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Fruit damage caused by okra shoot and fruit borer, *Earias vittella* (Fabricius) in relation to various abiotic factors in Gujarat

PP Dave and HV Pandya

Abstract
Investigations on fruit damage caused by okra shoot and fruit borer, *Earias vittella* (Fabricius) in relation to various abiotic factors was carried out under field condition during *kharif* season of 2015 and 2016 at Regional Horticultural Research Station, Navsari Agricultural University, Navsari, Gujarat. The results revealed that during 2015 in GAO-5, fruit damage per cent caused by *E. vittella* reached its peak at 10th WAS i.e. 36 SW (48.05 per cent fruit damage/week). While in Vikas 101 (Hybrid) fruit damage by E. vittella reached its peak at 10th WAS i.e. 36 SW (30.14 per cent fruit damage/week). During 2016 in GAO-5, fruit damage caused by E. vittella reached its peak at 13th WAS i.e. 38 SW (45.15 per cent fruit damage/week). While in Vikas 101 (Hybrid), fruit damage caused by *E. vittella* reached its peak at 13th WAS i.e. 38 SW (30.92 per cent fruit damage/week). Among various weather parameters, during 2015 in GAO-5 maximum temperature (-0.605) was significant and negatively correlated and average temperature (-0.687) was highly significant and negatively correlated with per cent fruit damage of *E. vittella* on okra whereas significant positive correlation was found between per cent fruit damage of *E. vittella* on okra and evening relative humidity (r= 0.516), average relative humidity (r= 0.500). While in Vikas 101 (Hybrid) significant negative correlation was found between per cent fruit damage of *E. vittella* on okra and maximum temperature (r= -0.620) while average temperature (r= -0.706) found highly significant and negatively correlated with per cent fruit damage of *E. vittella* on okra whereas significant positive correlation was found between per cent fruit damage of *E. vittella* on okra and evening relative humidity (r= 0.537), average relative humidity (r= 0.522). During 2016 in GAO-5, The data indicated that significant negative correlation was found between per cent fruit damage caused by E. vittella on okra and maximum temperature (r= -0.503), average temperature (r= -0.538), wind velocity (r= -582) whereas, significant positive correlation was found between per cent fruit damage of *E. vittella* on okra and morning relative humidity (r= 0.578), rain fall (r= 0.591) while average relative humidity (r= 0.725) found highly significant and positively correlated with per cent fruit damage of *E. vittella* on okra. While in vikas 101 (Hybrid)it is revealed that maximum temperature (r= -0.579), sun shine hours (r= -0.593) found significant and negatively correlated with per cent fruit damage of *E. vittella* on okra. Similarly, significant positive correlation was found between evening relative humidity (r= 0.537), average relative humidity (r= 0.522) and per cent fruit damage of *E. vittella* on okra while rain fall (r= 0.754) found highly significant and positively correlated with per cent fruit damage of *E. vittella* on okra.

Keywords: *Earias vittella*, okra, fruit damage

Introduction
Okra [*Abelmoschus esculentus* (L.) Moench] is mostly grown for its immature green and non fibrous edible fruits in the tropical and sub tropical regions of the world (Chauhan, 1972) [6]. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. The major okra growing states in India includes Andhra Pradesh (20%), West Bengal (15%), Bihar (14%), Orissa (11 %), Gujarat (10 %), Jharkhand (7%), Maharashtra (4%), Assam (3%) and Haryana (3%)(Anonymous, 2012) [3]. In Gujarat, okra is grown throughout the year providing continuous and good source of income to the farmers. The world total area, production and productivity of okra is reported to be 11,48,000 ha, 78,96,000 tonnes and productivity 6.90 metric tons per hectare, respectively (Anonymous, 2011) [2]. There are many factors affecting the low productivity of okra. One of them is the losses caused by insect pests. Information regarding screening of genotypes in a most preferable crop like okra is helpful to the farmers for managing the pest population.The crop is affected by number of insect pest, mites and nematodes during different growth stages. Of these pests, shoot and fruit borer, The *Earias vittella* (Fabricius) (Lepidoptera: Noctuidae) is a widely distributed insect pest causing

economic damage to the crop at all the growth stages. This pest has been reported to infest okra, cotton, *Hibiscus* spp.

Many researchers have attempted to estimate the losses in yield of okra due to *E. vittella* infestation. Yield losses up to 49 to 74% at Bangalore, Karnataka (Krishnaiah, 1980) [14], 50% at Ludhiana, Punjab (Brar *et al.*, 1994) [4], 30.81% at Coochbehar, West Bengal (Ghosh *et al.*, 1999) [12]; 52.33 to 70.75% and 48.97% at Udaipur, Rajasthan (Pareek and Bhargava, 2003 and Kanwar and Ameta, 2007) [15, 13] and fruit damage to extent of 91.6% at Anand, Gujarat (Shah *et al*., 2001) [20] was reported. It was estimated about 69% loss in marketable yield due to attack of this insect on okra (Rawat and Sahua, 1973) [19]. Radke and Undirwade (1981) [17] observed the appearance of *Earias* spp. with the initiation of fruiting. The infestation increased and reached its peak up to 100% after 12 weeks of sowing with an average larval population of 1.3 per fruit. Similarly, Agrawal (1993) [1] recorded the incidence at first picking that remained till 5th picking (10 weeks after germination) and the resultant loss in yield was 60.0 and 63.3% during *kharif* 1991 and 1992, respectively. However, the peak incidence in okra was observed in the last week of August with 34 to 45% damage to fruits (Rana, 1983) [18]; 67.7% in October (Dhawan and Sidhu, 1984) [11]; and 25.9 to 40.9% (Dhamdhere *et al*., 1984) [10].

The freshly hatched larvae bore into tender shoots and tunnel downwards. As a results, shoots wither, droop down and ultimately the growing point is killed. Side shoots may be raised giving the plants a bushy appearance due to the damage of main shoot. With the formation of buds, flowers and fruits, the larvae bore inside and feed on inner tissues. The damaged buds and flowers wither and fall down without bearing any fruit whereas, the affected fruits show deformity in shape and remain stunted in growth. Such fruits had hardly any marketable value (Butani, 1984) [5]. Therefore, attempts have been made to have comprehensive information on population dynamics and correlation coefficient of *E. vittella* infestation with weather parameters for South Gujarat condition.

Materials and Methods

Investigations on fruit damage caused by okra shoot and fruit borer, *Earias vittella* (Fabricius) in relation to various abiotic factors was carried out on okra varieties *viz.*,GAO-5 and Vikas-101 (Hybrid). For the purpose, the varieties were raised in two different plots during *kharif* season of 2015 and 2016. The plot size was 427.68 m^2 (21.6 m X 19.8 m) for each variety. The experiment was conducted at Regional Horticultural Research Station, NAU, Navsari. The plots were kept without any insecticidal spray to allow shoot and fruit borer to multiply throughout the season.

For this study, 20 plants were randomly selected from net plot area. The observations on fruit and shoot borer were recorded by counting number of damaged fruits and per cent damage was worked out. Observations were recorded from first week after sowing till harvest. Weather data *viz.*, maximum temperature (^{0}C), minimum temperature (^{0}C), average temperature (^{0}C), morning relative humidity (%), evening relative humidity (%), average relative humidity (%),wind velocity (km/hrs), sun shine hours, rain fall (mm) and evaporation (mm/day) recorded as per standard meteorological week at Meteorological Observatory, College Farm, Navsari Agricultural University, Navsari were obtained and used for the present study.

Results and Discussion

The results recorded about per cent fruit infestation are presented in Table 1 to 8 and depicted in figure 1 to 4. The year wise result were discussed as under

To know the effect of various weather parameters on the per cent fruit damage of *E. vittella* on okra, simple correlation was worked out between weekly mean incidence of per cent fruit damage of *E. vittella* on okra and weekly mean values of different weather parameters.

First year (2015), Variety GAO 5

The results showed that (table 1 and figure 1) the earliest fruit damage per cent *E. vittella* was recorded from 7th Week after sowing (WAS) i.e. 6.16 per cent fruit damage/week during 33rd Standard week (SW) and population reached its peak at 10th WAS i.e. 36 SW (48.05 per cent fruit damage/week). The per cent fruit damage declined thereafter and, continued fluctuating till the 40th SW i.e. 14th WAS and then reached to disappear during 41st and 42nd SW.

Similarly, Yadvendu (2001) [21] reported that pest population attained its peak of 86.5 and 72.5 larvae/5 plants during first and fourth week of September, respectively. Dangi (2004) [7] also reported peak population (10.3 larvae/5 plants) in first week of October. Patel *et al.* (2014) [16] revealed that in pheromone trap, earliest catch of *E. vittella* males was recorded from 2nd WAT (9 male moth catch/trap/week) *i.e.* 48 standard week of 2011 and population reached its peak at 5th WAT *i.e.* 51th standard week of 2011 (38 male moth catch/trap/week).

The data presented in table 2 indicated that significant negative correlation was found between per cent fruit damage of *E. vittella* on okra and maximum temperature (r= -0.605) while average temperature (r= -0.687) found highly significant and negatively correlated with per cent fruit damage of *E. vittella* on okra. Similarly, significant positive correlation was found between per cent fruit damage of *E. vittella* on okra and evening relative humidity (r= 0.516), average relative humidity (r= 0.500). However, minimum temperature (r= -0.118), sun shine hours (r= -0.395), evaporation (r= -0.176) were non-significant and negatively correlated with per cent fruit damage of *E. vittella* on okra while morning relative humidity (r= 0.276), wind velocity (r= 0.192), rain fall (r= 0.231) were non-significant and positively correlated with per cent fruit damage of *E. vittella* on okra.

Devraj and Kumar (1987) [9] and Pareek *et al.*, (2001) observed that minimum temperature, relative humidity and rainfall had a significant negative correlation. Patel *et al.* (2014) [16] recorded that among various weather parameters, maximum temperature had significant negative and evening relative humidity had significantly positive influence on shoot and fruit borer population. The present findings are in confirmation with the same.

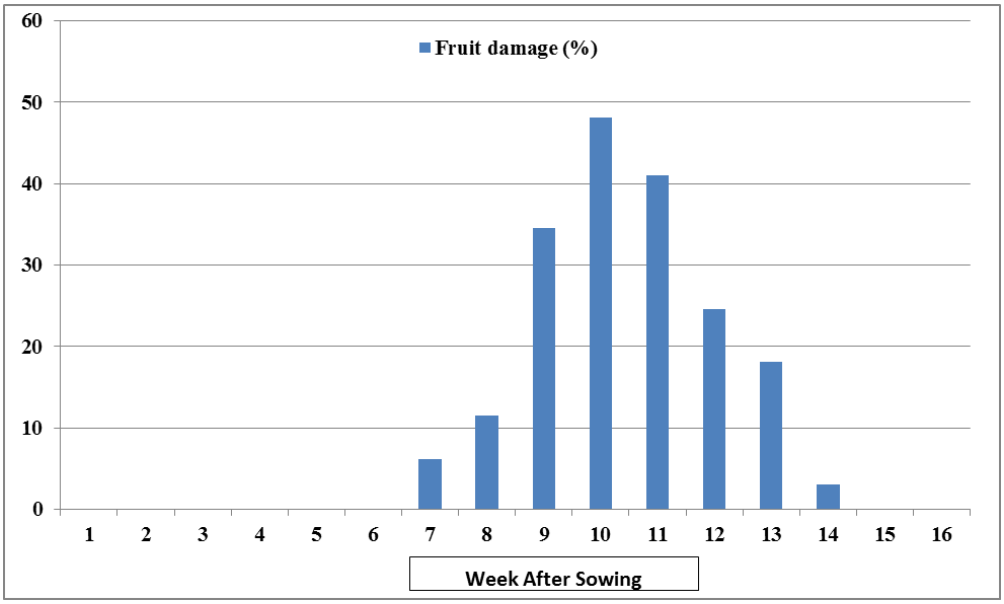

Fig 1: Per cent fruit damage by *E. vittella* on okra variety GAO-5 as well as weather parameters under field condition during June – October, 2015

First year (2015), Vikas 101 (Hybrid)

The data presented in table 3 and figure 2 showed that the earliest fruit damage per cent *E. vittella* was recorded from 8th Week after sowing (WAS) i.e. 8.82 per cent fruit damage/week during 34rd Standard week (SW) and population reached its peak at 10th WAS i.e. 36 SW (30.14 per cent fruit damage/week). The per cent fruit damage declined thereafter and, continued fluctuating till the 40th SW i.e. 14th WAS and then reached to disappear during 41st and 42nd SW.

Dave (2014) [8] reported that earliest catch of *E. vittella* males was recorded from 2nd Week after sowing (WAS) i.e. 9 Male moth catch/trap/week during 32 Standard week (SW) and population reached its peak at 5th WAS i.e. 35 SW (38 male moth catch/trap/week). However, Yadvendu (2001) [21] reported that pest population attained its peak of 86.5 and 72.5 larvae/5 plants during first and fourth week of September, respectively. Dangi (2004) [7] also reported peak population (10.3 larvae/5 plants) in first week of October.

The data presented in table 4 indicated that significant negative correlation was found between per cent fruit damage of *E. vittella* on okra and maximum temperature (r= -0.620) while average temperature (r= -0.706) found highly significant and negatively correlated with per cent fruit damage of *E. vittella* on okra. Similarly, significant positive correlation was found between per cent fruit damage of *E. vittella* on okra and evening relative humidity (r= 0.537), average relative humidity (r= 0.522). However, minimum temperature (r= -0.128), sun shine hours (r= -0.456), evaporation (r= -0.247) were non-significant and negatively correlated with per cent fruit damage of *E. vittella* on okra while morning relative humidity (r= 0.296), wind velocity (r= 0.196), rain fall (r= 0.313) were non-significant and positively correlated with per cent fruit damage of *E. vittella* on okra.

Dave (2014) [8] also reported that among various weather parameters, minimum temperature, morning relative humidity**,** evening relative humidity and average relative humidity had highly significant positive correlation, while average temperature had significant positive correlation with shoot and fruit borer moth catches in the pheromone trap. The present findings are in confirmation with the same.

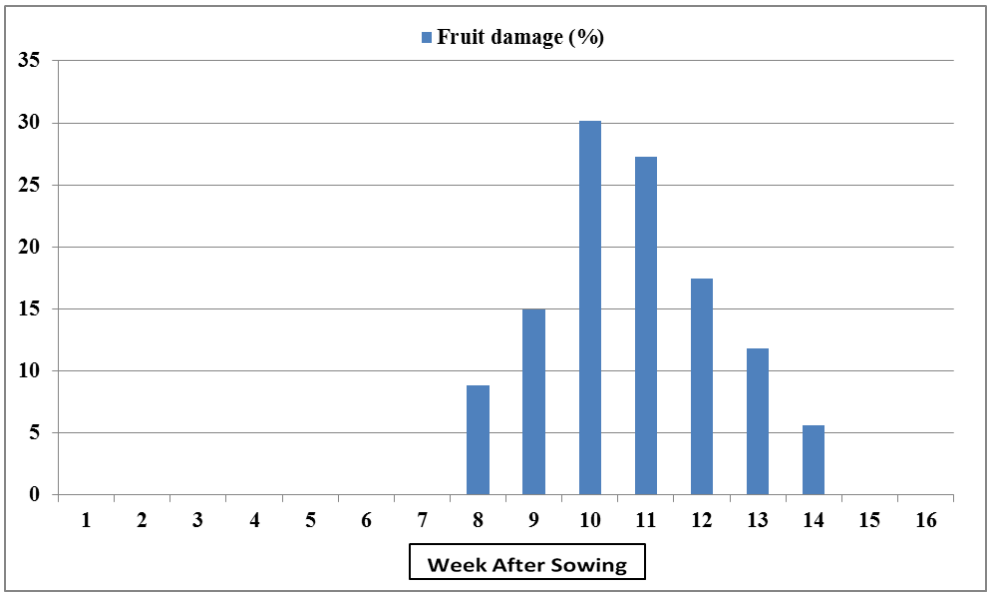

Fig 2: Per cent fruit damage by *E. vittella* on okra Vikas 101 (Hybrid) as well as weather parameters under field condition during June – October, 2015

Second year (2016), Variety GAO 5

The results (table 5 and figure 3) revealed that the earliest fruit damage per cent *E. vittella* was recorded from 8th Week after sowing (WAS) i.e. 8.21 per cent fruit damage/week during 33rd Standard week (SW) and population reached its peak at 13th WAS i.e. 38 SW (45.15 per cent fruit damage/week). The per cent fruit damage declined thereafter and, continued fluctuating till the 41st SW i.e. 16th WAS.

As per the data recorded by Yadvendu (2001) [21] pest population attained its peak of 86.5 and 72.5 larvae/5 plants during first and fourth week of September, respectively. Dangi (2004) [7] also reported peak population (10.3 larvae/5 plants) in first week of October.

The data presented in table 6 revealed that significant negative correlation was found between per cent fruit damage of *E. vittella* on okra and maximum temperature (r= -0.503), average temperature (r= -0.538), wind velocity (r= -582). Similarly, significant positive correlation was found between per cent fruit damage of *E. vittella* on okra and morning relative humidity (r= 0.578), rain fall (r= 0.591) while average relative humidity (r= 0.725) found highly significant and positively correlated with per cent fruit damage of *E. vittella* on okra. However, minimum temperature (r= -0.260), sun shine hours (r= -0.379), evaporation (r= -0.237) were non-significant and negatively correlated with per cent fruit damage of *E. vittella* on okra while evening relative humidity (r= 0.276) was non-significant and positively correlated with per cent fruit damage of *E. vittella* on okra.

However, Devraj and Kumar (1987) [9] and Pareek *et al.*, (2001) observed that minimum temperature, relative humidity and rainfall had a significant negative correlation. The present findings are in confirmation with the same.

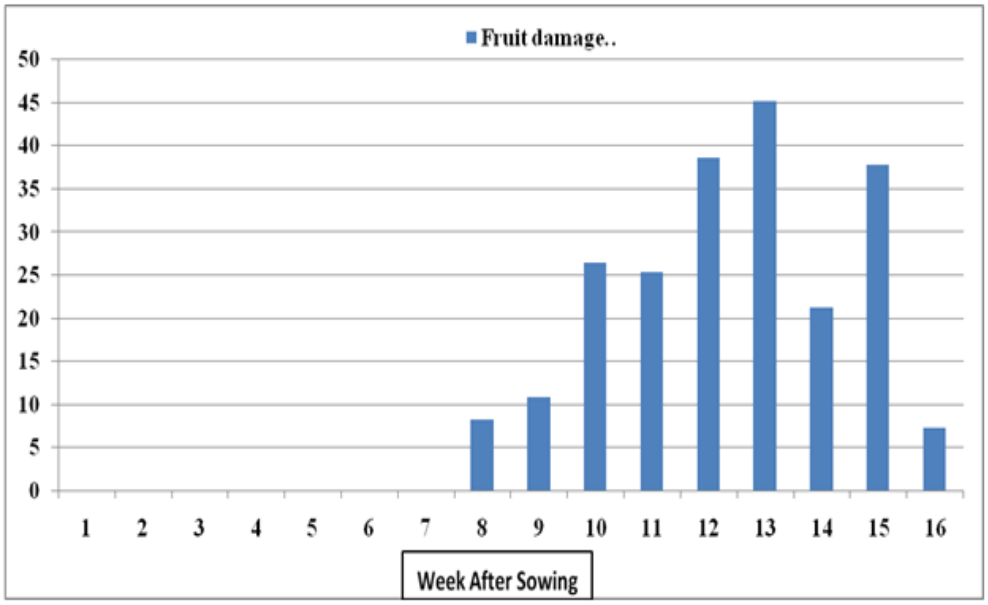

Fig 3: Per cent fruit damage by *E. vittella* on okra variety GAO-5 as well as weather parameters under field condition during June – October, 2016

Second year (2016), Vikas 101 (Hybrid)

The results of present investigation (table 7 and figure 4) revealed that the earliest fruit damage per cent *E. vittella* was recorded from 8th Week after sowing (WAS) i.e. 9.52 per cent fruit damage/week during 33rd Standard week (SW) and population reached its peak at 13th WAS i.e. 38 SW (30.92 per cent fruit damage/week). The per cent fruit damage declined thereafter and, continued fluctuating till the 40th SW i.e. 15th WAS and then reached to disappear during 41st SW.

The results of present investigation (table 8) revealed that among various weather parameters maximum temperature (r= -0.579), sun shine hours (r= -0.593) found significant and negatively correlated with per cent fruit damage of *E. vittella* on okra. Similarly, significant positive correlation was found between evening relative humidity (r= 0.537), average relative humidity (r= 0.522) and per cent fruit damage of *E. vittella* on okra while rain fall (r= 0.754) found highly significant and positively correlated with per cent fruit damage of *E. vittella* on okra. However, minimum temperature (r= -0.006), sun shine hours (r= -0.593), evaporation (r= -0.126) were non-significant and negatively correlated with per cent fruit damage of *E. vittella* on okra while morning relative humidity (r= 0.264), wind velocity (r= -0.184) were non-significant and positively correlated with per cent fruit damage of *E. vittella* on okra.

Yadvendu (2001) [21] reported that pest population attained its peak of 86.5 and 72.5 larvae/5 plants during first and fourth week of September, respectively. Dangi (2004) [7] also reported peak population (10.3 larvae/5 plants) in first week of October. Patel *et al.* (2014) [16] revealed that earliest catch of *E. vittella* males was recorded from 2nd WAT (9 male moth catch/trap/week) *i.e.* 48 standard week of 2011 and population reached its peak at 5th WAT *i.e.* 51th standard week of 2011 (38 male moth catch/trap/week). Among various weather parameters, maximum temperature had significant negative and evening relative humidity had significantly positive influence on shoot and fruit borer population. The present findings are in confirmation with the same.

Thus, the present findings are in confirmation with the same. However, Devraj and Kumar (1987) [9] and Pareek *et al.*, (2001) observed that minimum temperature, relative humidity and rainfall had a significant negative correlation with the population build up. The present findings different from the same which may be due to variation in weather conditions of the past research and present investigation.

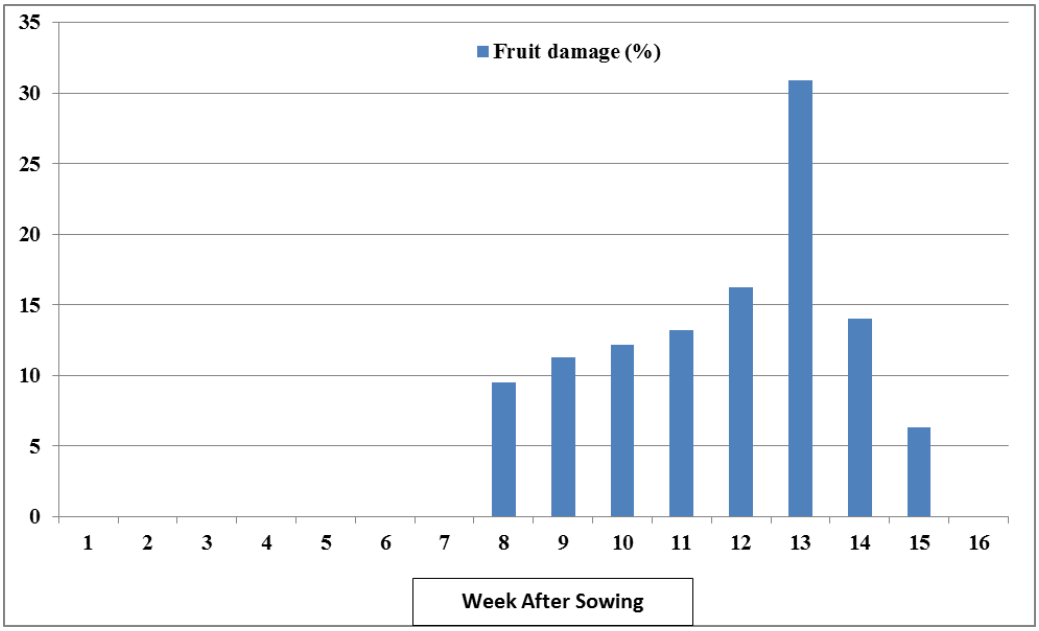

Fig 4: Per cent fruit damage by *E.vittella* on okra Vikas 101 (Hybrid) as well as weather parameters under field condition during June – October, 2016

Table 1: Per cent fruit damage by *E. vittella* on okra variety GAO-5 as well as weather parameters under field condition during June – October, 2015

Standard Week	Week After Sowing	Fruit damage (%)	Maximum Temperature	Minimum Temperature	Average Temperature	Relative Humidity (%)		Average Relative Humidity (%)	Wind Velocity (km/hrs)	Sun Shine Hours	Rain Fall (mm)	Evaporation (mm/day)
27	1	0	31.9	27.4	29.6	81.9	72.7	77.3	12.6	6.3	2.0	5.5
28	2	0	31.8	26.9	29.4	85.3	75.5	80.4	9.8	4.1	6.5	4.5
29	3	0	30.9	26.0	28.5	90.5	81.0	85.8	9.0	1.9	70.0	3.9
30	4	0	28.6	24.4	26.5	92.5	86.2	89.4	11.0	0.1	238.5	2.6
31	5	0	30.0	26.4	28.2	86.1	77.9	82.0	9.4	2.7	4.2	3.9
32	6	0	30.4	25.1	27.8	93.8	74.2	84.0	6.4	2.3	9.8	3.4
33	7	6.16	30.3	25.3	27.8	92.9	75.4	84.2	5.6	4.4	49.0	3.2
34	8	11.53	30.9	25.4	28.1	85.6	71.3	78.5	7.9	6.3	5.0	3.8
35	9	34.51	31.4	24.6	28.0	90.8	69.1	79.9	5.7	6.4	7.0	4.2
36	10	48.05	32.4	23.2	27.8	86.6	58.9	72.7	3.7	7.7	0.0	4.0
37	11	40.95	31.2	23.5	27.4	95.0	74.0	84.5	3.8	2.9	106.0	3.2
38	12	24.53	28.5	24.0	26.3	94.7	87.3	91.0	7.9	1.7	328.0	2.0
39	13	18.09	32.0	22.7	27.3	91.7	56.0	73.8	3.1	8.4	0.0	3.6
40	14	3.02	35.1	24.6	29.9	89.0	50.5	69.8	3.5	7.9	0.0	4.6
41	15	0	34.7	24.1	29.4	92.3	57.7	75.0	2.9	6.4	3.0	4.2
42	16	0	37.5	22.6	30.0	84.9	34.6	59.7	2.5	9.3	0.0	3.2

Table 2: Correlation between weather parameters and per cent fruit damage by *E. vittella* on okra variety GAO-5 as well as weather parameters under field condition during June – October, 2015

	Maximum Temperature	Minimum Temperature	Average Temperature	Relative Humidity (%)		Average Relative Humidity (%)	Wind Velocity (km/hrs)	Sun Shine Hours	Rain Fall (mm)	Evaporation (mm/day)
Fruit Damage (%)	-0.605*	-0.118	-0.687**	0.276	0.516*	0.500*	0.192	-0.395	0.231	-0.176

*Significant at 5% level of significant **Significant at 1% level of significant

Table 'r' 0.05 = 0.4973, 0.01 = 0.6226

Table 3: Per cent fruit damage by *E. vittella* on okra Vikas 101 (Hybrid) as well as weather parameters under field condition during June - October, 2015

Standard Week	Week After Sowing	Fruit damage (%)	Maximum Temperature	Minimum Temperature	Average Temperature	Relative Humidity (%)		Average Relative Humidity (%)	Wind Velocity (km/hrs)	Sun Shine Hours	Rain Fall (mm)	Evaporation (mm/day)
27	1	0	31.9	27.4	29.6	81.9	72.7	77.3	12.6	6.3	5.5	5.5
28	2	0	31.8	26.9	29.4	85.3	75.5	80.4	9.8	4.1	4.5	4.5
29	3	0	30.9	26.0	28.5	90.5	81.0	85.8	9.0	1.9	3.9	3.9
30	4	0	28.6	24.4	26.5	92.5	86.2	89.4	11.0	0.1	2.6	2.6
31	5	0	30.0	26.4	28.2	86.1	77.9	82.0	9.4	2.7	3.9	3.9
32	6	0	30.4	25.1	27.8	93.8	74.2	84.0	6.4	2.3	3.4	3.4
33	7	0	30.3	25.3	27.8	92.9	75.4	84.2	5.6	4.4	3.2	3.2
34	8	8.82	30.9	25.4	28.1	85.6	71.3	78.5	7.9	6.3	3.8	3.8
35	9	14.97	31.4	24.6	28.0	90.8	69.1	79.9	5.7	6.4	4.2	4.2
36	10	30.14	32.4	23.2	27.8	86.6	58.9	72.7	3.7	7.7	4.0	4.0
37	11	27.23	31.2	23.5	27.4	95.0	74.0	84.5	3.8	2.9	3.2	3.2
38	12	17.45	28.5	24.0	26.3	94.7	87.3	91.0	7.9	1.7	2.0	2.0
39	13	11.80	32.0	22.7	27.3	91.7	56.0	73.8	3.1	8.4	3.6	3.6
40	14	5.58	35.1	24.6	29.9	89.0	50.5	69.8	3.5	7.9	4.6	4.6
41	15	0	34.7	24.1	29.4	92.3	57.7	75.0	2.9	6.4	4.2	4.2
42	16	0	37.5	22.6	30.0	84.9	34.6	59.7	2.5	9.3	3.2	3.2

Table 4: Correlation between weather parameters and per cent fruit damage by *E. vittella* on okra Vikas 101 (Hybrid) as well as weather parameters under field condition during June – October, 2015

	Maximum Temperature	Minimum Temperature	Average Temperature	Relative Humidity (%)		Average Relative Humidity (%)	Wind Velocity (km/hrs)	Sun Shine Hours	Rain Fall (mm)	Evaporation (mm/day)
Fruit Damage (%)	-0.620*	-0.128	-0.706**	0.296	0.537*	0.522*	0.196	-0.456	0.313	-0.247

*Significant at 5% level of significant **Significant at 1% level of significant

Table 'r' 0.05 = 0.4973, 0.01 = 0.6226

Table 5: Per cent fruit damage by *E. vittella* on okra variety GAO-5 as well as weather parameters under field condition during June – October, 2016

Standard Week	Week After Sowing	Fruit damage (%)	Maximum Temperature	Minimum Temperature	Average Temperature	Relative Humidity (%)		Average Relative Humidity (%)	Wind Velocity (km/hrs)	Sun Shine Hours	Rain Fall (mm)	Evaporation (mm/day)
26	1	0	32.7	25.2	28.9	91.1	79.9	85.5	8.3	4.8	12.2	4.2
27	2	0	30.0	25.6	27.8	93.8	85.1	89.5	7.7	1.9	28.7	2.6
28	3	0	30.1	25.5	27.8	91.6	83.0	87.3	8.7	0.7	2.9	3.5
29	4	0	29.9	24.4	27.1	92.1	79.6	85.9	7.2	2.7	12.2	2.9
30	5	0	29.5	24.3	26.9	95.4	83.2	89.3	4.7	0.4	12.3	2.3
31	6	0	28.3	24.5	26.4	95.3	90.0	92.7	5.9	0.6	30.4	2.0
32	7	0	29.2	24.5	26.8	94.5	87.9	91.2	9.0	1.7	16.7	2.3
33	8	8.21	30.2	25.5	27.8	90.5	77.5	84.0	8.5	3.4	0.3	3.1
34	9	10.88	29.9	25.0	27.4	86.6	80.1	83.4	7.5	2.6	1.8	2.8
35	10	26.48	30.4	24.8	27.6	95.4	69.1	82.2	5.4	4.1	3.1	3.4
36	11	25.3	30.1	23.9	27.0	88.4	73.3	80.8	6.4	6.4	21.4	3.1
37	12	38.63	30.3	23.6	26.9	103.7	73.4	88.6	3.6	4.9	2.9	3.1
38	13	45.15	28.7	23.6	26.2	98.6	88.3	93.4	3.2	0.4	41.4	2.3
39	14	21.19	31.1	23.1	27.1	95.5	74.6	85.0	3.5	4.5	9.4	2.8
40	15	37.74	29.8	23.9	26.8	97.4	81.8	89.6	3.7	2.9	8.4	2.3
41	16	7.31	30.4	22.7	26.5	95.7	72.9	84.3	3.3	5.6	5.3	2.6

Table 6: Correlation between weather parameters and per cent fruit damage by *E. vittella* on okra variety GAO-5 as well as weather parameters under field condition during June – October, 2016

	Maximum Temperature	Minimum Temperature	Average Temperature	Relative Humidity (%)		Average Relative Humidity (%)	Wind Velocity (km/hrs)	Sun Shine Hours	Rain Fall (mm)	Evaporation (mm/day)
Fruit Damage (%)	-0.503*	-0.260	-0.538*	0.578*	0.392	0.725**	-0.582*	-0.379	0.591*	-0.237

*Significant at 5% level of significant **Significant at 1% level of significant

Table 'r' 0.05 = 0.4973, 0.01 = 0.6226

Table 7: Per cent fruit damage by *E. vittella* on okra Vikas 101 (Hybrid) as well as weather parameters under field condition during June - October, 2016

Standard Week	Week After Sowing	Fruit damage (%)	Maximum Temperature	Minimum Temperature	Average Temperature	Relative Humidity (%)		Average Relative Humidity (%)	Wind Velocity (km/hrs)	Sun Shine Hours	Rain Fall (mm)	Evaporation (mm/day)
26	1	0	32.7	25.2	28.9	91.1	79.9	85.5	8.3	4.8	12.2	4.2
27	2	0	30.0	25.6	27.8	93.8	85.1	89.5	7.7	1.9	28.7	2.6
28	3	0	30.1	25.5	27.8	91.6	83.0	87.3	8.7	0.7	2.9	3.5
29	4	0	29.9	24.4	27.1	92.1	79.6	85.9	7.2	2.7	12.2	2.9
30	5	0	29.5	24.3	26.9	95.4	83.2	89.3	4.7	0.4	12.3	2.3
31	6	0	28.3	24.5	26.4	95.3	90.0	92.7	5.9	0.6	30.4	2.0
32	7	0	29.2	24.5	26.8	94.5	87.9	91.2	9.0	1.7	16.7	2.3
33	8	9.52	30.2	25.5	27.8	90.5	77.5	84.0	8.5	3.4	0.3	3.1
34	9	11.3	29.9	25.0	27.4	86.6	80.1	83.4	7.5	2.6	1.8	2.8
35	10	12.14	30.4	24.8	27.6	95.4	69.1	82.2	5.4	4.1	3.1	3.4
36	11	13.22	30.1	23.9	27.0	88.4	73.3	80.8	6.4	6.4	21.4	3.1
37	12	16.25	30.3	23.6	26.9	103.7	73.4	88.6	3.6	4.9	2.9	3.1
38	13	30.92	28.7	23.6	26.2	98.6	88.3	93.4	3.2	0.4	41.4	2.3
39	14	14.02	31.1	23.1	27.1	95.5	74.6	85.0	3.5	4.5	9.4	2.8
40	15	6.3	29.8	23.9	26.8	97.4	81.8	89.6	3.7	2.9	8.4	2.3
41	16	0	30.4	22.7	26.5	95.7	72.9	84.3	3.3	5.6	5.3	2.6

Table 8: Correlation between weather parameters and per cent fruit damage by *E. vittella* on okra Vikas 101 (Hybrid) as well as weather parameters under field condition during June – October, 2016

	Maximum Temperature	Minimum Temperature	Average Temperature	Relative Humidity (%)		Average Relative Humidity (%)	Wind Velocity (km/hrs)	Sun Shine Hours	Rain Fall (mm)	Evaporation (mm/day)
Fruit Damage (%)	-0.579*	0.006	-0.351	0.264	0.530*	0.559*	-0.184	-0.593*	0.754**	-0.126

*Significant at 5% level of significant **Significant at 1% level of significant

Table 'r' 0.05 = 0.4973, 0.01 = 0.6226

From the result of this experiment it can be inferred that during first year (2015) for variety GAO 5, the earliest fruit damage per cent *E. vittella* was recorded from 7th WAS i.e. during 33rd Standard week SW to 40th SW i.e. 14th WAS and population reached its peak at 10th WAS i.e. 36 SW. While in case of Vikas 101 (Hybrid), results showed that the earliest fruit damage by *E. vittella* was recorded from 8th WAS i.e. 34rd SW to 40th SW i.e. 14th WAS and population reached its peak at 10th WAS i.e. 36 SW. During 2015 for both the okra variety GAO 5 and Vikas 101 (Hybrid), per cent fruit damage of *E. vittella* on okra was significant and negatively correlated with maximum temperature and average temperature was highly significant and negatively correlated. Whereas per cent fruit damage of *E. vittella* on okra was negatively correlated with relative humidity of evening and average relative humidity. Similarly, during 2016 for variety GAO 5, the results revealed that the earliest fruit damage by *E. vittella* was recorded from 8th WAS i.e. 33rd SW to 41st SW i.e. 16th WAS and population reached its peak at 13th WAS i.e. 38 SW. Among various weather parameters significant negative correlation was found between per cent fruit damage caused by *E. vittella* on okra and maximum temperature, average temperature, wind velocity. Similarly, significant positive correlation was found between per cent fruit damage of *E. vittella* on okra and morning relative humidity, rain fall while average relative humidity found highly significant and positively correlated with per cent fruit damage of *E. vittella* on okra. While in case of Vikas 101 (Hybrid), the results of present investigation revealed that the earliest fruit damage per cent *E. vittella* was recorded from 8th WAS i.e. 33rd SW to 40th SW i.e. 15th WAS and population reached its peak at 13th WAS i.e. 38 SW. The results of present investigation revealed that among various weather parameters maximum temperature, sun shine hours found significant and negatively correlated with per cent fruit damage of *E. vittella* on okra. Similarly, significant positive correlation was found between evening relative humidity, average relative humidity and per cent fruit damage of *E. vittella* on okra while rain fall found highly significant and positively correlated with per cent fruit damage of *E. vittella* on okra.

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References

1. Agrawal PK. Key insect pests of okra, *Abelmoschus esculentus* (L.) Moench and their management. Ph.D. *thesis submitted* to Rajasthan Agricultural University, Bikaner, Rajasthan, 1993.
2. Anonymous. Indian Horticulture Data Base-2011, Ministry of Agriculture, Government of India, Gurgaon, 2011, 1-296.
3. Anonymous. Integrated Pest Management Schedule for Vegetables, National Horticulture Mission, Ministry of Agriculture, Technical Bulletin New Delhi, 2012; 6:10.
4. Brar KS, Arora KS, Ghai TR. Losses in fruit yield of okra due to *Earias* spp. as influenced by dates of sowing and varieties. J Insect Sci. 1994; 7(2):133-135.
5. Butani DK. Insects in vegetables. Periodical Expert Book Agency, Delhi. 1984, 46.
6. Chauhan DVS. Vegetable production in India. 3rd Ed.,

Pub. Ram Prasad and Sons, Agra (Fide: Journal of Biopesticides. 1972, 2008; 1(2):154-169
7. Dangi PR. Incidence of *Earias vittella* (Fabricius) and its management in okra, [*Abelmoschus esculentus* (L.) Moench]. M.Sc. thesis Submitted to Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, Rajasthan, 2004.
8. Dave PP. Screening of genotypes and bio-efficacy of botanicals and biopesticides under field condition against major insect pests of okra. [*Abelmoschus esculentus* (L.) Moench]. Thesis M.Sc. Submitted to Navsari Agricultural University, Navsari (unpublished), 2014.
9. Devraj U, Kumar KK. Studies on the economic threshold and management of the spotted bollworm. Proceedings of the National Symposium on Integrated Pest Control Progress and Perspective, Trivendrum, 1987, 85-85.
10. Dhamdhere SV, Bhadur I, Misra US. Studies on occurrence and succession of pests of okra at Gwalior. Indian Journal of Plant Protection. 1984; 12:9-12.
11. Dhawan AK, Sidhu AS. Incidence and relative abundance of different species of spotted bollworms on okra at Ludhiana, Punjab. Journal of Research. (PAU) 1984; 21:533-542.
12. Ghosh J, Ghosh SK, Chatterjee H, Senapati SK. Pest constraints of okra under Terai region of West Bengal. Indian J Ent. 1999; 61**(4)**:362-371.
13. Kanwar N, Ameta OP. Assessment of losses caused by insect pests of okra. Pestology. 2007; 31(6):45-47.
14. Krishnaiah K. Methodology for assessing crop losses due to pests of vegetable. Assessment of crop losses due to pests and diseases. Proc. of workshop held from Sept, 19-30, 1977 at Univ. Agric. Sci., Bangalore, 1980, 259-267.
15. Pareek BL, Bhargava MC. Estimation of avoidable losses in vegetable crops caused by borers under semi arid condition of Rajasthan. Insect Environ. 2003; 9:59-60.
16. Patel SD, Pandya HV, Dahatonde JA, Patel SR, Bambhaniya KC. Population dynamics of *Earias vittella* through pheromone trap and correlation coefficient between moth catches with weather parameters. Intern. J. Plnt. Protection. 2014, 1-5
17. Radke SG, Undirwade RS. Seasonal abundance and insecticidal control of shoot and fruit borer, *Earias* spp. On okra, *Abelmoschus esculentus* (L.) Moench. Indian Journal of Entomology. 1981; 43:283-287.
18. Rana BS. Studies in the effectiveness of some insecticides against insect pests of bhendi, *Abelmoschus esculentus* (L.) Moench. *Thesis M.Sc. Submitted* to Udaipur University, Rajasthan, 1983.
19. Rawat RB, Sahua HR. Estimation of losses in growth and yield of okra due to *Empoasca devastans* Dist. and *Earias* spp. Indian Journal of Entomology. 1973; 35:252-254.
20. Shah BR, Vyas HN, Jhala RC. Life table of shoot and fruit borer. *Earias vittella* (Fab.) for determining key mortality factors in okra, *Abelmoschus esculentus* (L.) Moench. Paper presented in National Conference on "*Plant Protection* - New Horizons in the Millennium" held at RAU, Udaipur during, 2001, 4.
21. Yavendu TC. Evaluation of newer insecticides against insect pests of okra [*Abelmoschus esculentus* (L.) Moench]. *M.Sc. thesis Submitted to* Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, 2001.