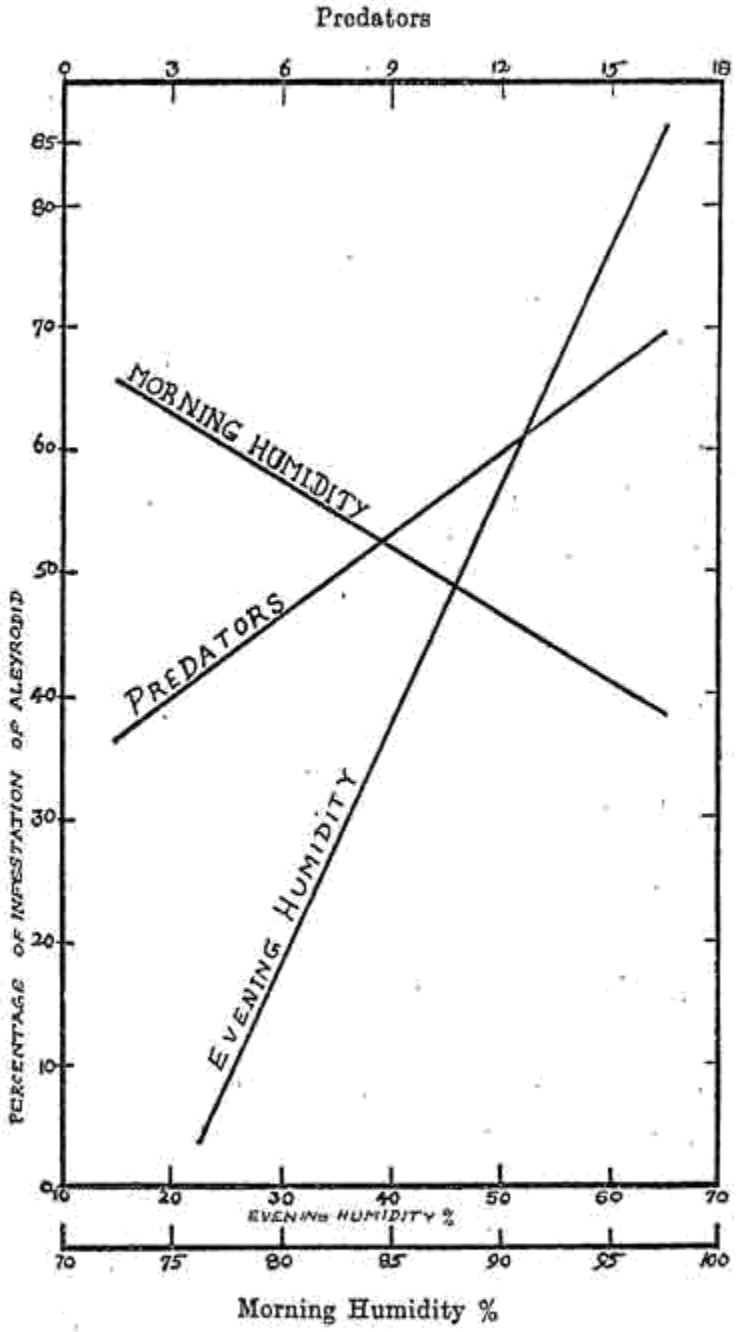


temperature and population of predators is expressed with the correlation co-efficient of 0·3688* when both the varieties are taken into consideration. Individually and in combination in both the varieties a significant but negative correlation between morning humidity and the population of predators is noticed. The other weather factors viz., maximum temperature, evening humidity and rainfall do not have any significant relationship to the population of predators.

(b) *Multiple correlation studies:* For working out the multiple correlations minimum temperature and morning humidity which have significant relationship with population of predators were taken into account. Further, in view of the significant association ($r = 0{\cdot}4327^{**}$) between minimum temperature and evening humidity, the latter weather factor was also included.

FIG. 8.

Influence of Evening Humidity, Morning Humidity and Predators on Aleyrodid Infestation (Kashmiri variety)



The values of correlation co-efficient between the population of predators and evening humidity have not improved to any considerable extent to warrant any significant association between them when minimum temperature and morning humidity were individually taken into consideration along with evening humidity. Though morning humidity which individually possesses a negatively significant correlation with population of predators loses its significant association in combination with evening

humidity, yet there is a significant correlation (R = 0·6702**) in *Vellodu* variety when the two factors minimum temperature and morning humidity are considered in combination with their relationship with the occurrence of predators, but in *Kashmiri* variety no such significant association is found to exist. The addition of the third weather element viz., evening humidity to minimum temperature and morning humidity has not improved the correlation coefficient to any considerable extent.

HOST-PREDATORS ASSOCIATION

To assess the relationship between the percentage of infestation of aleyrodid on the *Vellodu* and *Kashmiri* varieties of pomegranate and the percentage of population of predators on aleyrodid simple correlations were worked out and the results show that there are positive and significant associations in the *Kashmiri* variety and when both the varieties are considered together with correlation co-efficients of 0·3678* and 0·3372* respectively. Though a significant association was not encountered in the *Vellodu* variety there seems to be the prevalence of a positive association, the significance being missed by a marginal value.

Host-Predators relationship with emphasis on weather factors: It has been indicated earlier that evening humidity individually possesses a positive significant association with aleyrodid infestation with a coefficient value of 0·8417** in the *Kashmiri* variety. This value gets improved (R = 0·8810**) when morning humidity is also taken into account, thereby showing that both the weather elements viz., morning humidity and evening humidity together exert a definite influence on the percentage of infestation of aleyrodid. When these weather factors are considered along with the population of predators the correlation coefficient gets further improved to 0·8999** thereby indicating that morning humidity, evening humidity and the population of predators in combination have a definite association on the percentage of infestation of aleyrodid on the *Kashmiri* variety. In other words, it may be said that the aleyrodid infestation depends mainly upon two weather factors viz., morning humidity and evening humidity in their combination with the biological factor viz., the population of predators on the aleyrodid.

Discussion: The infestation trend of aleyrodid on pomegranate indicates that the peak infestation occurs from the second fort-night of May to first week of June, during the last week of August, third week of October, middle of November and last week of March under Coimbatore conditions. It has been recorded by Karam Singh (1931) that the white-fly on pomegrante appeared early in February and produced maximum infestation in March.

The population of the white-fly, *Bemisia tabaci* G. on tobacco was the maximum in autumn i. e. upto the middle of November, went down in winter and rose again in March (Pruthi & Samuel *loc cit.*). In the present studies it is observed that the highest infestation occurs during June and November and the infestation level goes down in December and January with gradual increase even from the commencement of February.

Considering the influence of the different w ...s infestation trend of aleyrodid the results of simple correlations indicate that minimum temperature and evening humidity exert a significantly positive influence on aleyrodid infestation. Among the combination of two of the weather factors, morning humidity in conjunction with evening humidity and minimum temperature separately exercises a positive association on aleyrodid infestation though when all the three factors are combined they do not exhibit any significant relationship. The influence of minimum temperature on the population of aleyrodid has been established by Prasad (*loc cit.*) in *Neomaskellia bergii* Sign. on sugarcane and Butler (1938a) in *Aleurodes brassicae* Walk. Although a significant positive association is observed between evening humidity and aleyrodid infestation in both the varieties of pomegranate at Coimbatore these results are not in conformity with that of Butler (1938b) and Avidov (1956) according to whom humidity had no effect on the population rate of aleyrodids. The high degree of association between aleyrodid and morning and evening humidity in combination shows that under tropical conditions humidity in general plays a more important role in conditioning the infestation of aleyrodid than any other weather factor.

During the studies on the population trend of predators on aleyrodid the author came across three species of insects viz., *Sticholotis* sp., *Chrysopa* sp. and *Acletoxenus indica* Malloch which are recorded for the first time as predaceous on the aleyrodid. Karam Singh *(loc cit.)* has earlier recorded several Coccinellid larvae feeding on the nymphs and among these *Clanis* sp. was especially abundant.

Though it is obvious that weather factors are considered to control the trend of infestation of aleyrodid it should not be ignored that the population trend of predators will also exert a definite influence on that of their prey. If the predator population alone is taken into consideration it is observed that though a more or less similar trend of population fluctuation is observable, many instances of rapid falls and increases in the population of predators are noticed even when the fluctuation with regard to its host was gradual. On a detailed consideration of the predators and host populations it is seen that the population fluctuations of both the predators and

the pest are more or less interdependent. This observation finds concurrence in the contributions of many previous workers on predator—host relationship. Allee *et al.* (1949) showed that "the abundance of a predator is usually associated with the abundance of its prey". Studies on predation and Cyclamen mite populations on strawberries in California by Huffaker and Kennett *(loc cit.)* indicated fairly regular reciprocally dependent oscillations of predator and pest (prey) populations, with the pest held to economically unimportant levels. Thompson (1956), Huffaker *(loc cit.)* and Kenneth *(loc cit.)* also endorse the view that "the increase in density of predators in response to the increase in density of its prey was immediate"!

Among the different meteorological factors that exert their influence on the population of predators the minimum temperature and the morning humidity are found to show a positive and negative associations respectively. These factors in combination also exhibit a definite influence on the percentnge of predators in the *Vellodu* variety. None of the other factors viz., maximum temperature, evening humidity and rainfall is found to condition the population of predators. Though Putman (1955) found that high temperatures decreased the efficiency of the predator *Stethorus punctum* (Leb.) on European red mite, the significance of high temperatures is not felt in the case of insects predaceous on the aleyrodid.

Studies on the influence of two or more factors on the infestation of aleyrodid indicated that morning humidity individually with evening humidity and minimum temperature showed a definite association with aleyrodid infestation in the *Kashmiri* variety, whereas significant correlations were not established in *Vellodu* variety. This, perhaps, may be attributed to the varietal difference or the place of origin of the varieties. Multiple correlations have established that aleyrodid infestation is governed by morning and evening humidity and the population of predators. Based on the values of correlation coefficient it may be said that among these three factors the population of predators acts secondary to evening humidity in conditioning aleyrodid infestation. This may bring out the fact that the host—predators relationship in this particular case is governed in essential by humidity.

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* Original not seen.

BOOK REVIEW

Banana in India: By T. Gopalan Nayar (The FACT Technical Society, Udyogamandal, Kerala. Published 1962; pp. 179; illustrated. Price Rs. 9/- inland, and Rs. 10/- foreign)

This book has its own merits and demerits. It contains some useful information on the work carried out at the Central Banana Research Station at Aduthurai, and which information is not readily available to the layman. An attempt, however meagre it may be, has been made to present some facts about the classification of the bananas. Notes on the commercial cultivation of some banana varieties are also informative and useful.

Printer's error are many; the colour illustrations are of very poor quality and some illustrations referred to in the text are missing atleast in the reviewer's copy; citation of literature is not standardised and some of the references are wrongly cited; certain statements are ambiguous and some are even misleading. All these at once give the impression that the manuscript was not edited, nor the proof corrected at any stage. Two important and standard textbooks on bananas, viz. *Diseases of the banana* by C. W. Wardlaw and *Bananas* by N. W. Simmonds, published prior to the publication of the book under review, do not find mention anywhere in the text.

A mature research worker could certainly sift the grain from the chaff and find something useful in this book, but the reviewer would hesitate to place the book, in its present form, in the hands of the modern under-graduate student.