Impact of ecological factors on incidence and development of tobacco cut worm, *Spodoptera litura* Fabricius on cotton

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ABSTRACT

The studies were conducted to ascertain the effect of ecological factors on incidence and development of *Spodoptera litura* at five different dates of sowing on three varieties of cotton. Sowing dates commenced on 1st February and went upto 1st March with an interval of seven days. The *S. litura* population was built up progressively from April (1st week) and acquired its peak in the month of May (1st week). Maximum *S. litura* (25.46%) was built up at temperature ranges from 26.0˚C to 35.1˚C, relative humidity ranges from 89 and 62 per cent, zero rainfall, wind velocity 6.2 km/hr, total sunshine hours (64.6 hrs/week), evaporation (53.20 mm) and dewfall (0.161 mm). This built up *S. litura* showed a positive correlation with relative humidity, sunshine hours and dewfall, whereas negatively correlated with wind velocity. The determination of the effects of different weather factors on population and incidence of *S. litura* in cotton is essential for effective pest management. This study will be very helpful not only in forecasting outbreaks of *S. litura* but also in formulating effective pest management strategies.

Key words: Cotton, *Spodoptera litura*, weather factors, correlation, date of sowing, varieties, crop pest

INTRODUCTION

Cotton crop suffers heavily due to attack of various pests which reduce its yield. Tobacco caterpillar, *S. litura* is one of the important lepidopteran noctuids. *Spodoptera* is an obiquitous, polyphagous, multivoltine, lepidopterous pest that feeds on 112 cultivated crops all over the world (Moussca *et al*., 1960). The tobacco caterpillar, *S. litura* is a noxious pest that damages cotton crop extensively by skeletonizing the leaves and thus reducing the photosynthetic capacity of the plant. The *Spodoptera* moths are found primarily active during night and due to its high mobility, female ovipositing on a wide range of host plants, which promotes or even ensures survival of *S. litura* individual over a broad range of environmental conditions (Chelliah, 1985). The out breaks of this pest occurs due to resistance to insecticide, favourable weather conditions, cyclonic weather and heavy rainfall after a long dry spell (Thanki *et al.*, 2003).

In view of the existing situation in cotton pest manage ment and the importance of cotton for India, it is a neces sary prerequisite for developing effective pest mana gement programme to know the proper and appropriate ecological requirements, particularly weather factors like temperature, relative humidity and rainfall which play a vital role in multiplication and distribution of insect pests, and these factors have given a great momentum to research approach on pest management. To develop any pest management programme for a specific agro-ecosystem, information on abundance and distribution of pest in relation to weather parameters is a basic requirement (Patel and Shekh, 2006). The study of the relationship between pest population and weather factors were taken up, with an ultimate aim to help the entomologist develop the best IPM strategy for the control of major insect pests of cotton. The present study was undertaken to observe the impact of abiotic factors on the buildup of *S. litura* population.

MATERIALS AND METHODS

The experiment was laid out in Factorial concept of Randomized Block Design (FRBD) with three replications and three treatments (Varieties/hybrid - MCU 7, SVPR 3, SPCH 22) having five sub - treatments (Date of sowing – 1st, 8th, 15th, 22nd February and 1st March). The plot size for each treatment was 5 x 4 m (20 m^2). The seeds of varieties MCU 7, SVPR 3 and SPCH 22 were sown at two per hole with a spacing 60 x 30 cm, 60 x 30 cm and 120 x 60 cm respectively. The data on abiotic factors i.e., temperatures, relative humidity, wind speed, rainfall, sunshine hours, evaporation, and dewfall were taken from the department of Agronomy, Pajancoa & RI, Karaikal. *Spodoptera litura* population was recorded at weekly intervals from February to August 2007. The data for the damage percentage of *Spodoptera* was recorded as detailed below.

The observations were recorded at weekly intervals on ten plants selected at random per plot. The *S. litura* damage assessment was done by counting the total number of leaves and the number of affected leaves and the percentage was worked out as follows (Thanki *et al.*, 2003). At the end of season, the data was to statistical analysis using SPSS package. Population data of *S. litura* and weather factors were subjected to correlation and regression analyses.

RESULTS AND DISCUSSION

Seasonal incidence

The *S. litura* infestation was observed at different growth stages of the cotton crop. The activity of *S. litura* commenced during 9th Meteorological Standard Week (MSW) and it attained its peak in 18th MSW with 25.46 per cent damage of *S. litura* (Table 1). Studies on the seasonal abundance of *S. litura* in relation to weather factors indicated that the activity of *S. litura* was governed by maximum and minimum temperature, relative humidity, wind speed, rainfall, evaporation and dewfall.

Weekly mean weather and population growth of *S. litura*

The highest incidence of *S. litura* was recorded during 18th MSW which was corresponding to the period when maximum temperature ranged from 32.0° to 35.0°C, minimum temperature from 24.0° to 26.0°C, morning relative humidity from 89 to 92 per cent, evening relative humidity from 62 to 64 per cent, wind speed 6.2 kmph and zero rainfall which seems to be optimum for the aphid multiplication.

The correlation matrix between the weather factors and *Spodoptera* damage per cent revealed that a significant positive correlation existed with morning relative humidity (r = 0.632), sunshine hours (r = 0.492) and dewfall (r = 0.415), whereas a significant negative correlation was recorded with wind speed (r = -0.499). While non significant and negative correlation was recorded with

Table 1. Weekly mean weather parameters and damage percentage of *S. litura* in cotton

Weather factors										Damage Percentage
MSW	T_{Max} (°C)	T_{Min} (°C)	Morning RH (%)	Evening RH (%)	Wind speed (kmph)	Bright sunshine (hrs)	Rainfall (mm)	Evaporation (mm)	Dewfall (mm)	*S. litura*
7	31.70	22.50	95.00	67.00	4.70	51.00	1.25	35.10	1.409	0.00
8	30.20	21.80	85.00	59.00	6.40	47.00	5.00	45.60	0.282	0.00
9	31.70	22.30	95.00	63.00	4.70	40.30	0.00	42.60	1.400	5.26
10	31.00	21.10	94.00	55.00	4.00	66.70	0.00	56.10	1.491	9.54
11	31.30	22.40	94.00	63.00	4.60	71.10	0.00	50.70	1.229	13.56
12	30.20	21.70	95.00	60.00	4.60	67.10	0.00	46.70	1.908	18.23
13	31.90	22.90	94.00	64.00	4.70	64.80	0.00	49.80	1.431	17.59
14	33.10	24.60	94.00	66.00	4.40	61.30	0.00	46.00	1.067	19.26
15	33.30	25.50	92.00	70.00	5.60	42.20	1.50	45.30	0.198	21.97
16	33.70	25.10	92.00	66.00	5.30	55.60	16.25	40.50	0.633	24.01
17	35.20	26.10	92.00	67.00	6.30	66.20	0.00	52.20	0.708	23.99
18	35.10	26.00	89.00	62.00	6.20	64.60	0.00	53.20	0.16	25.46
19	38.80	27.50	83.00	44.00	11.20	59.30	2.50	56.90	0.000	18.03
20	38.80	28.20	77.00	41.00	12.80	62.10	0.00	65.70	0.000	15.64
21	37.70	27.50	85.00	54.00	9.50	60.20	0.00	55.70	0.000	12.03
22	37.00	27.20	81.00	62.00	9.20	62.50	0.00	65.60	0.000	6.25
23	36.90	26.30	91.00	63.00	8.20	63.10	42.75	45.70	0.033	5.00
24	36.00	27.10	80.00	60.00	8.00	52.70	3.00	55.00	0.000	5.05
25	33.70	25.90	80.00	58.00	10.80	2.30	2.00	42.10	0.000	5.07
26	35.70	26.60	75.00	55.00	11.00	22.30	5.00	56.80	0.000	3.45
27	37.10	27.50	72.00	47.00	14.80	49.40	0.00	85.00	0.000	3.93
28	37.30	27.10	78.00	50.00	11.70	57.80	0.00	83.70	0.000	2.65
29	36.20	26.30	76.00	50.00	8.50	51.40	0.00	67.00	0.000	1.03
30	34.10	26.10	85.00	56.00	6.60	26.60	10.00	52.20	0.203	0.00

MSW - Meteorological Standard Week, $T_{.Max}$ - Maximum temperature, T_{Min} - Minimum temperature RH - Relative humidity

Table 2. Effect of date of sowing on the incidence of *S. litura* damage in cotton

Days after sowing	Date of sowing				
	First sowing	Second sowing	Third sowing	Fourth sowing	Fifth sowing
16 DAS	0.00	0.00	5.36	9.78	13.54
23 DAS	0.00	6.94	9.21	12.03	15.68
30 DAS	3.49	8.54	11.06	16.79	19.27
37 DAS	5.78	10.25	12.35	17.98	20.89
44 DAS	9.20	11.26	10.26	18.64	22.06
51 DAS	13.65	16.78	13.25	15.24	25.26
58 DAS	15.26	12.03	14.25	21.03	26.45
65 DAS	16.02	13.02	15.69	21.56	27.89
72 DAS	16.02	18.05	15.00	22.50	21.01
79 DAS	18.94	17.98	20.23	18.78	18.24
86 DAS	20.02	22.06	18.74	18.06	15.02
93 DAS	21.03	19.05	16.21	19.05	10.56
100 DAS	17.00	17.05	14.02	16.42	10.00
107 DAS	13.82	15.02	13.97	2.33	9.72
114 DAS	9.33	11.64	10.56	2.54	1.06
121 DAS	4.58	2.56	12.58	3.56	2.11
128 DAS	3.10	3.56	9.82	3.11	1.06
135 DAS	2.56	2.86	4.78	2.16	2.75
142 DAS	2.33	3.54	0.00	2.54	1.06
149 DAS	0.00	2.41	0.00	1.00	0.00
Mean	9.60	10.73	11.96	12.23	13.18

DAS –Days After Sowing

maximum temperature (r = -0.227), minimum temperature (r = -0.274), rainfall (r = -0.177) and evaporation (r = -0.403). The regression equation Y = -44.076 + 0.652 (X_1) fitted to *S. litura* damage and meteorological factors. The coefficient of determination (R^2) was 0.39 showing thereby that as much as 39.0% variation in the *Spodoptera* damage was due to the effect of weather factors.

The minimum temperature, relative humidity and rainfall proving negative relationship with population of *S. litura* infesting groundnut crop in Junagadh area (Anonymous, 1992). Zag and Kushwaha (1983) reported the population of *S. litura* in cabbage crop to be negatively correlated with average and maximum temperature. Sojitra (1990) reported the infestation of *S. litura* during July to September in Soybean cultivated at Junagadh. The minimum temperature, evening relative humidity, morning and evening vapour pressure showed negative effect on oviposition behaviour and larval development of *S. litura*, whereas correlation analysis showed non significant difference between various abiotic factors and leaf damage caused by *S. litura* infesting castor crop in middle Gujarat (Thanki *et al.*, 2003). Minimum temperature, morning and evening relative humidity and rainfall exhibited non-significant and negative relationship with population of *S. litura* infesting onion crop in Guntur area (Sailaja Rani, 2006). Selvaraj *et al*. (2010) reported that infestation of bollworms in bhendi crop to be positively correlated with maximum temperature and dewfall.

Date of sowing on *S. litura* damage

The incidence of *S. litura* damage per cent was compared with different dates of sowing. The incidence of *S. litura* damage per cent (9.60%) was least in st February 2007 sowing while, the incidence was high (13.18%) in 1st March 2007 (Table 2). A gradual increase was observed when the sowing dates were progressed.

Varieties on *S. litura* damage

The effect of varieties on the incidence of *S. litura* damage per cent was studied. The overall mean incidence of *S. litura* damage per cent recorded in respect of three different varieties was maximum in 93rd DAS. The highest incidence of *S. litura* damage percent in SVPR 3 (23.44%) followed by SPCH 22 (18.08%) and MCU 7 (17.66%) was recorded, while the lowest incidence of *S. litura* damage per cent was recorded on 149th DAS in MCU 7 (0.58%), SPCH 22 (2.64%) and SVPR 3 (3.56%). The incidence of *S. litura* damage per cent was compared with three different varieties. The mean incidence of *S. litura* damage was least in MCU 7 (9.48%) variety while, the incidence was high in SVPR 22 (13.39%) variety (Fig 1).

Table 3. Correlations coefficient between the incidence of *S. litura* damage in varieties and various weather factors.

Variety	Weather factors							
	T_{Max} (°C)	T_{Min} (°C)	Morning RH (%)	Evening RH (%)	Wind speed (kmph)	Bright sunshine (hrs)	Rainfall (mm)	Evaporation (mm) Dewfall (mm)
MCU 7	-0.432	-0.551*	0.299*	-0.524	-0.009	-0.433*	-0.359*	-0.290 0.074
SVPR 3	-0.657	-0.439*	-0.152	-0.583	0.431	-0.208	-0.208	-0.024 0.058
SPCH 22	-0.591	-0.627*	0.379*	-0.656	-0.025	-0.164	-0.441	-0.180 0.156

* Significant at 0.05 level, ** Significant at 0.01 level, T_{Max} - Maximum temperature, T_{Min} - Minimum temperature RH - Relative humidity

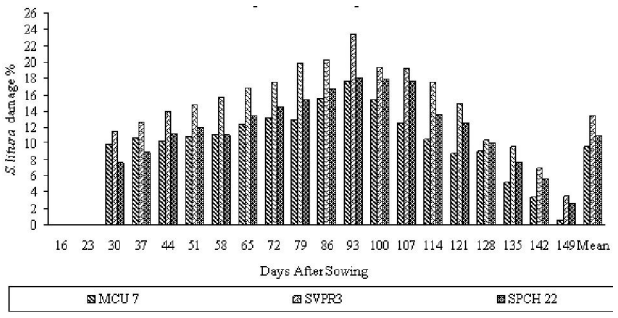

Fig 1. Effect of different varieties on the incidence of *Spodoptera litura* damage in cotton during summer, 2007.

Maximum temperature that affected the incidence of *S. litura* damage was negatively correlated for all varieties where effect was non significant. Minimum temperature was correlated negatively with all varieties where effect was significant (Table 3). The correlation between incidence of *S. litura* damage and minimum temperature was significant effect for all varieties. The effect of morning relative humidity and dewfall was correlated positively with all varieties except SVPR 3 with significant effect. The correlation effect of evening relative humidity, wind velocity and evaporation was non significant and correlated negatively for all varieties. Sunshine hours and rainfall had a significant effect and correlated negatively for MCU 7 and non significant negatively correlated for SVPR 3 and SPCH 22 (Table 3). It was found that weather factors have significant influence of incidence of *S. litura* damage (100 R^2 values 66.3 for *Spodoptera*).

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