

Effect of weather on activity of cotton bollworms in middle Gujarat

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ABSTRACT

Pheromone traps for capture of cotton bollworms viz., *Helicoverpa armigera* Hub., *Earias vittella* Fab., *Pectinophora gossypiella* saund and *Spodoptera litura* Fab. were installed at Anand during January 1994 to December 1996 to study the effect of weather on activity of cotton bollworms in middle Gujarat agro-climatic condition. Peak activity of *S. litura* and *P. gossypiella* during all the three years occurred in the second week of March. In respect of *H. armigera* and *E. vittella* in all the three years, peaks were noticed during different weeks. In general, the bollworm activity was negatively influenced by rainfall, wind speed, minimum temperature, relative humidity and vapour pressure, whereas bright sunshine hours were positively correlated. Weekly mean temperature range of 20 to 30°C and relative humidity range of 50 to 65 per cent seemed to be suitable for the multiplication of the pest. Monthly mean maximum temperature greater than 37°C in summer and intensive rainfall in monsoon months were found to be the factors inhibiting growth and development of the insect pest.

Key words: Cotton, Pheromone traps, Bollworms, Weather

Climatic conditions influence pest numbers, pest activity and also the parasites and predators either directly or indirectly. For developing any insect pest management programme for specific agro-ecosystems, information on abundance and distribution of pest in relation to weather parameters is basic. Advance information on forthcoming and prevailing weather conditions can be helpful in developing effective methods of prevention and control. The present study was undertaken to establish the relationship between weather parameters and the four different pest species viz., American bollworm (*Helicoverpa armigera* Hub.), spotted bollworm (*Earias vittella* Fab.), Pink bollworm (*Pectinophora gossypiella* saund) and Tobacco leaf eating cater pillea (*Spodoptera litura* Fab.) affecting cotton yields.

MATERIALS AND METHODS

To study the population dynamics of *S. litura*, *H. armigera*, *E. vittella* and *P. gossypiella* pheromone traps were installed in the cotton field at the Anand campus of Gujarat Agricultural University for a three year period (1994-96). Pheromone-lures supplied by the Pest Control (India) Pvt. Ltd., Bangalore were used and replaced every month in the respective traps. Moths were collected daily from each trap early in the morning hours during the study period. Weather data for the corresponding period were collected from the Meteorological Observatory located in the adjoining farm.

RESULTS AND DISCUSSION

Population dynamics

Insect-pest populations trapped dur-

ing the individual years (Table 1) revealed large variation in *H. armigera*, *E. vittella*, *P. gossypiella* and *S. litura* in relation to frequent changes in monthly and yearly average weather phenomena. The activity of *H. armigera*, *P. gossypiella* and *S. litura* were found in kinematic mode during dry season under high influence of thermal energy over the humidified atmosphere.

Insect-pest count was very low or negligible during the rainy season June to August. The total number of *H. armigera* moths trapped during January, February and March, 1994 was roughly double than that trapped during the corresponding periods of 1995 and 1996. More counts were recorded from October to March in all the species. However during all the three years, the trap count of *E. vittella* was very low compared to the rest of the species.

Weekly weather and population growth

The number of insect-pests trapped at weekly interval (Table 2) indicated that *H. armigera*, *E. vittella*, *P. gossypiella* and *S. litura* populations reached their peaks between the standard meteorological weeks of (i) 6 to 14 and 40 to 44; (ii) 16 to 18 and 37 to 48; (iii) 1 to 14 and 51 to 52; and (iv) 8 to 18 and 43 to 46, respectively. The peak occurrence in respect of *H. armigera*, *P. gossypiella* and *S. litura* populations corresponded to the periods when weekly mean temperature and relative humidity ranged between 20 to 30°C and 50 to 65 per cent respectively which seems to be optimum for their multiplication.

The correlation matrix between the population of all the four insect-pests and weather parameters (Table 3) indicated positive correlation between *H. armigera* popula-

tion and bright sunshine hours ($r=0.50$), and negative association with rainfall ($r=-0.50$), wind speed ($r=-0.54$), minimum temperature ($r=-0.62$), mean relative humidity ($r=-0.64$) and mean vapour pressure ($r=-0.74$). Similarly negative relationship was also obtained for *E. vittella*, *P. gossypiella* and *S. litura* with rainfall, wind speed, minimum temperature and mean relative humidity. Daware *et al.* (1994) have also observed negative relationship between minimum temperature and relative humidity with *P. gossypiella* incidence. Positive correlation was observed for *E. vittella*, *P. gossypiella*, *S. litura* with bright sunshine hours (Table 3). Weekly mean maximum temperatures greater than 39°C coupled with total weekly rainfall greater than 20.0mm in monsoon season was found to inhibit growth and multiplication of all the insect-pests.

Monthly weather and pest population.

The number of bollworm moths trapped (Table 4) indicated higher values during the months of January to April and October to December. The population was relatively very low during summer and monsoon seasons in all the three years under study, which might be due to either high temperature ($>37^{\circ}\text{C}$) in summer or intensive rainfall in the monsoon months. Bilapate *et al.* (1977) and Fitt (1989) have also reported the effect of high temperature on growth and multiplication of *H. armigera*. Correlations between mean monthly weather and pest populations with bright sunshine hours were positive (Table 5); correlations were negative with rainfall, wind speed, relative humidity and vapour pressure.

Seasonal weather and pest population

The weather data and pest popula-

Table 1: Monthly mean weather and cotton bollworm population during 1994-96

Month	Weather factors							Average number of moths trapped				
	Bright sunshine (hrs)	Rain fall (mm)	Wind speed (kmph)	T _{max} (°C)	T _{min} (°C)	T _{mean} (°C)	Vapour pressure (mm Hg)	Relative humidity (%)	<i>H. armigera</i>	<i>E. vit-tella</i>	<i>P. gossy piella</i>	<i>S. Litura</i>
1994												
JAN.	9.3	21.8	2.64	28.9	12.9	20.9	10.8	64	171	30	935	230
FEB.	10.0	0.0	3.31	29.8	11.1	20.4	8.3	53	354	48	799	688
MAR.	10.2	0.0	2.0	37.3	16.9	27.2	9.7	42	658	20	1491	2057
APR.	10.4	0.0	3.85	37.3	20.9	29.2	13.5	46	64	35	293	1253
MAY	10.4	0.0	5.51	39.9	25.2	32.5	20.3	53	66	7	1	334
JUNE	5.2	99.0	5.99	35.3	26.8	31.0	23.1	72	21	1	1	62
JULY	2.0	502.4	5.10	30.5	25.3	27.9	24.3	87	13	1	1	52
AUG.	2.2	285.2	4.07	30.1	24.8	27.5	23.5	88	1	8	1	35
SEPT.	5.8	328.3	3.18	31.0	23.5	27.2	20.9	79	58	60	28	126
OCT.	9.7	0.0	2.29	36.2	19.6	27.9	14.1	55	241	66	32	726
NOV.	9.2	0.0	2.71	32.5	16.2	24.4	10.9	51	88	59	369	1060
DEC.	9.4	0.0	2.07	29.4	10.9	20.2	9.1	57	185	32	658	399
1995												
JAN.	9.3	0.5	3.04	26.7	9.8	18.3	8.5	60	92	39	1110	483
FEB.	9.8	0.0	2.85	30.3	12.4	21.3	9.3	54	282	61	957	336
MAR.	8.9	1.8	3.86	33.2	17.3	25.3	10.9	48	254	24	1045	1209
APR.	9.9	0.0	2.95	37.7	20.5	29.1	12.7	44	172	87	404	1179
MAY	10.3	0.0	5.48	39.6	25.7	32.7	18.0	52	66	45	70	385
JUNE	8.9	0.0	7.43	39.2	27.8	33.5	21.7	59	38	9	13	78
JULY	4.9	334.7	6.05	33.4	25.8	29.6	24.2	82	7	1	6	26
AUG.	4.6	61.8	5.82	32.3	25.7	28.9	24.0	78	2	1	1	50
SEPT.	8.4	149.0	4.20	33.7	24.7	29.2	22.3	75	74	77	15	143
OCT.	9.1	9.6	3.0	35.6	22.2	28.9	17.8	61	196	116	32	427
NOV.	9.5	0.0	2.52	32.4	14.7	23.6	12.2	57	168	115	404	776
DEC.	9.0	0.0	3.02	29.2	13.3	21.3	10.4	59	331	72	745	216
1996												
JAN.	8.9	2.2	3.73	27.6	12.4	19.9	10.4	64	54	24	529	234
FEB.	9.7	0.0	3.18	30.9	12.9	21.9	9.4	59	191	21	337	161
MAR.	9.5	0.0	3.22	36.4	17.8	27.1	10.8	44	199	13	704	806
APR.	10.3	0.0	3.35	37.8	20.1	28.9	13.6	48	141	40	247	684
MAY	11.0	0.0	5.51	39.5	24.7	32.1	18.2	54	37	40	101	246
JUNE	9.6	137.0	7.13	37.0	26.5	32.1	22.0	66	42	7	8	31
JULY	5.7	339.6	5.35	32.6	25.9	29.3	24.5	83	1	1	3	11
AUG.	4.3	146.4	4.79	30.6	24.7	27.7	22.3	83	3	6	1	10
SEP.	6.9	247.5	3.19	31.6	24.0	27.8	21.6	79	42	44	14	111
OCT.	8.6	25.2	3.31	34.1	20.6	27.4	18.9	65	63	54	2	113
NOV.	9.3	0.0	2.44	31.6	14.0	22.8	11.6	58	78	39	86	121
DEC.	9.1	0.0	2.71	29.2	11.9	20.6	9.5	57	86	15	130	114

Table 2: Weekly mean weather and cotton bollworm population (pooled : 1994-96)

MSW	Weather factors							Average number of moths trapped			
	Bright sunshine (hrs)	Rain fall (mm)	Wind speed (kmph)	T _{max} (°C)	T _{min} (°C)	Vapour pressure (mm Hg)	Relative humidity (%)	<i>H. armigera</i>	<i>E. vit-tella</i>	<i>P. gossypiella</i>	<i>S. Litura</i>
1	3.2	0.0	3.5	28.0	12.8	11.8	65	27	5	123	75
2	2.8	7.4	3.9	37.3	11.6	10.5	67	38	11	307	80
3	2.9	0.7	3.1	25.3	9.4	9.1	63	19	9	260	66
4	3.4	0.0	2.6	29.8	13.3	10.8	60	17	6	189	65
5	4.4	0.0	3.4	29.1	10.7	7.7	50	54	9	166	82
6	4.3	0.0	2.8	30.5	11.7	8.8	54	78	8	111	58
7	4.7	0.0	3.1	29.9	12.2	8.8	55	87	32	157	66
8	5.0	0.0	3.4	30.7	12.8	8.9	54	59	11	253	127
9	5.9	0.0	3.2	32.2	13.8	8.9	50	87	7	250	143
10	6.1	0.2	2.8	34.2	15.6	7.9	44	91	6	306	373
11	7.3	0.4	3.5	36.3	18.5	9.9	43	86	4	297	456
12	7.8	0.0	3.4	36.7	18.4	9.8	44	77	3	235	285
13	8.0	0.0	3.6	36.9	19.0	10.0	46	70	10	335	193
14	7.9	0.0	3.1	36.9	18.8	10.2	43	54	9	137	344
15	8.1	0.0	2.9	37.0	19.1	9.4	42	25	8	77	313
16	8.0	0.0	3.3	37.6	21.4	13.4	48	13	13	27	203
17	8.1	0.0	3.7	38.7	22.8	15.2	51	9	18	13	225
18	8.8	0.0	4.0	39.5	33.0	13.0	48	36	33	17	153
19	9.0	0.0	5.7	39.4	25.4	17.8	61	20	2	19	20
20	9.4	0.0	5.7	39.4	25.2	18.9	59	3	3	9	67
21	9.9	0.0	5.5	40.1	25.9	16.5	52	5	1	7	26
22	9.9	0.0	5.8	41.5	36.7	16.1	52	33	1	8	31
23	9.8	0.0	7.1	40.5	27.8	19.1	50	4	2	2	9
24	7.4	27.13	5.7	36.7	26.9	22.6	69	5	2	0	11
25	6.4	29.6	8.2	35.0	26.8	22.7	72	3	0	1	11
26	5.9	41.1	6.7	34.9	26.9	21.9	71	2	0	0	9
27	6.5	19.3	6.7	34.5	26.7	23.0	75	4	0	0	6
28	4.2	66.5	5.0	33.4	25.7	25.1	82	1	0	1	6
29	3.1	129.6	4.9	31.0	25.4	25.0	88	0	0	2	6
30	2.1	136.8	5.5	30.1	35.0	34.5	90	0	0	0	6
31	3.4	48.2	4.8	30.4	25.2	23.9	87	1	0	0	10
32	3.1	31.8	4.8	29.9	24.9	23.3	85	0	0	0	8
33	3.8	13.6	4.9	31.6	25.3	23.7	84	1	0	0	2
34	4.4	53.0	4.4	31.9	35.1	33.7	79	0	0	0	6
35	3.4	66.3	3.9	31.0	24.8	24.7	88	4	12	0	15
36	3.4	130.4	4.5	29.9	24.3	22.8	86	9	6	1	27
37	4.0	52.5	3.2	31.7	24.7	22.6	81	14	14	5	20
38	5.0	0.8	3.9	32.5	23.4	19.3	72	10	14	5	27
39	5.3	0.0	2.6	34.5	23.5	19.2	68	22	18	8	34
40	6.0	0.6	3.0	35.8	22.7	16.6	61	47	26	3	68
41	5.9	0.0	2.6	36.5	21.7	14.8	58	57	23	3	48
42	5.2	3.3	3.5	34.9	30.5	15.3	60	35	18	4	50
43	4.6	7.8	3.6	33.9	19.4	14.9	63	29	9	8	176
44	4.4	0.0	2.2	34.0	17.0	12.1	66	38	12	14	203
45	5.2	0.0	2.8	33.3	16.8	11.3	52	22	13	17	189
46	4.2	0.0	2.5	32.4	14.8	11.2	55	34	13	31	186
47	4.0	0.0	2.9	30.9	14.4	12.5	57	19	25	131	98
48	3.6	0.0	1.8	31.0	12.8	10.3	69	25	19	68	57
49	3.4	0.0	2.2	30.2	12.3	10.0	55	36	8	98	50
50	3.6	0.0	2.8	28.6	10.8	9.1	55	27	7	93	57
51	3.4	0.0	2.5	29.5	12.4	10.0	56	46	13	110	53
52	3.2	0.0	3.0	28.8	12.3	10.8	62	78	7	181	62

Table 3 : Correlation coefficients between weekly mean weather factors and pest population (pooled : 1994 - 96)

Pest	Weather factors					
	BSS	RF	WS	T _{min}	RH	VP
<i>H.armigera</i>	0.50*	-0.45*	-0.54*	-0.62*	-0.64*	-0.74*
<i>E.vittella</i>	0.42*	-0.37*	-0.63*	-0.38*	-0.33*	-0.41*
<i>P.gossypiella</i>	0.40*	-0.38*	-0.44*	-0.74*	-0.53*	-0.77*
<i>S.litura</i>	0.45*	-0.39*	-0.40*	-0.32*	-0.71*	-0.56*

* Significant at 5% level ($r=0.27$) ; N=52**Table 4 :** Mean monthly weather and cotton bollworm population (pooled : 1994-96)

Month	Weather factors							Average number of moths trapped				
	Bright sunshine (hrs)	Rain fall (mm)	Wind speed (kmph)	T _{max} (°C)	T _{min} (°C)	T _{max} (°C)	Vapour pressure (mm Hg)	Relative humidity (%)	<i>H.armigera</i>	<i>E.vittella</i>	<i>P.gossypiella</i>	<i>S.Litura</i>
JAN.	9.17	8.2	3.13	27.7	11.7	19.7	9.9	63	105	31	858	315
FEB.	9.85	0.0	3.11	30.3	12.1	21.2	8.9	53	275	43	697	395
MAR.	9.57	0.6	3.32	35.6	17.3	26.5	10.1	45	370	19	1080	1357
APR.	10.19	0.0	3.38	37.6	20.5	29.1	13.3	46	127	54	315	1038
MAY	10.59	0.0	5.50	39.7	25.2	32.5	18.8	55	56	31	57	321
JUNE	7.89	78.6	6.85	37.4	27.0	32.2	22.3	65	34	6	7	57
JULY	4.23	392.2	5.50	32.2	25.7	28.9	24.3	83	7	1	3	30
AUG.	3.70	164.5	4.89	31.0	25.1	28.0	23.3	84	2	5	1	32
SEPT.	7.04	241.6	3.52	32.1	24.0	28.1	21.6	77	58	60	19	127
OCT.	9.12	11.6	2.87	35.3	20.8	28.1	16.3	60	167	79	22	422
NOV.	9.33	0.0	2.55	32.2	14.2	23.6	11.5	55	111	71	286	652
DEC.	9.15	0.0	2.60	29.3	12.0	20.7	9.7	57	202	40	511	243

Table 5 : Correlation coefficients between monthly mean weather factors and pest population (pooled : 1994 - 96)

Pest	Weather factors					
	BSS	RF	WS	T _{min}	RH	VP
<i>H.armigera</i>	0.48*	-0.45*	-0.52*	-0.54*	-0.61*	-0.65*
<i>E.vittella</i>	0.42*	-0.34*	-0.57*	-0.29*	-0.33*	-0.34*
<i>P.gossypiella</i>	0.43*	-0.44*	-0.49*	-0.72*	-0.55*	-0.77*
<i>S.litura</i>	0.49*	-0.44*	-0.41*	-0.31*	-0.72*	-0.55*

* Significant at 5% level ($r=0.28$) ; N=36

tion trapped during the three years were classified into three seasonal groups. In *rabi* mean relative humidity was found to have negative association with *H. armigera* and *E. vittella*. A compound effect of weather on different pest population was observed during summer. In *kharif* season all the weather factors were found to have significant influence on all the pests but valid conclusions could not be drawn as the pest populations were very low. During post monsoon period except mean vapour pressure, which had significant correlation with *H. armigera* and *P. gossypiella*, no other weather factor was found to influence the four pests. This might be due to high fluctuations in day and night temperature.

Regression analysis

To establish the appropriate relationship between different weather parameters and the pest population, the data were statistically analyzed and resultant regression equations were obtained as under.

$$(i) Y_1 = -700.49 - 6.81 * BSS + 0.19 * RF - 4.34 * WS + 47.25 * MEAN TEMP - 63.59 * VP + 10.33 * RH \quad (R^2 = 0.52)$$

$$(ii) Y_2 = -21.27 + 7.92 * BSS - 0.04 * RF - 21.74 * WS + 4.87 * WP + 0.05 * RH \quad (R^2 = 0.55)$$

$$(iii) Y_3 = -2880.26 - 30.49 * BSS + 0.69 * RF + 130.91 * WS + 152.15 * MEAN TEMP - 270.80 * VP + 50.59 * RH \quad (R^2 = 0.67)$$

$$(iv) Y_4 = 4655.56 - 108.78 * BSS + 0.96 * RF - 104.25 * WS + 27.54 * VP - 55.33 * RH \quad (R^2 = 0.69)$$

where,

Y_1 = *Helicoverpa armigera* Hub. Population

Y_2 = *Earias vittella* Fab. Population

Y_3 = *Pectinophora gossypiella* Saund Population

Y_4 = *Spodoptera litura* Fab. Population

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