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RESEARCH ARTICLE

Effect of environmental factors on population dynamics of *Aphis gossypii* (Glover) (Aphididae ; Hemiptera), in cotton under agro-climatic condition of Madhya Pradesh

■ YOGESH PATEL

Jawaharlal Nehru Krishi Vishwa Vidhyalaya, College of Agriculture, Ganj-Basoda, VIDISHA (M.P.) INDIA

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ABSTRACT

Effect of environmental factors on the population of aphid, *Aphis gossypii* Glover on cotton variety JK-4 were studied during two consecutive cropping seasons of *Kharif* 2005-06 and 2006-07. The cotton aphid, *A. gossipii* was first noticed in the 27th SMW *i.e.* first week of July during both the years of study and remained up 47th SMW *i.e.* 4th week of November. The peak population 32.33 aphids / 3 leaves was observed during 33rd SMW *i.e.* 3rd week of August. The correlation study revealed that the aphid population had a significant negative correlation with maximum temperature (r=-0.531) and positive with minimum temperature (r=0.654), morning relative humidity (r=0.665), evening relative humidity (r=0.662) and wind velocity (r=0.654). Further multiple regressions computed for combined effect of eleven environmental factors on aphid population was $Y=-31.861 -1.456X_1 +1.152X_2 +0.557X_3 +0.216X_4 -0.146X_5 +1.106X_6 -0.118X_7 -0.858X_8 +8.314X_9 -3.726X_{10} -4.241X_{11}$ (R^2=0.907). Path analysis worked out also supported the above findings. The results revealed that cotton aphid population had the positive and highest direct effect on aphid population followed by wind velocity, morning relative humidity, minimum temperature, rainy days and evening relative humidity while spider population, green lacewing population, maximum temperature, and rainy day in a week had negative effect on aphid population.

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***Corresponding author:**
Email: yogeshpatelt2@rediffmail.com

INTRODUCTION

Cotton (*Gossypium hirsutum* Linnaeus) called as "white gold" is one of the most important fibre, cash crops in India and plays a dominant role in agricultural economy of the country. India ranks first in the world in area and third in production (Anonymous, 2002). Among various cardinal factors responsible for poor yield of cotton in India, the damage caused by large number of insect pests during different stages of crop growth are of prime importance. Rathod and Bapoorda (2006) had estimated that about 20 to 25 per cent yield losses were encountered due to the damage caused by insect pest. Dhawan, (2001) recorded 162 insect species on cotton crop in India. Of these, cotton aphids (*Aphis gossypii* Glover) is one of the most serious pests and is considered to be the major limiting factor in the successful cultivation of crop. In the early stages of crop, aphid causes heavy economic losses by sucking cell sap from the tender leaves and secreted honey dew like substance, resulted in development of black sooty mold fungus which hinders photosynthesis, the leaves get wrinkled and curled badly (Rathod, and Bapodra 2006) In addition, it is capable of transmission over 50 viral disease (Nontia, 2007). Taking into consideration, the present investigation was undertaken to assess the seasonal density of *A. gossypi* in relation to environmental factors on cotton.

MATERIAL AND METHODS

The population dynamics of *A. gossypii* in relation to environmental factors was assessed at the Jawharlal Nehru Krishi Vishwa Vidhyalaya, Cotton Research Station, Khandwa, M.P. during *Kharif* seasons of 2005-06 & 2006-07. The Cotton, *Hirsutum* variety JK-4 was sown in observation plot of 4000 sq. m under rain fed condition in black cotton soil during the last week of June in both the years of studied. All the normal agronomical practices recommended for the region were followed for raising the crop. No plant protection measure was taken throughout the crop season. The regular observations on the population dynamics of *A. gossypii* was made at weekly interval by randomly selected 25 plants from first appearance of pest until its cessation. The observation unit was five leaves per plant, two each from lower, middle and one from upper canopy of the plant. Similarly, the observation on the population of predator of cotton pests *viz.*, coccinellid, lady bird beetle, *Coccinella septumpunctata* Linn. (adults and larva), chrysopids, green lacewing, *Chrysoprela cornea* Stephens (stalked egg) and spider, *Oxyopes shweta* Tikader (adult) were made on the tagged plants. A total of 21 observations were recorded during the activity period of pest. Weekly population indices of different months of year were subjected to time series analysis (Croxton and Crowden, 1964) and computed.

At the same time, observations on meteorological parameters *viz.*, minimum and maximum temperature, morning and evening per cent relative humidity, total rainfall per week, total rainy days per week, wind velocity (kmph) and sunshine hours per day were recorded daily. Standard meteorological week (SMW) average of all the data collected for the pest, predator and weather parameters were calculated before statistical analysis. The data thus, collected were computed and subjected to statistical analysis (Panse and Sukhatme, 1985). All the possible correlations, multiple regression and path analysis among the environmental factors were worked out.

RESULTS AND DISCUSSION

The perusal of the data on the population fluctuation of cotton aphid revealed that it was a regular pest on cotton in both the year of study (Fig.1).

The cotton aphid, *A. gossipii* was first recorded in the 27th SMW *i.e.* first week of July during both the year of study and remained up to 47th SMW *i.e.* 4th week of November. The pest was first noticed when the crop age ranged between 7-16 days old, which normally coincided with the early vegetative stage of the crop. The population increased gradually 27th to 33rd SMW and reached its peak (32.33 aphid / leaf) during 33rd SMW *i.e.* 3rd week of August. During this week the weather conditions *viz.*, maximum temperature (31.49°C), minimum temperature (25.45C), morning relative humidity (88.97%), evening relative humidity (75.85%), sunshine hours (6.62 hours

Table 1 : Correlation (r) and simple regression (Y) of aphids, *Aphis gossypii* (Glover) population with environmental factors (2005-07)

Sr. No.	Character	2005-06	2006-07	Pooled
1.	T MX	r= -0.574**	r= -0.234	r= -0.531*
	(°C)	Y=111.03-2.955X		Y=129.825-3.591X
2.	T MN	r= 0.583**	r= 0.648**	r= 0.654**
	(°C)	Y=-21.394+1.487X	Y=-106.31+1.49X	Y=-105.152+1.477X
3.	RHM	r= 0.594**	r= 0.691**	r= 0.665**
	(%)	Y=-87.884+1.274	Y=-106.31+1.49X	Y=-105.152+1.477X
4.	RHE	r= 0.592**	r= 0.685**	r= 0.662**
	(%)	Y=-9.347+0.424X	Y=-16.417+0.547X	Y=-13.575+0.498X
5.	SSH	r= -0.019	r= -0.326	r= -0.277
	(hpd)			
6.	WV	r= 0.676**	r= 0.559*	r= 0.654**
	(kmph)	Y=-1.424+2.2X	Y=-0.999+2.281X	Y=-2.375+2.412X
7.	RF	r= 0.346	r= 0.287	r= 0.180
	(mm)			
8.	RD	r= 0.452*	r= 0.376	r= 0.272
	(dpw)	Y=7.858+2.161X		
9.	LBB	r= 0.258	r= -0.012	r= 0.204
	(/ plants)			
10.	WLB	r= 0.141	r= -0.047	r= 0.075
	(/ leaf)			

* Significant at P=0.05%, ** Significant at P=0.01%

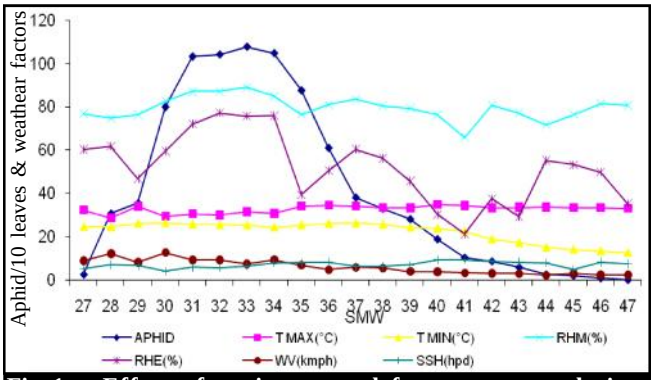

Fig. 1 : Effect of environmental factors on population dynamics oof *Aphis gossypii* (Glover)

per day), wind velocity (7.51 kmph), rainfall (29 mm) and rainy day (2.50 days par week) were prevailed. The present study clearly indicated that the maximum activity of pests was observed in the month of July, August and September and were in accordance with the findings of Dhawan *et al.* (1987) and Gupta *et al*. (1996).

The simple correlation study revealed that the aphid population had a significant negative correlation with maximum temperature (r=-0.531) and positive with minimum temperature (r=0.654), morning relative humidity (r=0.665), evening relative humidity (r=0.662) and wind velocity (r=0.654) (Table 1). After 33rd SMW, there was a decrease in aphid population. The regression equation compiled between aphid population and environmental factors revealed that every unit decrease in maximum temperature that was an increase of aphid population 3.591 and every unit increase of minimum temperature, morning relative humidity, evening relative humidity and wind velocity there was increase in population of aphid 1.447, 1.447, 0.498 and 2.412, respectively. After 33rd SMW there was a decrease in aphid population.

The multiple regression computed with eleven parameters *i.e.* maximum temperature (X_1), minimum temperature (X_2), morning relative humidity (X_3), evening relative humidity (X_4), sunshine hours (X_5), wind velocity (X_6), rainfall (X_7), rainy day (X_8), ladybird beetle population (X_9), green lacewing population (X_{10}) and spider population (X_{11}) as independent variables and aphid population as dependent variables was as follows :

Table : 2 Multiple correlation and regression coefficient (R^2) between population of aphid and environmental factors

	2005-06	2006-07	Pooled
R^2	0.879	0.918	0.907
Multiple coefficientder (%)	87.90	91.80	90.70
Regression coefficient	$-3.382X_1 +2.022X_2+0.913X_3 +0.084X_4-0.0006X_5-0.207X_6 -0.130X_7 +0.817X_8 +2.664X_9 -2.88X_{10} +0.600X_{11}$	$+6.711X_1+0.342X_2+0.765X_3+0.540X_4+4.104X_5+3.530X_6+0.238X_7-0.575X_8-1.582X_9+5.829X_{10}-4.088X_{11}$	$-1.456X_1 +1.152X_2 +0.557X_3 +0.216X_4 -0.146X_5 +1.106X_6-0.118X_7- 0.858X_8 +8.314X_9 -3.726X_{10} -4.241X_{11}$
Regression equation	$Y=2.772-3.382X_1 +2.022X_2+0.913X_3 +0.084X_4-0.0006X_5-1.207X_6-0.130X_7 +0.817X_8 +2.664X_9 -2.88X_{10} +0.600X_{11}$	$Y=350.657+6.711X_1+0.342X_2+0.765X_3+0.540X_4+4.104X_5+3.530X_6+0.238X_7-0.575X_8-1.582X_9+5.829X_{10}-4.088X_{11}$	$Y=-31.861 -1.456X_1 +1.152X_2 +0.557X_3 +0.216X_4 -0.146X_5 +1.106X_6-0.118X_7-0.858X_8 +8.314X_9 -3.726X_{10} -4.241X_{11}$

Table 3 : Path coefficient analysis of environmental factors on aphid, *Aphis gossypii* (Glover) population in cotton

	T MX (°C)	T MN (°C	RHM (%)	RHE (%)	SSH (hpd)	WV (kmph)	RF (mm)	RD (dpw)	LBB (/ plants)	GLW (/ leaf)	Spider (/plants)	Correlation coefficient
TMX	-0.5966	0.2608	-0.0007	0.0023	-0.1492	0.2884	0.0328	-0.0132	0.5242	-0.1225	-0.2931	-0.0668
TMN	-0.3754	0.4144	-0.0053	0.0202	-0.0644	0.4917	-0.2669	0.0309	1.1989	-0.2745	-0.6427	0.5268**
RHM	0.001	-0.0052	0.4222	0.0265	-0.0221	-0.071	-0.1457	0.0333	0.7693	-0.1635	-0.4056	0.4392**
RHE	-0.0246	0.1493	0.1996	0.0561	0.0237	0.3104	-0.2244	0.037	0.0392	0.0076	-0.0145	0.5595**
SSH	-0.468	0.1404	0.0491	-0.007	-0.1902	0.1235	0.18	-0.0289	0.4991	-0.129	-0.2936	-0.1246
WV	-0.2732	0.3235	-0.0476	0.0277	-0.0373	0.6299	-0.2398	0.016	-0.277	0.0802	0.1725	0.3749*
RF	0.0391	0.221	0.1229	0.0252	0.0684	0.3018	-0.5005	0.0657	0.7515	-0.1503	-0.3688	0.5758*
RD	0.0876	0.142	0.1563	0.0231	0.0611	0.1123	-0.3651	0.0900	0.8306	-0.1743	-0.4255	0.5382*
LBB	-0.1214	0.1928	0.126	0.0009	-0.0368	-0.0677	-0.146	0.029	2.577	-0.6099	-0.4159	0.5281**
GLW	-0.1168	0.1817	0.1102	-0.0007	-0.0392	-0.0807	-0.1202	0.0251	2.5102	-0.6261	-1.3999	0.4437**
Spider	-0.1228	0.1871	0.1203	0.0006	-0.0392	-0.0763	-0.1296	0.0269	2.5626	-0.6156	-1.4239	0.4900**

Residual=0.3457, *& ** showed significant at 5% & 1% level of significance, respectively. The bold figures denote the direct effect of different factors on population of pest

$Y=-31.861 -1.456X_1 +1.152X_2 +0.557X_3 +0.216X_4 - 0.146X_5 +1.106X_6-0.118X_7- 0.858X_8 +8.314X_9 -3.726X_{10} -4.241X_{11}$ (R^2=0.907)

The multiple co-efficient value between the aphid population and group of variable clearly indicated that 90.02% change in aphid population were influenced by maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours, wind velocity, rainfall, rainy day, population of ladybird beetle, green lacewing and spider, respectively. The data also revealed that 9.30% variation caused by inexplicable reason or due to error beyond the control of experiment or due to factors not included in the investigation.

Path co-efficient analysis of aphid population with different environmental factors are presented in Table 3 and Fig. 2 revealed that LBB population had the positive and highest direct effect on aphid population (2.5770), followed by wind velocity (0.6299), morning relative humidity (0.4222), minimum temperature (0.4144), rainy days (0.0900) and evening relative humidity (0.0561) while Aphid predator *i.e.* spider population, Green lacewing population, Maximum temperature, and Rainey day in a week had negative effect on aphid population. In addition to the above the positive indirect effect of high magnitude of ladybird beetle population was obtained via minimum temperature (0.1928), morning relative humidity (0.1260), and rainy days (0.0290) and evening relative humidity (0.009) however highest and negative indirect effect of spider population was obtained via minimum temperature, rainy day and maximum temperature. This study also revealed that the humid weather was favourable for the aphid multiplication.

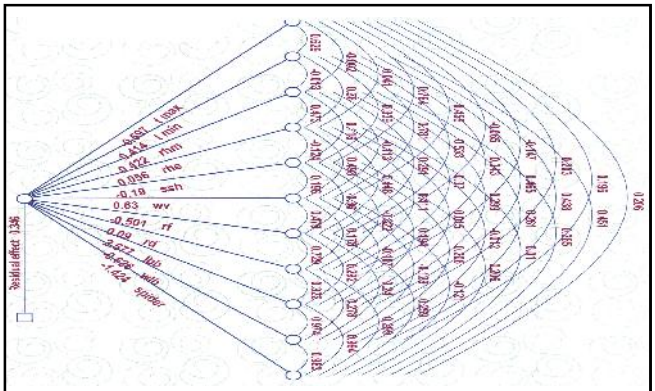

Fig. 2 : Path diagram showing direct and indirect effect of various environmental factors on the population of *Aphis gossypii*

On the bases of the present investigation, it can be concluded that associated aphidophagous predators *i.e.* LBB, GLW and spider and weather factors *i.e.* minimum temperature, evening relative humidity and rainy day play vital role in suppression of aphid population and it can be used as effective tool in the sustainable management of *A. gossypii* population in the cotton ecosystem.

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