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A study on the effects of certain abiotic factors on the activity of *Adoretus epipleuralis* Arrow (Coleoptera: Scarabaeidae)

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Abstract. The effect of certain abiotic factors viz. temperature relative humidity and soil moisture has been revealed on the activity of *Adoretus epipleuralis* Arrow. This beetle was caught with the help of Pilani type light trap operated daily for 2 years (1976, 1977) from dusk to dawn at Pilani (Pilani is on the North-eastern side of Jhunjhunu District of Shekhawati Region in semi-arid zone of Rajasthan, India. Its geographical position is 28°20′ N latitude and 75°35′ E longitude and 330 mase.). To ascertain in mathematical terms the extent of relationship between the prevailing weather conditions and the light trap catches of *Adoretus epipleuralis*, regression analysis, partial regression analysis, multiple linear regression analysis and β-coefficient analysis have been exercised.

Keywords. Abiotic factor; catch; flight activity.

1. Introduction

The study shows that *Adoretus epipleuralis* responds well to the soil moisture component of the abiotic environment (correlation coefficient $r = 0{\cdot}7991$, regression coefficient $= 0{\cdot}2215$ and β-regression coefficient is $= 0{\cdot}5716$). This response is the highest in comparison to its response to other weather factors and is closely followed by minimum temperature (correlation coefficient $= 0{\cdot}6439$, regression coefficient $= 0{\cdot}0706$, and β-regression coefficient $= 0{\cdot}4947$). The rest of the factors are having either negative or just negligible influence.

Nothing is known about its ecology in the Indian context. Practically no work has been done on *A. epipleuralis* in Rajasthan. The present work will help unfold certain ecological facts about *A. epipleuralis*, a voracious forest pest.

2. Material and methods

The dependent factor i.e. the abundance of *A. epipleuralis* was recorded daily for 2 years (1976, 1977). This has been accomplished by operating the Pilani type light trap (Kundu *et al* 1961; Jakhar 1969; Narula 1969; Bandyopadhyay 1970; Naik and Kundu 1977; Chand 1979) daily from dusk to dawn.

The independent abiotic factors i.e. 8.30 AM relative humidity, 5.30 PM relative humidity, mean relative humidity, minimum temperature, maximum temperature, mean temperature and rainfall were also recorded from the meteorological sub-station

of Government of India which is being maintained over here at Pilani. Readings of the Stevensen's Screen were taken twice a day, once at 8.30 AM and again at 5.30 PM.

As far as soil moisture factor is concerned, 3 samples of soils were taken from the vicinity at 3 depths (0–5, 10–15 and 25–30 cms) just after switching on the light trap and completing the other necessities to make it functional. All the samples were brought to the laboratory and processed in IR Moisture Balance (Toshniwal) to calculate the moisture contents on dry matter weight basis. The following given formula was used:

$$\text{Moisture } (\%) = \frac{100 \times P}{100 - P}$$

where P is the reading read directly on the balance. The samples were put to a temperature of 105°C for a duration of half an hour. The mean of the 3 samples were recorded for further calculations.

2.1 *Interpretation of the catch*

Williams (1940) opined that "the catch in the light trap in any night is a sample, as unbiased as possible, of the night flying positively phototrophic insects which are active in the neighbourhood of the trap". According to Williams (1940):

Catch α-activity $\times$ population.

Since the flight activity of various insects is again dependent on the effect of various weather components, the total activity is defined as:

Total activity = activity due to temperature = activity due to humidity etc.

Catch α (activity due to temperature $\times$ activity due to humidity etc.) $\times$ population.

Now, as a result of the values being expressed in log catch by proportional changes

Log catch = (log activity temperature + log activity humidity etc. + log population).

The log catch is, therefore, made up of portions due to the effect on the activity of different climatic factors plus a portion decided by the total population available for sampling. It may be pointed out here that light trap captures or catches have been used to specify the individuals caught, of a particular species, in the light trap.

The numbers of all the captures of *A. epipleuralis* have been converted to log values from which all mathematical calculations have been done (Williams 1937). Here 5-day means of the log values of the captures have been used for the purpose of calculations (Jakhar 1969; Narula 1969; Bandyopadhyay 1970; Naik and Kundu 1977; Chand 1979). Since the value of log of zero is minus infinity, one has been added to all catches before taking their log values (Williams 1937).

In order to estimate the level of correlationship between activity of *A. epipleuralis* (captures in the light trap) and the selected abiotic factors simple regression analysis and partial regression analysis has been done following Williams (1937, 1939, 1941), Jakhar (1969), Narula (1969), Bandyopadhyay (1970) and Chand (1979).

Since a number of factors affect the flight activity of insects, the contribution due to each of these can be assessed with the help of multiple regression models. Multiple regression analysis has been done following Laebo (1968). It may be mentioned here that the two abiotic factors viz. mean temperature and mean relative humidity have been excluded from the models as they are functions of maximum and minimum temperature, and 08.30 hr and 17.30 hr relative humidity parameters respectively. Once the temperature and relative humidity factors are defined in the models, their means are automatically defined.

Since the β-regression coefficients provide a more accurate information of the relative importance of the independent variables, such an analysis has also been taken following Laebo (1968).

3. Results

The 8 regression equations obtained on *A. epipleuralis* due to the effect of various 8 abiotic factors for the period January to December both years (1976, 1977) taken together are given below:

(i)	Soil moisture	$\hat{Y} = 0{\cdot}2215X + 0{\cdot}1731$:($r = 0{\cdot}7991$, $P = 0{\cdot}001$)
(ii)	8.30 AM relative humidity	$\hat{Y} = 0{\cdot}0232X - 1{\cdot}0910$:($r = 0{\cdot}4293$, $P = 0{\cdot}001$)
(iii)	5.30 PM relative humidity	$\hat{Y} = 0{\cdot}0229X - 0{\cdot}4015$:($r = 0{\cdot}4320$, $P = 0{\cdot}001$)
(iv)	Mean relative humidity	$\hat{Y} = 0{\cdot}0248X - 0{\cdot}8467$:($r = 0{\cdot}5021$, $P = 0{\cdot}001$)
(v)	Maximum temperature	$\hat{Y} = 0{\cdot}0439X - 0{\cdot}8384$:($r = 0{\cdot}2989$, $P = 0{\cdot}01$)
(vi)	Minimum temperature	$\hat{Y} = 0{\cdot}0706X - 0{\cdot}5956$:($r = 0{\cdot}6439$, $P = 0{\cdot}001$)
(vii)	Mean temperature	$\hat{Y} = 0{\cdot}0677X - 1{\cdot}0780$:($r = 0{\cdot}5173$, $P = 0{\cdot}001$)
(viii)	Rainfall	$\hat{Y} = 0{\cdot}1398X - 0{\cdot}3428$:($r = 0{\cdot}6719$, $P = 0{\cdot}001$)

The extent of increase or decrease in various climatic factors required to double catch is as below:

Soil moisture (%)	= 1·36%
8.30 AM relative humidity	= 12·97%
5.30 PM relative humidity	= 13·14%
Mean relative humidity	= 12·13%
Maximum temperature	= 14·26°C
Minimum temperature	= 6·85°C
Mean temperature	= 4·44°C
Rainfall	= 2·15 mm

The values of partial correlation coefficients of log catch on various climatic factors are given in table 1.

Multiple regression equation derived is given below:

$$\hat{Y} = 0{\cdot}4262 + 0{\cdot}1584X_1 + 0{\cdot}0052X_2 - 0{\cdot}0018X_3 - 0{\cdot}0150X_4 + 0{\cdot}0542X_5 - 0{\cdot}0019X_6\text{: } (r = 0{\cdot}6705,\ P = 0{\cdot}001).$$

Table 1. Partial correlation coefficients of log catch for *A. epipleuralis* on various climatic factors for the period January 1976–December 1977

Independent variable \ Eliminated variable	Soil moisture	8.30 AM relative humidity (%)	5.30 PM relative humidity (%)	Mean relative humidity (%)	Maximum temperature (°C)	Minimum temperature (°C)	Mean temperature (°C)	Rainfall (mm)
Soil moisture	—	0·2251	0·2167	0·2288	0·2195	0·1777	0·1977	0·2354
8.30 AM relative humidity	−0·0012	—	−0·0085	−0·0373	0·0345	0·0221	0·0281	0·0078
5.30 PM relative humidity	0·0011	0·0288	—	0·0373	0·0271	0·0179	0·0224	0·0088
Mean relative humidity	0·0001	0·0576	−0·0170	—	0·0323	0·0210	0·0203	0·0092
Maximum temperature	0·0409	0·0798	0·0644	0·0729	—	−0·1192	−0·2646	0·0448
Minimum temperature	0·0406	0·0691	0·0611	0·0544	0·1452	—	0·2544	0·0515
Mean temperature	0·0436	0·0780	0·0660	0·0715	0·2906	−0·2384	—	0·0523
Rainfall	−0·0121	0·1256	0·1144	0·1183	0·1404	0·1066	0·1233	—

The β-regression coefficient values due to the various climatic factors are:

Soil moisture (%)	= 0·5716
8.30 AM relative humidity (%)	= 0·0969
5.30 PM relative humidity (%)	= −0·0418
Maximum temperature (°C)	= −0·1025
Minimum temperature (°C)	= 0·4947
Rainfall (mm)	= −0·0093

Based upon the multiple regression analysis technique, the level of increase required in a particular parameter in order to double the catch of *A. epipleuralis*, keeping all other parameters constant at that time are given below:

Soil moisture (%)	= 1·89
8.30 AM relative humidity	= 57·80
5.30 PM relative humidity	= −167·20
Maximum temperature (°C)	= − 20·06
Minimum temperature (°C)	= 5·55
Rainfall (mm)	= −158·40

4. Discussion

It is evident, based upon the values of simple correlation coefficients, that the highest value is obtained due to soil moisture ($r = 0{\cdot}7991$) followed by rainfall ($r = 0{\cdot}6719$); minimum temperature ($r = 0{\cdot}6439$); 5.30 PM relative humidity (%) ($r = 0{\cdot}5320$); mean temperature ($r = 0{\cdot}5173$); mean relative humidity (%) ($r = 0{\cdot}5021$); and 8.30 AM relative humidity (%) ($r = 0{\cdot}4293$) all significant at $P = 0{\cdot}001$ level. Further the most influential values of regression coefficients are obtained on soil moisture (0·2215); rainfall (0·1398) and minimum temperature (0·0706). It is also evident that the minimum level of increase required in a certain parameter in order to evoke a response in the log catch of *A. epipleuralis* to double itself; is found in case of soil moisture (1·36%) followed by rainfall (2·15 mm) and mean temperature (4·44°C). It is also clear that this influential mean temperature effect on the log catch of *A. epipleuralis* is being exercised indirectly through minimum temperature (level of increased temperature required is 6·85°C) whereas in case of maximum temperature this value is 14·26°C. So according to the results of simple regression analysis it seems that soil moisture, rainfall and minimum temperature are more influential in that order. It is also clear that the relative humidity parameters are exercising almost equal influential role. However, maximum temperature seems to play an insignificant role in determining the log catch of *A. epipleuralis* ($r = 0{\cdot}2989$, $P = 0{\cdot}01$).

The salient feature of partial regression analysis is that soil moisture acts most positively on the log catch of *A. epipleuralis* (table 1).

The coefficient of multiple correlation is 0·8705 which is significant at $P = 0{\cdot}001$ level thus 75·78% variability in the log catch is associated for by a linear combination of soil moisture (X_1), 8.30 AM relative humidity (X_3), minimum temperature (X_4), maximum temperature (X_5) and rainfall in mm (X_6) according to the following regression:

$$\hat{Y} = 0{\cdot}4262 + 0{\cdot}1584X_1 + 0{\cdot}0052X_2 + 0{\cdot}0018X_3 - 0{\cdot}9150X_4 + 0{\cdot}0542X_5 - 0{\cdot}0019X_6,$$

which may be interpreted to mean that estimated log catch increases or decreases by a value equal to the net regression coefficients of the respective climatic factor as shown in the equation.

From the absolute values of β-coefficients it is apparent that the order of relative importance of the different climatic factors is as follows:

> Soil moisture (0·5716), Minimum temperature (0·4947), Maximum temperature (−0·1025), 8.30 AM relative humidity (0·0969), 5.30 PM relative humidity (−0·0418), rainfall (−0·0093).

From the above it is evident that soil moisture and minimum temperature are the two most influential climatic factors in determining the log catch of *A. epileuralis* and maximum temperature tends to play a negative role whereas all others are insignificant.

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