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Umesh Das
Department of Agricultural Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India

J Ghosh
Department of Agricultural Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India

N Chaudhuri
Regional Research Station, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India

Corresponding Author:
Umesh Das
Department of Agricultural Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India

Influence of weather factors on incidence of fruit borer complex (*Earias vittella* Fabricius and *Helicoverpa armigera* Hub.) on okra

Umesh Das, J Ghosh and N Chaudhuri

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Abstract
An experiment was conducted to study the seasonal incidence of fruit borer infesting okra (cultivar – Bhindi No.10) during post-kharif (2015 & 2016) and pre-kharif (2016 & 2017) season at Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal, India. The result revealed that the activity of fruit borer was found more during pre-kharif season in comparison to post-kharif season. The peak incidence of fruit borer (28.43%/plant) was observed in 45SW during post-kharif season and (33.22%/plant) in 20SW during pre-kharif season. Weather play an important role in incidence of fruit borer in both post-kharif and pre-kharif seasons under study. During post-kharif season, fruit borer (bored fruit %) had significantly negative correlation with maximum and minimum temperature of all weeks. During pre-kharif season the maximum temperature of current week, minimum temperature of all the week, evening RH of current week, 1-lag week and total rainfall of 2-lag week had positively significant influence on fruit borer incidence.

Keywords: Fruit borer, *Earius vittella* Fab., weather parameter, *Helicoverpa armigera* Hub

Introduction
Vegetables are an indispensable part of our diet supplying vitamins, carbohydrates and minerals needed for a balanced diet. Their value is important especially in developing countries like India, where malnutrition abounds (Randhawa, 1974) [17]. Amongst the various vegetables grown, okra *Abelmoschus esculentus* L. (Moench) is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. This crop is also suitable for cultivation as a kitchen garden crop as well as on large high-tech commercial farms beside usual cultivation. In India, major okra producing states are Uttar Pradesh, Bihar, West Bengal, Andhra Pradesh, Karnataka and Assam (Anon., 2004) [2]. West Bengal is the leading state in okra sharing 18.4% of the total national production of okra production. In West Bengal, okra occupies an area of 77.40 thousand hectares with production of 913.32 thousand MT during 2016-17 (Anon., 2017) [3]. Hoogly and Burdwan districts are the major growing belts.
Okra crop is ravaged by as many as 45 species of insect-pests throughout its growth period. Among these, cotton jassid, *Amrasca biguttula biguttula* (Ishida) and shoot and fruit borers, *Earias vittella* (Fabricius), *E. insulana* (Boisduval) are quite serious and major limiting factors in okra cultivation (Mandal *et al*., 2006a) [11]. These pests are found to infest the crop throughout vegetative as well as reproductive stages causing ample reduction in yield (Satpathy and Rai, 1999). Pareek *et al.* (2003) [16] has also been reported that the fruit borer complex alone was responsible to cause economic damage to the extent of 52.33 to 70.75 per cent in okra. Keeping these in view, the present investigation was carried out to evaluate the impact of weather parameters on fruit borer incidence.

Material and Methods
The field experiments were carried out in Instructional farm of UBKV, Pundibari, Coochbehar (WB) during post-kharif (2015 and 2016) and pre-kharif (2016 and 2017) season. The seeds of okra variety (Bhendi No.10) were sown in a plot having size of 3m x 3m with spacing of 60cm x 40cm in both two seasons. The crop was grown under usual recommended fertilizer dosages of 120: 60: 60 kg NPK per ha with proper agronomic practices without adopting any plant protection measures Observations of fruit borer on okra were recorded at 7 days.

interval starting from initiation of pests to maturity. Five plants were randomly selected from each plot for each observation and percent of bored fruit was calculated by the following formula

$$\% \text{ damage: } P = \left[\frac{\text{No.of damaged fruits}}{\text{No.of healthy fruit} + \text{No.of damaged fruits}}\right] \times 100$$

Statistical analysis: Correlation analysis was done by in statistical software SAS (Version 9.2) with transformed values whichever applicable for interpretation of data.

Result and Discussion

Post-kharif season (2015 and 2016)

Fluctuation of fruit borer complex infestation during post-kharif: With the initiation of fruit setting, the infestation of fruit borer was noticed. The average fruit damage was recorded 11.10%, 12.25% and 11.68% in 2015, 2016 and pooled mean respectively during post-kharif season (Fig. 1). The infestation was initiated on 42th SW in 2015 (6.56%/ plant), in 2016 (4.24%/plant) and pooled mean of two years study with 5.41% damaged fruit. The highest per cent of damage was found on 45th SW in all cases causing 24.42% damage in 2015, 32.45% during 2016 and 28.43% damage in pooled mean of both the years. Thereafter the level of damage declined gradually and reached 9.67%, 10.01% and 9.84% respectively on 50th SW in both the years and pooled mean at the end of the crop growing period respectively.

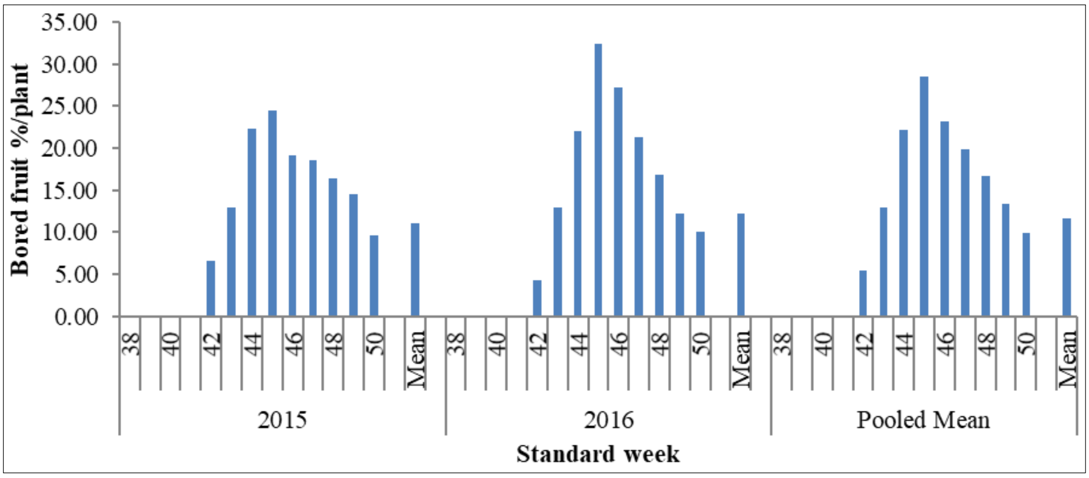

Fig 1: Fluctuation of fruit borer complex (bored fruit %) population during post-kharif season

Correlation study showed that during post-kharif season, the minimum and maximum temperature had negatively significant effect on fruit borer population in all weeks. Evening RH of 2-lag week had significant negative effect on fruit borer infestation during 2015 (Table 1). The maximum and minimum temperature of all the week were found to have significant negative relation with fruit borer population during 2016. The pooled mean data also revealed that maximum and minimum temperature of all the weeks had shown negatively significant influence on fruit borer infestation.

Table 1: Correlation between fruit borer complex (% bored fruit) and the environmental factors during post-kharif season

Year	Week	Temperature ^{0}C		Relative humidity %		Total rainfall (mm)
		Maximum	Minimum	Morning	Evening	
2015	Current	-0.608*	-0.808****	0.322	-0.178	-0.449
	1-lag	-0.715*	-0.778***	0.250	-0.459	-0.468
	2-lag	-0.624*	-0.775***	-0.149	-0.622*	-0.456
2016	Current	-0.830****	-0.804****	0.372	0.060	0.253
	1-lag	-0.918****	-0.914****	0.336	0.121	0.174
	2-lag	-0.899****	-0.899****	0.299	0.284	0.076
Pooled Mean	Current	-0.825****	-0.906****	0.435	-0.112	-0.440
	1-lag	-0.883****	-0.878****	0.373	-0.295	-0.460
	2-lag	-0.807****	-0.847****	0.099	-0.294	-0.443

*Significant at 0.05%, ** Significant at 0.01%, *** Significant at 0.005%, **** Significant at 0.001%

Pre-kharif season (2016 and 2017)

Fluctuation of fruit borer complex infestation during pre-kharif season: It was observed that the higher per cent of fruit damage due to fruit borer was recorded in 2017 (12.95%) as compared to 2016 (11.71%). The pooled data of both years revealed that 12.33% of fruits were damaged by borer (Fig. 2). Initiation of fruit borer infestation was recorded on 14th SW in both years with the level of 6.00% and 8.39% in 2016 and 2017 respectively. The pooled mean data showed 7.20% damage at initial harvest on 14th SW. The highest percent of damage was recorded on 20th SW (43.07%) in 2016, 18th SW (26.25%) in 2017 and the pooled mean it was 33.22% on 20th SW. Thereafter the damage level declined and reached 2.15%, 9.48% and 5.82% on 26th SW during 2016, 2017 and pooled mean respectively.

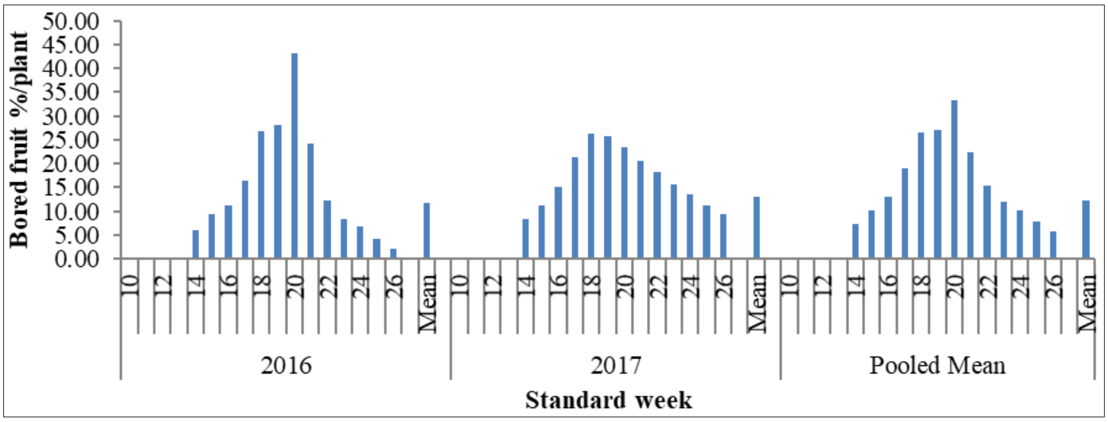

Fig 2: Fluctuation of fruit borer complex (bored fruit %) population during pre-kharif season

The correlation analysis during pre-kharif showed that morning RH of current week and total rainfall of current and 1-lag week had positive significant effect on fruit borer infestation during 2016 (Table 2). During 2017, maximum and minimum temperature, evening RH and total rainfall of all week were found to have significant positive relation. The pooled mean data revealed that maximum temperature of current week, minimum temperature of all the week, evening RH of current week, 1-lag week and total rainfall of 2-lag week had positively significant influence on fruit borer damage.

Table 2: Correlation between fruit borer complex (bored fruit %) population and the environmental factors during pre-kharif season

Year	Week	Temperature ^{0}C		Relative humidity %		Total rainfall (mm)
		Maximum	Minimum	Morning	Evening	
2016	Current	0.176	0.289	0.492*	0.312	0.498*
	1-lag	0.107	0.340	0.456	0.328	0.570*
	2-lag	0.240	0.263	0.243	0.113	0.344
2017	Current	0.655***	0.790****	0.023	0.683***	0.510*
	1-lag	0.758****	0.769****	-0.190	0.592*	0.477*
	2-lag	0.636*	0.796****	-0.403	0.670***	0.604**
Pooled Mean	Current	0.493*	0.586*	0.411	0.545*	0.462
	1-lag	0.442	0.634**	0.342	0.564*	0.382
	2-lag	0.419	0.573*	0.062	0.454	0.543*

*Significant at 0.05%, ** Significant at 0.01%, *** Significant at 0.005%, **** Significant at 0.001%

Discussion

In present study revealed that there was no incidence of fruit borer at early crop growth stage. The fruit borer infestation was started from 42th SW (3rd week of October) showing 5.41% damage in post-kharif which was about 5 weeks after sowing and from 14th SW (1st week of April) causing 7.20% damage in pre-kharif. The maximum percentage of fruit borer damage (bored fruit %) was recorded in pre-kharif (12.33%) as compare to post-kharif (11.68%). These observations are more or less similar with the observations recorded by Acharya (2002) [1] and Dangi (2004) [7] who reported the incidence of okra shoot and fruit borer was commenced from 6th week after sowing. No incidence of shoot and fruit borer was observed by Pal *et al.* (2013) [15] at early growth stages of the crop, however, the population was observed from 14th standard week *i.e.* 2nd week of April that confirms our present findings.

The correlation study showed that minimum and maximum temperature of all week had significant negative influence on fruit borer (bored fruit %) during post-kharif season. The results of this present study are partially supported by the findings of Chauhan (2014) [6] who observed fruit damage by *Earias* spp. and minimum temperature had significantly negatively correlation**.** Mandal *et al*. (2006a) [11] reported that maximum temperature had negative effect on larval population buildup at Samastipur, Bihar. During pre-kharif season the minimum temperature of all weeks, maximum temperature of current week, evening RH of current and 1-lag week had significant positive correlation with bored fruit % while total rainfall of 2-lag week also showed significant positive effect. This result during pre-kharif season is partially confirmed by Selvaraj *et al.* (2010) [19] who also noticed significant positive correlation between *E. vitella* population and maximum temperature. In the same way Mohanasundaram and Sharma (2011b) [12] and Aziz *et al.* (2011) [4] also confirm our observations by reporting significant positive effect of minimum temperature on the fruit damage.

Conclusion

It was found that fruit borer was found more during pre-kharif season as compared to post-kharif season in present study. The peak incidence of fruit borer complex (28.43%/plant) was observed in 45 SW during post-kharif season. Correlation between the incidences of different insect pests with abiotic factors revealed that fruit bore (bored fruit %) had significantly negative correlation with maximum and minimum temperature of all weeks.

During pre-kharif season, the peak incidence of fruit borer (33.22%/plant) was observed in 20SW. Correlation study revealed that the maximum temperature of current week, minimum temperature of all the week, evening RH of current week, 1-lag week and total rainfall of 2-lag week had positively significant influence on fruit borer damage.

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