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Path analysis of environmental factors affects the population dynamics of American bollworm, *Helicoverpa armigera* (Hubner) lepidoptera - noctuidae in cotton

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Abstract
The path analysis of environmental factors affects the population dynamics of American Bollworm (ABW), *Helicoverpa arecmigera* (Hubner) Lepidoptera –Noctuidae was assessed at the Jawharlal Nehru Krishi Vishwa Vidhyalaya, Cotton Research Station, Khandwa M.P. The perusal of data on the population of American bollworm, *Helicoverpa armigera* revealed that the pest was first come into view in the 28th SMW i.e. Ist week of July and remained active till 51st SMW (III week of December). The peak population level was observed during 35th SMW i.e. Ist week of September. The weather condition prevailed during the peak population *viz*. maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours, wind velocity, rainfall and rainy day were 34.11°C, 25.49°C, 76.54%, 39.56%, 8.29 hours per day, 6.94 kmph, 18.50 mm and 0.50 days respectively. The simple correlation studies between American bollworm eggs population and weather factors revealed that the ABW Eggs population had a significant positive correlation with minimum temperature. The multiple regression computed with eleven parameters as independent variables and ABW population as dependent variables was as follow Y=72.7571.401X1+0.027X2+0.276X3+0.048X4+0.056X5+1.517X6-0.052X7-1.413X8-0.624X9+2.657X10-0.945X11 (R^2=0.772). The Path coefficient analysis revealed that minimum temperature had positive and high direct effect on ABW egg population, followed by spider, morning relative humidity and green lacewing respectively.

Keywords: Cotton, American bollworm, Environmental factors, Population dynamics

Introduction
Cotton (Gossypium hirsutum Linnaeus) "White Gold" is the most valuable textile fiber produced and utilized in the world from prehistoric times. It accounts for 50 per cent of the total world production of textile fiber and is commercially cultivated in 111 countries. Cotton yield per hectare in India is one of the lowest in the world and as a result the net income of the cotton growers is low [1]. Reliance on rains, a weak seed supply system, small land holding and scanty use of pests and disease management strategies are responsible for low yield in India. The problem is further compounded by world Trade Agreement that will have an impact on cotton production and marketing particularly due to termination of multi fiber agreement (MFA) and withdrawal of domestic support [2] (Basu, 2001). 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 Baporda [3] has been estimated that about 20 to 25 percent yield losses were encountered due to the damage caused by insect pest. Dhawan [4] recorded 162 insect species on cotton crop in India. The biotic and abiotic factor responsible for fluctuation in the pest population on cotton crop might assist in the prediction of the occurrence in a give an area. Thus, The path analysis of environmental factors affects the population dynamics of American Bollworm (ABW), *Helicoverpa arecmigera* (Hubner) Lepidoptera –Noctuidae was undertaken in present investigation.

Materials and Methods

The population dynamics of American Bollworm (ABW), *Helicoverpa armigera* (Hubner) Lepidoptera –Noctuidae in relation to environmental factors was assessed at the Jawharlal Nehru Krishi Vishwa Vidhyalaya, Cotton Research Station, Khandwa M.P. 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 year 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 ABW was made at weekly interval by randomly selected 25 plants from first appearance of pest until its cessation. At the same time, observations on meteorological parameters *viz.* minimum and maximum temperature, morning and evening percent relative humidity, total rainfall per week, total rainy days per week, wind velocity (kmph) and sunshine hours per days 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 [5]. All the possible correlations, multiple regression and path analysis among the environmental factors were worked out [6].

Results and Discussion

Population Dynamics of ABW

The data on the population of American bollworm (Fig:1) revealed that the American bollworm, *Helicoverpa armigera* was first come into view in the 28th SMW i.e. Ist week of July and remained active till 51st SMW (III week of December). The peak population level was observed (15.26 Eggs / 5 plants) during 35th SMW i.e. Ist week of September. The weather condition prevailed during the peak population *viz.* maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours, wind velocity, rainfall and rainy day were 34.11°C, 25.49°C, 76.54%, 39.56%, 8.29 hours per day, 6.94 kmph, 18.50 mm and 0.50 days respectively. These finding confirm the findings of Jawalkar *et al.* (2004) they also reported that American bollworm peak incidence from 36th to 41st meteorological week (2nd week of September to the 2nd week of October). The present findings are also in confirmedly with the findings of Pawar *et al.* [7] they also noticed one peak of *Helicoverpa* during August to September.

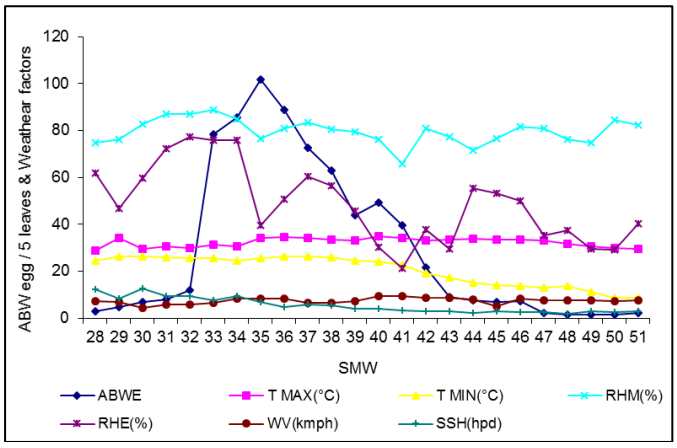

Fig 1: Influence of diferent weathear factors on the population of egg of american bollworm. (Pooled)

Simple Correlation & Regression

The perusal of data (Table:1) on simple correlation studies between ABW population with different environmental factors revealed that the ABW population had a significant positive correlation with Min. tem (r=0.356). After 35th SMW there was a decrease in ABW eggs population. It was estimated that every unit decrease Min tem there is decrease in population of ABW eggs is 0.478. The weather condition prevailed during the peak population *viz.* maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours, wind velocity, rainfall and rainy day were 34.11°C, 25.49°C, 76.54%, 39.56%, 8.29 hours per day, 6.94 kmph, 18.50 mm and 0.50 days respectively. These finding parallel to Vaishampayan and Veda [8], Koushik and Naresh [9] Bishnoi *et al.* [10] and Jawalkar *et al.* [11].

Table 1: Simple Correlation (r) and regression (Y) of ABW, *H. armigera* (Hubner) eggs population with abiotic and biotic factors

S. No.	Character	First Year	Second Year	Pooled of two year
1	T MX (°C)	r= 0.398	r= 0.373	r= 0.406
2	T MN (°C)	r= 0.602** Y=-5.541+0.517X	r= 0.532* Y=-4.19+0.401X	r= 0.597* Y=-5.24=0.478X
3	RHM (%)	r= 0.121	r= 0.206	r= 0.166
4	RHE (%)	r= 0.174	r= 0.299	r= 0.240
5	SSH (hpd)	r= 0.515* Y=-5.134+1.366X	r= -0.155	r= 0.219
6	WV (kmph)	r= 0.213	r= 0.059	r= 0.168
7	RF (mm)	r= 0.033	r= 0.070	r= -0.405
8	RD (dpw)	r= -0.009	r= 0.178	r= -0.431
9	LBB (/ plants)	r= 0.802** R=2.152+0.535X	r= 0.540* Y=3.793+0.318X	r= 0.698** Y=2.481+0.491X
10	GLW (/ leaf)	r= 0.825** Y=1.252+0.455X	r= 0.514	r= 0.711** Y=1.419+0.428X
11	Spider (/plants)	r= 0.815** Y=1.852+0.509X	r= 0.541* Y=3.122+0.311X	r= 0.717* Y=2.081+0.466X

*& ** Showed significant at 5% & 1% level of significance respectively

Multiple Regression Analysis

The multiple regression computed with eleven parameters i.e. Maximum temperature (X1), minimum temperature (X2), morning relative humidity (X3), evening relative humidity (X4), sunshine hours (X5), wind velocity (X6), rainfall (X7), rainy day (X8), population of Ladybird beetle (X9), population of Green lacewing (X10) and population of Spider (X11) as independent variables and ABW population as dependent variables was as follow (fig:2).

$Y=72.7571.401X1+0.027X2+0.276X3+0.048X4+0.056X5+1.517X6-0.052X7-1.413X8-0.624X9+2.657X10-0.945X11$

($R^2=0.772$)

The multiple coefficient value between the ABW population and group of variable clearly indicated that 77.20% change in ABW population were affected by maximum temperature,

minimum temperature, morning relative humidity, evening relative humidity, sunshine hours, wind velocity, rainfall, rainy days, population of ladybird beetle, green lacewing and spider.

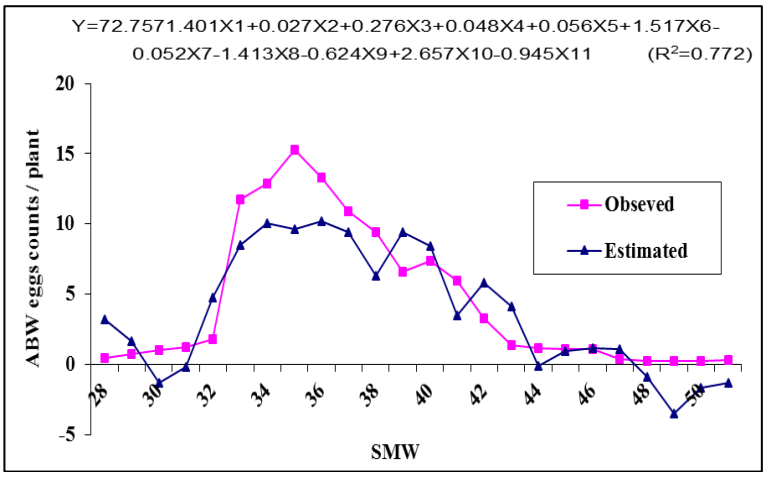

Fig 2: Mulltiple regession of certain factors on American bollworm egg population (Pooled)

Path coefficient analysis

The path coefficient analysis (Tab:2 & Fig:3) raveled that The minimum temperature had positive and high direct effect (0.8346) followed by spider (0.7003), morning relative humidity (0.0.3075) and green lacewing (0.2469) respectively. The observations revealed that the positive indirect effect of high magnitude of minimum temperature was obtained via spider (0.3161) and green lacewing (0.1082). The positive indirect effect of spider was also obtained via minimum temperature (0.3767), green lacewing (0.2427), morning relative humidity (0.0876), wind velocity (0.0124) and evening relative humidity (0.000). Positive indirect effect of morning relative humidity was obtained via spider (0.1995), green lacewing (0.0645), wind velocity (0.0115) and maximum temperature (0.0006). Path coefficient effect revealed that the positive indirect effect of green lacewing was obtained via spider (0.6885), minimum temperature (0.3660), morning relative humidity (0.0803) and wind velocity (0.0131).

Table 2: Path coefficient Analysis of abiotic and biotic factor on ABW, *H. armigera* population

	T MX (°C)	T MN (°C	RHM (%)	RHE (%)	SSH (hpd)	WV (kmph)	RF (mm)	RD (dpw)	LBB (/Plants)	GLW (/ leaf)	Spider (/plants)	Correlation Coefficient
T MX	-0.3537	0.5252	-0.0005	0.0000	-0.1231	-0.0469	0.0306	0.0120	-0.0792	0.0483	0.1441	0.1568
T MN	-0.2225	0.8346	-0.0039	-0.0002	-0.0532	-0.0800	-0.2489	-0.0280	-0.1812	0.1082	0.3161	0.4411**
RHM	0.0006	-0.0105	0.3075	-0.0002	-0.0183	0.0115	-0.1359	-0.0302	-0.1163	0.0645	0.1995	0.2722
RHE	-0.0146	0.3008	0.1454	-0.0005	0.0195	-0.0505	-0.2093	-0.0336	-0.0059	-0.0030	0.0071	0.1554
SSH	-0.2774	0.2827	0.0358	0.0001	-0.1570	-0.0201	0.1679	0.0263	-0.0754	0.0508	0.1444	0.1780
WV	-0.1619	0.6515	-0.0346	-0.0002	-0.0308	-0.1025	-0.2237	-0.0146	0.0419	-0.0316	-0.0848	0.0086
RF	0.0519	0.2860	0.1138	-0.0002	0.0564	-0.0491	-0.4669	-0.0596	-0.1136	0.0593	0.1814	0.1654
RD	0.0519	0.2860	0.1138	-0.0002	0.0505	-0.0183	-0.3405	-0.0817	-0.1256	0.0687	0.2092	0.2140
LBB	-0.0719	0.3883	0.0918	0.0000	-0.0304	0.0110	-0.1361	-0.0263	-0.3896	0.2405	0.2092	0.7736**
GLW	-0.0692	0.3660	0.0800	0.0000	-0.0323	0.0131	-0.1121	-0.0227	-0.3794	0.2469	0.6885	0.7790**
Spider	-0.0728	0.3767	0.0876	0.0000	-0.0324	0.0124	-0.1209	-0.0244	-0.3874	0.2427	0.7003	0.7819**

Residual= 0.5373,*& ** Showed significant at 5% & 1% level of significance respectively, The bold figures denote the direct effect of different factors on population of pest

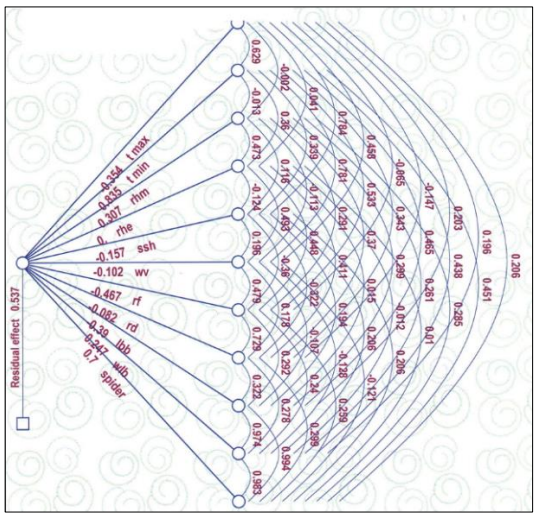

Fig 3: Phenotypical path diagram showing influence of various factors on the population of American bollworms

Conclusion

In the present investigation, it can be concluded that environmental factors play the critical role for build up the population of ABW. The multiple linear regression analysis raveled that the major climatic factors together were responsible for a total variation of 77.20% in ABW population. Mild rainfall with mild to high temperature (25 to 34 ºC) and high humidity (>60%) were congenial for the multiplication of the pest.

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