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INFLUENCE OF WEATHER PARAMETERS ON PHEROMONE TRAP CATCHES OF *SPODOPTERA LITURA* MALE MOTH

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ABSTRACT : The pheromone trap catches of *Spodoptera litura* (Fab.) from 1990 to 2000 belongs to AICRP on Groundnut, MARS UAS, Dharwad were studied to evaluate the impact of weather factors on the male moths trapped during the season. Pheromone traps with spodolure were installed in groundnut field at MARS, UAS, Dharwad during kharif season(June to November) and the number of moths trapped were recorded at daily interval during all the years. The lure and chemical was changed once in 15 days. Correlation and regression coefficients were also computed to know the relationship between weather factors and moth catches. Further, the influence of different independent variables on dependent variables were also measured. The results indicated the higher number of moths were trapped in 35th (1st week of September) to 38th (4th week of September) standard week in all the years. A negative and significant relation with maximum temperature (r= -0.665) and rainfall (r= -0.609*) and a positive significant relation with evening relative humidity (r= 0.701**) was existed. The multiple linear regression analysis between weather parameters and the trap catch indicated an increase of 46.02 mean number of trap catch for every degree increase in maximum temperature. An increase in 1mm rainfall would lead to decrease of 4.08 mean number of trap catch was noticed.**

Key words : Pheromone trap, *Spodoptera litura*, moth, weather parameter, correlation, regression.

INTRODUCTION

The tobacco caterpillar, *S. litura* is widely distributed throughout the world. It is next to *H. armigera* in terms of economic importance at national level. The population of this defoliator in groundnut ecosystem has been found to increase in number and intensity both in rainy and post rainy seasons, especially in fields where insecticides have been applied (Rao and Shanower, 1989; Stechmann and Semisi, 1984) due to destruction of natural control system. In recent years, these pests created a serious threat to agricultural industry due to development of resistance towards commonly used insecticides. Pheromone traps are usually used for sampling and monitoring the insects. The insect monitoring data over a period can give a picture about their status under different environmental condition.

The monitoring of insect pests can be done by using the sex pheromones and it has been reported that these are very useful in determining the seasonal activity of pests (Singh and Sachan, 1991; Patil *et al*, 1992). Further, information obtained from pheromone trap collections can be used for development of models to predict the seasonal incidence of pests. Environment can greatly affect the size of the trap catch by influencing both the activity of the insect as well as the relative performance of the trap. The interpretation of trap catch data is often difficult because of confounding affects of the environment /and interaction between insect activity and trap performance (Dent and Pawar, 1988). If a consistent relationship exists, between trap catches and weather parameters; pheromone traps can be used to indicate when the field should be scored more intensively to determine the need to initiate the protection measures. The historical data on *Spodoptera* male moth trap catch, integration of biological agents, mixed and intercropping, pheromone traps and resistant varieties appear to be ideal strategies against *S. litura* on groundnut crop. With this in background an analysis of pheromone trap catches of *S. litura* male moth made from 1990 to 2000 at AICRP on Groundnut, Dharwad is undertaken to assess the future prediction of the pest.

MATERIALS AND METHODS

The pheromone trap comprising a single plastic funnel was used with the septa obtained from Pest Control India Ltd., Bengaluru (Karnataka). The pheromone traps were installed in Groundnut field at Main Agricultural Research Station, University of Agricultural Sciences Dharwad. Dharwad is located in Northern Transition Zone (Zone 8) of Karnataka and is situated at 15° 26' North latitude, 75° 07' East longitude and at an altitude of 678 m above mean sea level (MSL) in India. The pheromone data pertaining to *kharif* (June to October) season was analyzed. Three pheromone traps were placed at a distance of 200 m between two traps (Rao *et al*, 1991a) and at 1 meter above the ground level. Later depending on the crop growth, the pheromone traps height was changed and placed up to 1.5 meter above ground level in groundnut crop (Krishnananda and Satyanarayana, 1985; Rao *et al*, 1991b and Krishnananda *et al*, 1992). Each pheromone lure was replaced with a new one after an exposure of 15 days (Rao *et al*, 1991a). A small cotton plug with few drops of dichlorvos was placed at the bottom of polythene sleeve of pheromone traps to kill the trapped moths. The number of moths trapped was recorded daily in the morning. Data on weather parameters were collected from the Meteorological Observatory of MARS, UAS, Dharwad. The relationship between different weather factors and male moth catches in the pheromone traps was established by using simple correlation and multiple regression analysis adopting stepwise method.

A statistical model is an equation or set of equations which represents the relationships among variables. Modelling may lead to an adhoc experimentation, as models sometimes make it easier to design experiments to answer particular questions, or to discriminate between alternative mechanisms. Modelling provides powerful tools for investigating the dependence and nature of relationships among the variables of interest. The relationship among variables must be determined for the purpose of predicting the values of dependent variable on the basis of observations of independent variables. The data was analyzed using correlation coefficient and multiple linear regression to fit a model.

Correlation coefficient : Correlation coefficient measures the strength of the linear relationship between two variables X and Y. It is calculated by using following formula, where X and Y are independent and dependent variable respectively.

$$r = \frac{n\{\Sigma(xy) - (\Sigma(x)\Sigma(y))\}}{\sqrt{\left[n\Sigma x^2 - (\Sigma x)^2\right]\left[n\Sigma y^2 - (\Sigma y)^2\right]}}$$

Multiple Linear Regression : Multiple regression is used to understand the functional relationships between the dependent and independent variables, to try to see what might be causing the variation in the dependent variable. It is often useful to decide which is important and unimportant variables are.

Where, Y is the dependent (or response) variable, Xi's are independent (or predictor) variables and e is the error term. When the number of variables which explain the dependent variable are more than one, multiple linear regression model can be used. Here, the model is,

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p + \varepsilon$$

RESULTS AND DISCUSSION

The *S. litura* male moths trapped in pheromone traps right from 26th standard week (4th week of June) in majority cases during kharif season and their activity was reduced from 41st standard week. The distribution of peak trap catches during the (Table 1) 11 years recorded between 27th and 39th standard week. However, in all the year considerable number of moths were trapped from 35th standard week (1st week of September) to distributed

Table 1 : Pheromone trap catches of *Spodoptera litura* male moths during *kharif* season (1990-2000).

MSW	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
26	16	74	171	0	332	18	90	0	0	0	0
27	0	72	105	105	482	16	**661**	64	434	32	9
28	168	64	30	98	88	26	324	297	951	37	5
29	197	39	37	49	113	58	121	**316**	**1849**	48	3
30	**664**	24	53	70	57	61	60	286	1580	15	89
31	600	96	52	99	454	85	113	91	658	29	324
32	646	**238**	105	264	1601	108	138	127	602	52	161
33	457	88	174	202	**2720**	159	103	204	777	66	181
34	267	78	159	269	2714	**311**	149	202	649	83	25
35	334	114	291	245	2086	308	141	151	457	90	84
36	246	123	**343**	410	1272	184	157	178	66	115	**415**
37	309	116	134	399	1659	196	**432**	111	156	127	110
38	282	157	140	**462**	72	129	260	53	108	152	215
39	178	93	131	375	0	19	310	129	35	**176**	43
40	33	104	38	161	0	99	399	102	0	167	0
41	27	28	45	49	0	77	454	7	0	159	0
42	33	10	0	22	0	0	288	0	0	54	0
43	25	0	0	7	0	0	198	0	0	0	0
44	88	0	0	6	0	0	0	0	0	0	0

Table 2 : Relationship between the trap catch with weather characters.

Weather parameters	Trap catch
Maximum temperature	-0.665**
Minimum temperature	0.265
Relative humidity (Morning)	0.383
Relative humidity (Evening)	0.701**
Rainfall	-0.609*

Note: ** Significance at 1%, * Significance at 5%.

between 32nd (2nd week of August) to 36th (2nd week of September) standard week in majority years. Their sudden increase in the trap catches in the absence of their noticeable incidence on the field where pheromone traps were installed might be due to migration of moths from nearby field. The migration of *S. litura* has already been reported in the past by Fu *et al* (2015).

The influence of weather parameters on pheromone trap catches of Spodoptera male moths were studied and which revealed a positive and non-significant relationship with minimum temperature (r= 0.265) and morning relative humidity (r= 0.383), negative and significant relation with maximum temperature (r= -0.665**) and rainfall (r = -0.609*). Interestingly there was a positive significant relation with evening relative humidity (r= 0.701**) was existed (Table 2). However, evening relative humidity (r= -0.310), total rainfall (r= -0.203), minimum temperature (r= -0.077) and morning relative humidity (r= -0.002) were found to have negative correlation with trap catches of *S. litura*. Moreover sunshine hours (r= 0.174), maximum temperature (r= 0.047) and number of rainy days (r= 0.061) were nonsignificant and positively correlated with trap catches of *S. litura*. It is very difficult to draw a concrete conclusion based on short period of observation. However, the present study was made for 11 years and

Table 3 : Model summary for multiple regression on trap catch with weather parameters.

Variables	Co-efficient		R^2
	b	SE	
(Constant)	-1641.41	5599.20	0.730
MAXTEMP(X1)	46.02	145.35	
MINTEMP(X2)	-45.04	80.41	
RH(X3)	-7.59	45.34	
RH(X4)	29.28	42.26	
RF(X5)	-4.08	2.62	

Equation : Trap catch = -1641.41 + 46.02 X1 - 45.04 X2 – 7.59 X3+29.28 X4– 4.08 X5

while analyzing the data only the moths trapped between 28th to 40th standard week was considered to avoid the influence of unseasonal catches or the migratory moths from nearby fields. Similar results of negative impact of rainfall was observed by Jagadish *et al* (2007) and Prasannakumar *et al* (2012). Rudraswamy *et al* (2006) reported a positive and highly significant relationship between number of moths caught and average weekly maximum temperature, followed by total rainfall in a week and number of rainy days in a week. They further reported a significant and negative relationship between moths caught in the traps and average weekly minimum temperature. This may be due to change in the method of analysis and also there was no mention about the season/ effective standard week. The present results is similar to Nandihalli *et al* (1989) and Kulkarni(1989) who observed the negative relationship between moths caught in the traps and average weekly minimum temperature. Basavaraj *et al* (2013) found that correlation between the pheromone trap catches of *S. litura* with the different weather parameters of the corresponding week was non-significant.

Table 4 : Model summary for Backward Regression on trap catch with weather parameters.

Steps	Variables entered	Variables removed	R^2
Starting	MAXTEMP, MINTEMP,RHm, RHe,RF,		0.730
1st step	MAXTEMP, MINTEMP, RHe,RF	RHm	0.729
2nd step	MINTEMP, RHe,RF	MAXTEMP	0.727
3rd step	RHe,RF	MINTEMP	0.719

Variable R^2

MAXTEMPT	**MINTEMP**	**RHm**	**RHe**	**RF**
MAXTEMP	**MINTEMP**	**RHe**	**RF**	
MINTEMP	**RHe**	**RF**		
RHe	**RF**			

Significant Variables equation: Evening RH and RF. Trap catch = -765.91 + 14.33 X_4 – 4.82 X_5

The multiple linear regression analysis between weather parameters and the trap catch (Table 3) showed a R^2 value of 0.730 indicating 73 per cent influence of all-weather parameters on the incidence of S*podoptera.* The multiple regression equation between them happens to be; $Y = -1641.41 + 46.02X_1 - 45.04X_2 - 7.59 X_3 + 29.28 X_4 - 4.08 X_5$. The results clearly indicates that for each degree increase in maximum temperature would lead to an increase of 46.02 mean number of trap catch. Similarly an increase in 1°C of minimum temperature would lead to decrease of 45.04 mean number of trap catch. Whereas, one per cent increase in morning and evening relative humidity would lead to decrease of 7.59 and increase of 29.28 mean number of trap catch, respectively. On the other hand, an increase in 1mm rainfall would lead to decrease of 4.08 mean number of trap catch (Table 3). In multiple regression was done to estimate the influence of all independent variables on dependent variable. Further, in order to know the variables which contribute significantly on dependent variable the data was subjected to backward regression analysis. The evening relative humidity and rainfall influenced significantly (71.90 per cent out of 73.00 per cent) and the influence remaining independent variables altogether was negligible (1.10 per cent) (Table 4 and Fig. 1). Thus, the final significant regression equation between them is: $Y = -765.91 + 14.33 X_4 - 4.82 X_5$. Multiple linear regression revealed that the weather parameters of corresponding week influenced *S. litura* and moth catches in pheromone traps to an extent of 25.7 per cent. Multiple linear regression revealed that the weather parameters of corresponding week influenced *S. litura* moth catches in pheromone traps to an extent of 25 (Jagadish *et al*, 2007 and Prasannakumar *et al*, 2012). The influence of weather parameters, especially evening relative humidity and rainfall influenced as much as 71.90 per cent out of 73.00 percent. While analyzing, we considered the moth collections from 28th standard week to 42nd standard week, thinking that collections at the end and beginning might have been influenced by other than weather factors.

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