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Population Dynamics of Pink Stem Borer on Maize Crop and its Correlation with Prevailing Abiotic Parameters

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A B S T R A C T

Population dynamics studies of pink stem borer was carried out during spring seasons of the year 2013-14 and 2014-15 at the Research cum Instructional Farm, IGKV, Raipur (C.G.). Larval population increased gradually and reached to a peak of 13.81 and 18.56 larvae /plant in 56 days (12th SMW) and 49 days (11th SMW) in spring season during 2013-14 and 2014-15, respectively. The maximum adult population was trapped during fourth week of March (13th SMW) and third week of March (12th SMW), when the mean maximum29.7 ºC and 36.4ºC and minimum temperatures were16.4and 19.4ºC and with mean relative humidities of 67 and 47.5 per cent during the years 2013-14 and 2014-15, respectively. The interactions between the larval population and weather parameters revealed non-significant correlation. The interactions between the adult population and weather parameters during spring 2013 and 2014 revealed negative and significant and non-significant correlation with maximum temperature (r = - 0.6519 and - 0.4964), negative and significant correlation with minimum temperature (r = - 0.682 and r = - 0.566) while the interactions with morning and evening relative humidity was positive as well as significant with morning relative humidity (r = 0.610 and 0.649) but non-significant with evening relative humidity, respectively.

Introduction

Maize (*Zea mays* L.) or corn is a grass of the family Poaceae grown primarily for its kernel. Maize is composed of 71.5 per cent starch, 1.9 per cent protein, 4.8 per cent fat and 1.4 per cent ash (Rathore, 2001). In Chhattisgarh, maize occupies an area of 242.52 thousand ha with an average productivity of 1935 kg/ha (Anonymous, 2015).

The replacement of traditional local cultivars with the commercial varieties and hybrids led to expansion of arthropod pest complex as pests of minor importance are now assuming major status. The scenario with respect to insect pests of this crop has changed a lot in the recent past owing to increased area under single cross hybrids and monocropping practiced by the farmers using indiscriminate quantity of insecticides and chemical fertilizers. Insects attack maize throughout the cropping cycle and during storage, resulting in as little as 10% to complete loss (Bergvinson *et al.*, 2002). During the winter season pink borer with more extensive

coverage, may cause damage up to 78.9% to the crop. It is a pertinent point to note that productivity of maize in peninsular India is higher than the northern states, and that of winter maize (3.22 t/ha) is higher than the rainy season maize (1.74 t/ha). Thus, to stabilize the maize production effective control of pink borer is of immense importance (Santosh *et al.,* 2012). Changing climatic scenario with modern cultivation practices in rice crop made pink stem borer to achieve pest status in many rice growing regions of India (Sampath *et al.,* 2014). The occurrence of pink stem borer in relation to weather parameters provides information on the initiation and extent of damage which is useful for the effective management and formulation of IPM strategies on maize.

Materials and Methods

A plot size of 200 m^2 with sugar - 75 popular hybrid was raised and maintained without insecticide application to study the occurrence of major insect pests on maize in relation to abiotic factors *viz*., maximum temperature, minimum temperature, relative humidity (morning and evening).The spring maize crop was sown on 22-01-2013 and 23-01-2014 following standard agronomical practices. The incidence of pink stem borer were recorded soon after noticing the initial infestation and continued up to the maturity of the crop at weekly intervals throughout the growing season.

The occurrence of maize pink stem borer, *S. inferens*, was observed by destructive sampling of 25 randomly selected plants at five different locations @ five plants at each location of plot. Then the stems were split open to count the number of larvae of *Sesamia inferens* at seven days interval starting from seven days after germination till harvest of the crop. The seasonal population fluctuations of maize pink stem borer moth recorded through light trap. The collections were made throughout the crop season. Number of pink stem borer, weekly catches was correlated with the abiotic factors. Meteorological data were received from Department of Agro meteorology, IGKV, Raipur and were utilized for correlations and regression studies *viz*. the cumulative and individual effects of temperature and relative humidity on population buildup of *S. inferens.* The influence of abiotic factors on the occurrence of pink stem borer of maize was statistically analyzed by subjecting the number of insects per plant and weather data to simple correlation and multilinear regression analysis (Gomez and Gomez, 1994).

Results and Discussion

The initial occurrence of *S. inferens* during spring season 2013-14 was observed during the first week of February (6^{th} SMW) i.e., at 14 days after germination with a mean population of 3.82 larvae/plant. The average maximum and minimum temperatures prevailing during the initial infestation were 28.8 ^{0}C and 11.4 ^{0}C, respectively. While, the average morning and evening relative humidity were 84 and 31 per cent respectively. The pest population increased gradually and reached to a peak on 12^{th} SMW i.e., 56 days after germination with a mean population of 13.81 larvae /plant. The average maximum and minimum temperatures prevailed during this period were 36.4 ^{0}C and 20.2 ^{0}C, respectively and the average morning and evening relative humidity were 66 and 22 per cent, respectively. Thereafter, the pest population was more or less uniform up to 14^{th} SMW i.e., tasseling stage of the crop with 11.81 larvae/ plant, when the average maximum and minimum temperatures ranged between 38.1 ^{0}C to 38.7 ^{0}C and 22.7 ^{0}C to 21.5 ^{0}C, respectively and the average morning and evening relative humidity were ranged

between 62 to 58 and 17 to 28 per cent, respectively. The pest population declined gradually with the rise in maximum and minimum temperatures and reached to a minimum (1.00 larvae per plant) by 19th SMW, when the average maximum and minimum temperatures were 43.6 ^{0}C and 27.2 ^{0}C and the average morning and evening relative humidity were 48 and 17 per cent, respectively (Figs. 1 and 2).

The adult moth appeared for the first time in the light trap during 5th SMW (19 adults) when the mean maximum and minimum temperatures (28.8 and 11.4ºC) and the average morning and evening relative humidity were 84 and 31 per cent, respectively. Maximum traps (44 adults / week) were observed during 11th SMW, when, average maximum and minimum temperature (29.7 ºC and 16.4 ºC) and the average morning and, evening relative humidity were 87 and 47 per cent, respectively. After 15th SMW, number of adults decreased gradually to 2 pink borer moths/ week in 18th SMW when the maximum and minimum temperature (43.1 and 27.6ºC) and the average morning and evening relative humidity were 51 and 21 per cent, respectively.

Similarly, during the second year of study i.e. 2014-15, the pink stem borer larvae presence on the maize crop was noted in the first week of February (6th SMW) i.e., at 14 days after germination with a weekly mean population of 4.16 larvae/ plant. The average maximum and minimum temperatures prevailed during the initial infestation were 31.7 ^{0}C and 14.8 ^{0}C, respectively. While, the average morning and evening relative humidity were 85 and 33 per cent, respectively. The pest population increased gradually and reached to a peak during 11th SMW i.e., 49 days after germination with a mean population of 18.56 larvae /plant. The average maximum and minimum temperatures prevailed during this period were 33.3 ^{0}C and 19.5 ^{0}C, respectively and the average morning and evening relative humidity were 89 and 38 per cent, respectively. Thereafter, the pest population was more or less uniform up to fourteenth standard week (14th SMW) i.e., tasseling stage of the crop with 10.67 larvae/ plant, when the average maximum and minimum temperatures ranged between 38.4ºC and 39.5ºC and 22.2ºC and 22.0ºC, respectively and the average morning and evening relative humidity were ranged between 67 and 59 and 24 and 17 per cent, respectively.

The pest population declined gradually with the rise in maximum and minimum temperatures and reached to a minimum 1.67 larvae/ plant by 18th SMW, when the average maximum and minimum temperatures were 40.1ºC to 25.6ºC and the average morning and evening relative humidity were 53 and 23 per cent, respectively.

During 2014-15 the pink stem borer adults were recorded throughout during growing season in the light trap. Maximum adults (39 adults /week) were trapped during 12th SMW, when average maximum and minimum temperatures (36.4 and 19.4 ºC) and average morning and evening relative humidity were 74 and 21 per cent, respectively. After 14th SMW, number of adults decreased gradually to 1 pink borer moth/week in 19th SMW, when the maximum and minimum temperature (38.1 and 26.0ºC) and the average morning and evening relative humidities were 59 and 27 per cent, respectively.

The data of both the spring seasons suggested that the infestation of pink stem borer larvae initiated during the first week of February (6th SMW) i.e., 14 days after germination. The larval population increased gradually and reached to a peak of 13.81 and 18.56 larvae

/plant in 56 and 49 days in spring season during 2013-14 and 2014-15, respectively. The pest population declined gradually with the rise in maximum and minimum temperatures and reached to its minimum population (1.00 and 1.67 larvae /plant) in first week of May during both the years.

Data for two years revealed that the pink stem borer adults active throughout the cropping period. The maximum adult population was recorded during 11th and 12th SMW for 2013-14 and 2014-15, respectively. When the mean maximum (29.7 ºC and 36.4ºC) and minimum temperatures (16.4 and 19.4 ºC) with mean relative humidity (67 and 47.5 per cent). Thereafter, during spring 2013-14 and 2014-15 the adult traps decreased gradually till 18th and 19th SMW when the mean maximum and minimum temperature (40.6 and 26.8ºC) and the average morning and evening relative humidity were 55 and 24 per cent, respectively (Figs. 1 and 2).

Table.1 Population dynamics of *Sesamia inferens* larvae and adult in relation to abiotic Parameters during spring 2013-14

SMW	Duration	Temperature (^{0}C)		Relative Humidity (%)		Number of *Sesamia inferens* larvae/ Plant/week	Total adult light trap catches/ Week
		Max	Min	I (Mor.)	II (Eve.)		
4	Jan22-28	27.0	12.2	81	36	-	-
5	Jan29-Feb 04	28.8	11.4	84	31	-	19
6	Feb 05-11	30.0	16.8	86	44	3.82	20
7	Feb 12-18	29.7	16.4	87	47	4.88	26
8	Feb 19-25	29.8	14.6	84	36	8.62	32
9	Feb 26-Mar 04	32.3	13.8	79	22	13.71	38
10	Mar.05-11	34.3	14.8	71	19	12.62	37
11	Mar.12-18	33.8	20.4	70	31	12.18	44
12	Mar.19-25	36.4	20.2	66	22	13.81	26
13	Mar.26-Apr. 01	38.1	22.7	62	21	7.82	37
14	April 02-08	38.7	21.5	58	17	11.81	21
15	April 09-15	39.9	24.7	57	28	6.12	10
16	April 16-22	38.0	21.9	63	28	5.52	9
17	April 23-29	38.1	24.4	64	29	8.55	4
18	Apr. 30-May 06	43.1	27.6	51	21	2.56	2
19	May 07-13	43.6	27.2	48	17	1.00	0
20	May 14-20	43.3	27.9	44	15	0.0	
			Overall seasonal mean			**7.063**	**13.62**
	Correlation coefficient values (r)						
	Maximum Temperature					**- 0.23 NS**	**- 0.65****
	Minimum Temperature					**-0.31 NS**	**-0.22 NS** **-0.68****
	Morning relative humidity					**-0.12 NS**	**0.61***
	Evening relative humidity						**0.21 NS**

Table.2 Population dynamics of *Sesamia inferens* larvae and adult in relation to abiotic Parameters during spring 2014-15

SMW	Duration	Temperature (^{0}C)		Relative Humidity (%)		Number of larvae/ Plant/week	Total light trap catches (Adult / Week)
		Max.	Min.	I (Mor.)	II (Eve.)		
4	Jan22-28	28.2	13.7	87	38	-	
5	Jan29-Feb 04	28.8	10.1	86	28	0	20
6	Feb 05-11	31.7	14.8	85	33	4.16	16
7	Feb 12-18	27.9	15.4	83	39	4.89	22
8	Feb 19-25	28.9	14.6	86	41	6.32	31
9	Feb 26-Mar 04	27.9	14.8	91	61	8.54	28
10	Mar.05-11	27.5	17.5	88	44	11.90	23
11	Mar.12-18	33.3	19.5	89	38	18.56	36
12	Mar.19-25	36.4	19.4	74	21	12.66	39
13	Mar.26-Apr. 01	38.4	22.2	67	24	10.53	35
14	April 02-08	39.5	22.0	59	17	10.67	29
15	April 09-15	38.5	22.4	58	23	6.00	12
16	April 16-22	37.8	23.4	67	28	3.05	07
17	April 23-29	41.1	25.1	58	18	2.78	02
18	Apr. 30-May 06	40.1	25.6	53	23	1.67	01
19	May 07-13	38.8	26.0	59	27	0.00	01
20	May 14-20	42.1	27.1	43	16	0.00	00
			Overall seasonal mean			**6.358**	**18.87**
	Correlation coefficient values (r)						
	Maximum Temperature					**-0.24 NS**	**-0.49***
	Minimum Temperature					**-0.18 NS**	**-0.56***
	Morning relative humidity					**0.45 NS**	**0.64****
	Evening relative humidity					**0.29 NS**	**0.37 NS**

*Significant at 5% level, ** Significant at 1 % level, **NS** = non-significant

Table.3 Multiple linear regression analysis of pink stem borer adult population on certain weather parameters

Year	Regression Equation	R^2
2013-14	**Y =183.784 - 7.383 X_1+ 4.985 X_2 + 0.935 X_3 - 2.291* X_4	0.657
	(219.49) (4.32) (3.12) (1.58) (1.00)	
2014-15	*Y = - 127.143 +2.301 X_1 -0.753 X_2 +1.184* X_3 - 0.1378 X_4	0.53
	(90.76) (2.29) (1.84) (0.55) (0.57)	

(**) = Significant at p ≤ 0.01, (*) = Significant at p ≤ 0.05, Y = larval/adult population, X_1 = Maximum Temperature, X_2 = Minimum Temperature, X_3 = Morning relative humidity, X_4 = Evening relative humidity, R^2 = Coefficient of determination.

Fig.1 Influence of weather parameters on populations of other insect pests on maize during spring season (2013-2014)

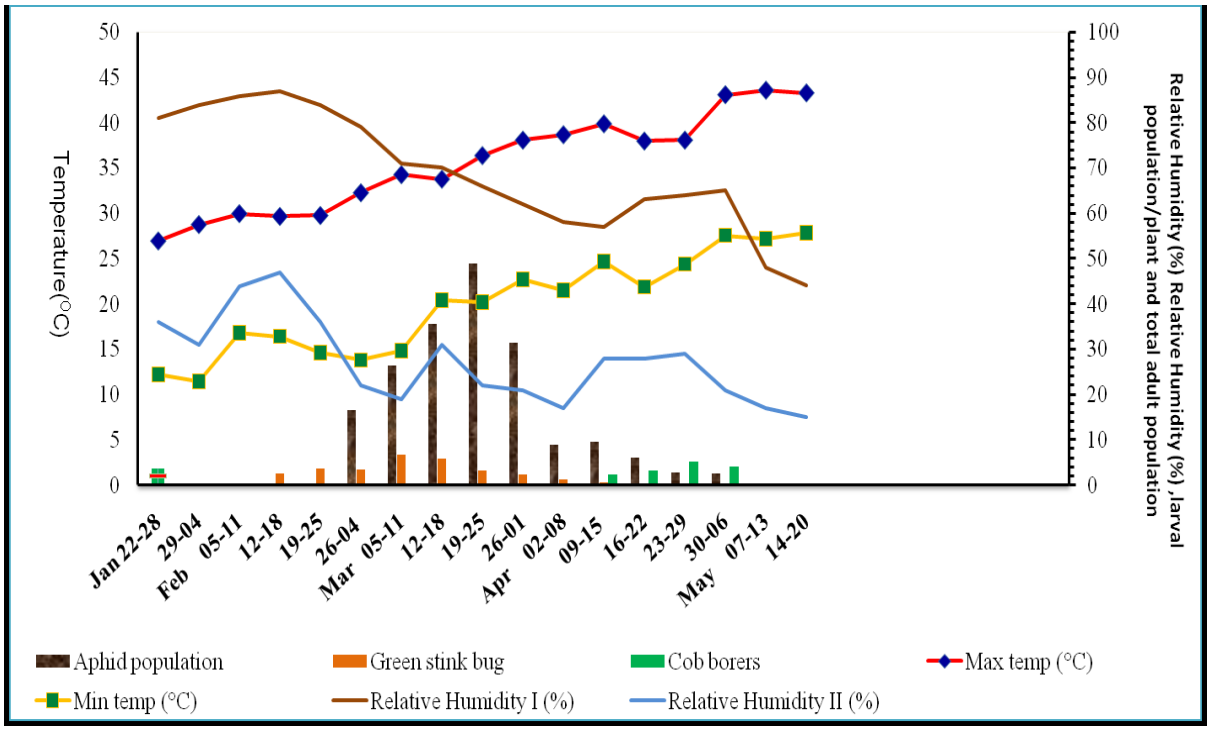


Fig.2 Influence of weather parameters on populations of other insect pests on maize during spring season (2014-2015)

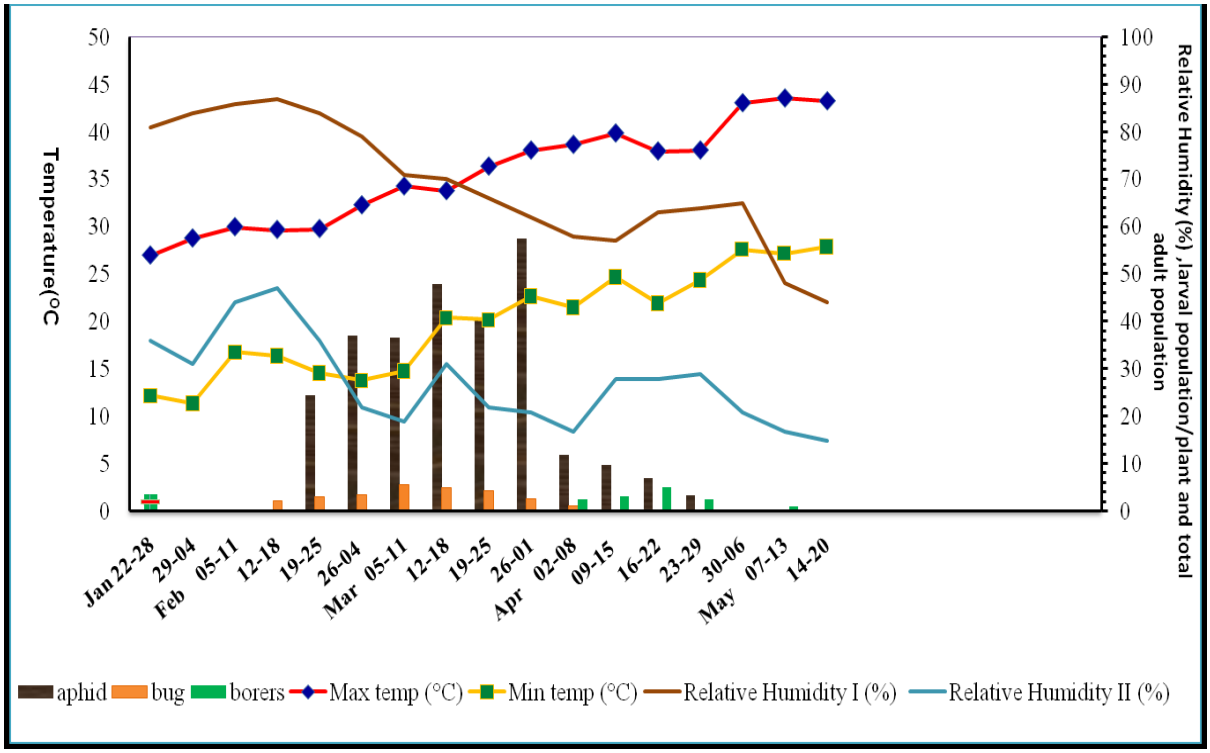


Fig.3 Regression of *Sesamia inferens* adult on abiotic parameters (2013-14)

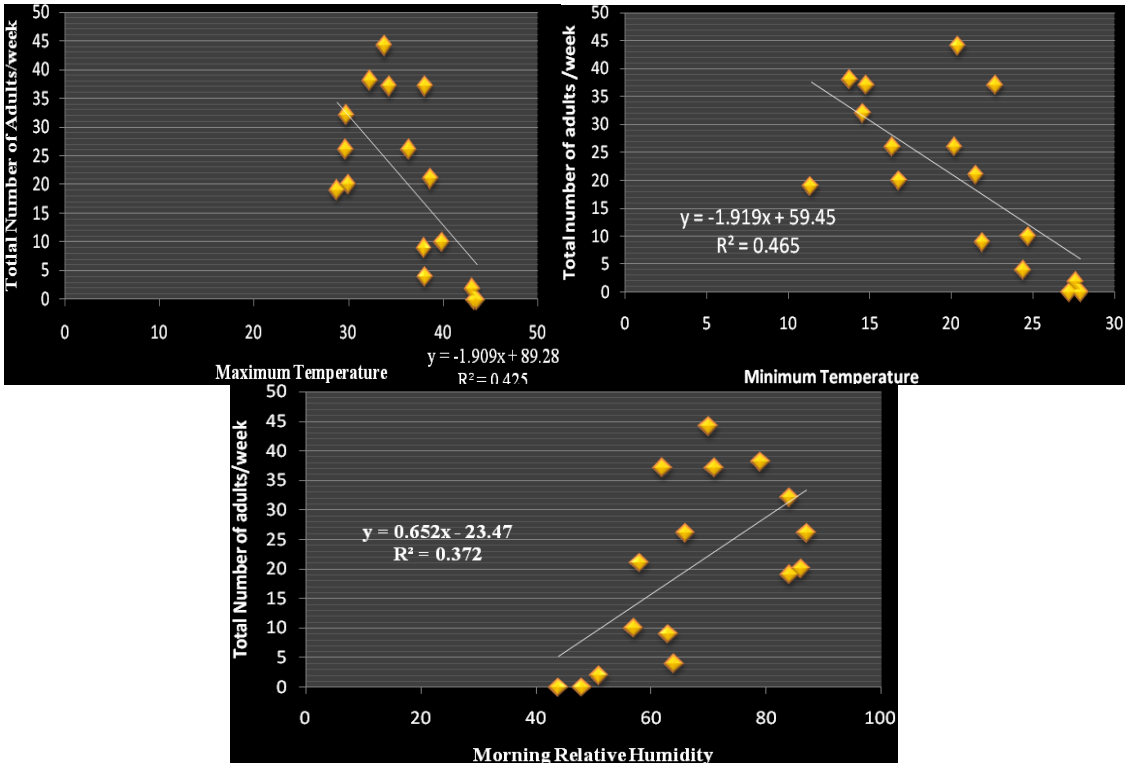
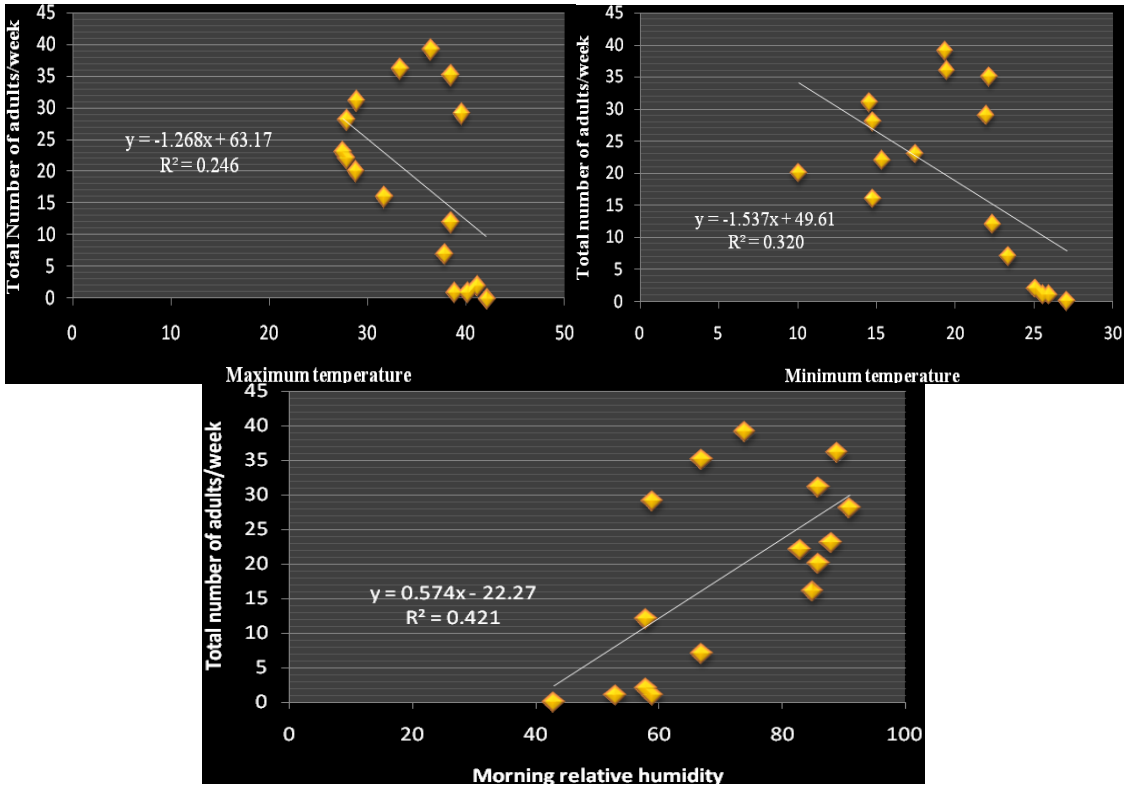


Fig.4 Regression of *Sesamia inferens* adult on abiotic parameters (2014-15)



This study was in agreement with the observation made by Jalali and Singh (2002) they observed the occurrence of *C. partellus* started during the third week of December i.e., 28 days after sowing (three weeks after crop emergence). Kandalkar *et al.,* (1996) also observed that the peak infestation of *C. partellus* from 31-60 days after sowing at Akola during kharif season. Mahadevan and Chelliah (1986) also observed the peak infestation of stem borer at 30-45 days after sowing in Coimbatore. There after the pest population declined gradually at harvesting stage where 0.8 larvae/ plant. These findings were also confirmed with the work of Timaru *et al.,* (2012) as most suitable condition for *Chilo partellus* Swinehoe development was 26 to 30 ºC temperature. Regarding the maize growing season, mean of the weeks revealed that borer damage was comparatively less (22.5%) at 21.1 ºC during winter seeded maize plants than spring (47.08% at 28.78 ºC) and rainy (47.03% at 29.2 ºC). The above statement is supported by Muhammad *et al.,* 2010 that the infestation of *Chilo partellus* Swinehoe was found highest at higher temperature (32.5 ºC). The results are also in close approximation with Thakur *et al.,* (2013) that the insect's injury was approximately in the same trend in both the years proportional to prevailing temperature. Percentage stem borer infestation was gradually increased toward the progress of weeks and more or less remained constant from 10 to 42 weeks and further started declining gradually. Thus, the temperature was pronounced resulting in higher percentage of infestation. Zafar and Chaudhry (1979) observed moth populations of the pink borer *Sesamia inferens* were highest in March and October; moths also emerged in February and November in both 1972 and 1973. *S. inferens* requires comparatively lower temperature for emergence than *Scirpophaga* spp. Mahesh *et al.,* (2013) assessed pink borer damage in sugarcane crop and found the maximum damage from March to May (peak period of its activity) as percent dead hearts from the number of damaged shoots with dead hearts and total number of shoots in different accessions.

Ahad *et al.,* (2008) also recorded the population of adult stem borer appeared throughout the growing season with their respective peaks of 49 and 47 adults/ trap during 2006 and 2007 and infestation of stem borer was recorded from 3rd week of crop season till harvest.

Correlation of pink stem borer (larvae and adult) and regression of adult population with certain weather parameters

The interactions between the larval population of *S. inferens* and weather parameters during spring 2013-14 and 2014-15 revealed non-significant correlation with maximum temperature, minimum temperature, morning and evening relative humidities.

The interactions between the adult population of *S. inferens* and weather parameters during spring 2013-14 revealed negative and significant correlation with maximum temperature (r = - 0.6519), minimum temperature (r = - 0.682) while, the interactions with morning and evening relative humidity were positive as well as significant with morning relative humidity (r = 0.610) but non-significant with evening relative humidity (r = 0.2135) (Table 1).

During spring 2014-15, the interactions between the adult population of *S. inferens* and weather parameters (Table 2) revealed negative and significant correlation with maximum temperature (r = - 0.4964) and minimum temperature (r = - 0.566) while, the interactions with morning humidity was positive as well as significant (r =0.649) and with evening relative humidity it shows non -

significant correlation(r = 0.379).Similarly, Kandalkar and Men (2004) also recorded negative and non-significant correlation (r = -0.0128) of *Chilo partellus* with maximum temperature; negative and significant correlation with minimum temperature and non-significant correlation with morning relative humidity (r = 0.0150).Similarly, Singh and Kular (2015) evaluated the values of correlation coefficient (r) between pink stem borer incidence and maximum, minimum, temperatures with the values of -0.19 and -0.005, respectively and they were non-significant at p=0.05%. The incidence of *S. inferens* has statistically significant and positive correlation (r = 0.53) with relative humidity. Average relative humidity of 80 per cent was favourable for its damage.

The data on *S. inferens* adult incidence when subjected to multiple linear regression analysis. The regression equation was worked out and found that the weather parameters could influence the adult population of *S. inferens* on maize to the extent of 65 per cent (R^2 =0.657) (Table 3 and Fig. 3).

During spring, 2014-15 again, it was found that the weather parameters could influence the adult population of *S. inferens* significantly on maize to the extent of 53 per cent (R^2 = 0.533) (Fig. 4).

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