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Seasonal incidence of pests of bell pepper (*Capsicum annum* var grossum Sendt) and their correlation with weather parameters

Mousumi Ghose, Swarnali Bhattacharya and SK Mandal

Abstract
Field experiments were conducted during rabi season of 2015 -16and 2016-17 at Barasat II block, North 24 Parganas, West Bengal to study the seasonal occurrence of pest complex of bell pepper vis-à-vis the effect of weather parameters on their incidence. During the study, whitefly (*Bemisia tabaci* Genn), aphid (*Aphis gossypii* Glover), chilli mite (*Polyphagotarsonemus latus* Banks), thrips (*Scirthothrips dorsalis* Hood) and fruit borer (*Helicoverpa armigera* Hubner) appeared as principal pests of bell pepper. Whitefly infested the crop from first fortnight of November to first week of April with peak population during end of March. Aphid was active from November till April with peak population during first week of April. Thrips appeared on the crop during last week of January that continued till April, with its peak population during end of March to first week of April. Fruit borers were active from first week of February to first week of April, showing peak population during first fortnight of March. Chilli mite was active during November to first fortnight of January with its peak during first fortnight of December. Among the weather parameters, maximum and minimum temperature, wind speed, rainfall and sunshine hour had positive correlation with thrips, aphids, white fly and fruit borer population, but had negative correlation with mite population. Morning and evening humidity showed positive correlation with mite population but negative correlation with thrips, aphids, white fly and fruit borer population.

Keywords: Bell pepper, pests, seasonal incidence, weather parameters

Introduction
Capsicum (*Capsicum annum* var *grossum* Sendt.), also known as 'Bell pepper' or 'Sweet pepper', is a highly remunerative vegetable crop grown in most parts of the world including India [1].

In India, capsicum is cultivated in an area of 30,000 ha with production of 1.71 lakh tons [2]. Jharkand is the major capsicum cultivating state with an area of 1,960 ha and production of 0.2 lakh tons followed by Karnataka, Himachal Pradesh and Jammu and Kashmir [3]. Capsicum cultivation is in limited scale in Kerala, Telangana, Andhra Pradesh, Maharastra, West Bengal, Gujarat and Goa [4]. Being the low temperature loving crop, in the plains of west Bengal it is grown during rabi season only.

About 35 species of insect and mite pests have been reported to infest capsicum, of which thrips *(Scirtothrips dorsalis* Hood and *Thrips palmi* Karny), aphids (*Aphis gossypii* Glover and *Myzus persicae* Sulzer), whitefly (*Bemisia tabaci* Gennadius), capsule borers (*Helicoverpa armigera* Hubner and *Spodoptera litura* Fabr.) and yellow mite (*Polyphagotarsonemus latus* Banks) cause serious damage to the crop in different regions of India [5-7].

In an IPM trial, it was estimated that per ha crop loss of 40 to 60 tons of capsicum if the crop is not subjected to insecticidal control [8]. In an experiment, it has anticipated the crop losses up to 34 percent due to attack of sucking pests [9]. Thrips, *Scirtothrips dorsalis* Hood, yellow mite, *Polyphagotarsonemus latus* Banks and fruit borer, *Helicoverpa armigera* Hubner economic loss every year especially in the southern districts of West Bengal, India, and has become a threat to chilli growers [10]. chilli yellow mite, *Polyphagotarsonemus latus* (Banks) is the major pest causing yield loss up to 96.4 percent in North Karnataka [11] and 25 percent in west Bengal [12] under open field conditions.

Due to variations in climatic conditions the pests show varying trends in their incidence and extent of damage to the crop. [13]. Information on seasonal incidence and influence of various environmental factors on population fluctuation of the pests of bell pepper are not available from West Bengal. Hence, an attempt was made to study the seasonal activity of the important pests of bell pepper as influenced by different weather parameters.

Materials and methods

The study was carried out in farmer's field in Barasat II Block, North 24 Parganas, West Bengal in two consecutive seasons i.e. Rabi 2015-16 and 2016-17. Bell pepper variety Indra was planted on large plots (18m X 4.5m) in three different dates at 15 days interval (1st November, 15th November and 1st December, 2015 / 2017) following standard package of practices to provide favourable stages of the crop to the pests over prolonged period. One month old seedlings were planted at a spacing of 60 X 45 cm. The crops were manured with FYM @ 10 tonne / ha and N_2: P_2O_5: K_2O @ 100:80:80 kg /ha. The entire amount phosphatic and potassic fertilizers were applied at planting while the nitrogenous fertilizer was applied in three splits (1/2 at final tillage, 1/4 at first earthing up and ¼ at second earthing up). In addition, micronutrient mixture of copper, zinc, boron (Agromin Soil plus by Aries agro Ltd.) @ 15 kg / ha was applied into soil at final tillage. Magnesium Sulphate fertilizer (Mag mix by Aries agro Ltd) was applied in soil @ 10 kg / ha at the time of first earthing up (21 days after planting) and water soluble fertilizer, N_2: P_2O_5: K_2O :: 19:19:19 @ 3 g / l of water was sprayed on foliages at three weeks interval starting from 60 days after planting. First earthing up was done 21 days after planting and second was 12 days after first. Hand weeding was done thrice at fortnightly interval starting from 15 days after planting. Irrigation was given as required. The crop was sprayed with Clorothilonil 75% WP (Kavach), azoxystrobin 25% SC (Amistar) and a mixture of carbendazim 25% and mancozeb 50% (Sprint WS) at fortnightly intervals started from 15 days after planting to protect the crop from different fungal diseases like damping off, powdery mildew, *Cercospora* leaf spot and *Phytophthora* blight (Chilli wilt).

The pest incidence was recorded from randomly selected thirty five fixed plants/ plot at 10 days interval starting from 15 days after planting. The population of whiteflies (nymphs and adults), thrips (larvae and adult) and motile stages of mite was recorded from five tender leaves per plant. The population of aphids was observed from five numbers of 10 cm terminal shoot from each plant All the observations were recorded during morning hours between 6:30 am to 8:30 am with the help of a hand lens (10X). Population of the fruit borer larvae was recorded on the whole plant basis. Thrips species was identified followed by Ananthakrisnan TN(1980) [14]. Other pests were identified following the descriptions provided by Butani and Verma (1981) [15]. The mean value of pest (thrips, aphids, white fly and mite / leaf and fruit borer larvae / plant) population at ten days interval were calculated and graphically represented in the fig 1 to 5 The data on weather parameters prevailed during the period of investigation as recorded at the nearest meteorological station, Dumdum (Airport Met Office, Kolkata). Correlation analysis was made to study the relationship between weather parameters and incidence of major insect pests of bell pepper by following Statistical Package for the Social Sciences (SPSS package).

Results and Discussion

In this study, the crop was infested by thrips (*Scirtothrips dorsalis* Hood), aphids (*Aphis gossypii* Glover and *Myzus persicae* Sulzer), whitefly (*Bemisia tabaci* Gennadius), fruit borer (*Helicoverpa armigera* Hubner) and chilli mite (*Polyphagotarsonemus latus* Banks) in considerable numbers.

3A. Thrips (*Scirtothrips dorsalis* Hood): Thrips population appeared on the crop during last week of January in both the years which continued till final harvest at 1st week of April. In both the crop seasons thrips population showed a gradual increase with rise in atmospheric temperature. In 2015-16, population attained peak (6.71thrips/ leaf) on 25th March, 2016 fallowed by a slight decline (6.62 thrips/ leaf) during the next observation i.e.4th April 2016. In 2016-17, however thrips population reached its peak (5.77 thrips / leaf) on 4th April, 2017 (Fig-1). Correlation between incidence of thrips and weather parameters based on two years pooled data showed highly significant positive correlation with maximum and minimum temperature and wind speed. The correlation between thrips population and rainfall and sunshine hour was positive but non- significant, whereas that with morning and evening relative humidity was negative and non-significant (Table 1).

3B. Aphid (*Aphis gossypii* Glover and *Myzus persicae* Sulzer): Aphid population was noticed throughout the cropping season in both the years. Aphid infestation started on 15th November with an average population of 0.14 aphids/ 10 cm terminal shoot which gradually attained peak on 4thApril in both the years (13.66 and 18.95 aphids/ 10 cm terminal shoot in 2015-16 and 2016-17, respectively) (Fig. 2). The pooled data on aphid populations exhibited highly significant positive correlation with maximum and minimum temperature and wind speed, but non-significant positive correlation with rainfall and sunshine hours.The population exhibited negative correlation with morning and evening humidity, though only evening relative humidity had significant effect (Ta 1).

3C. Whitefly (*Bemisia tabaci* Gennadius): The crop was infested by white fly all through the growth period in both the seasons. The population of white fly could be recorded on sample plants on 15th November in both the years with an average population of 0.47 and 0.86 white fly/ leaf in 2015-16 and 2016-17, respectively, which gradually increased till 15th December (3.60 and 3.71 white fly/ leaf). In 2015-16, population reduced to very low level during the first week of January, 2016 (0.71 white fly/ leaf), thereafter population started increasing and reached the peak on 1st week of April (10.33 white fly/leaf). In 2016-17, population declined to 0.80 white fly/ leaf during last week of December, 2016 which continued till 1st week of January, 2017. The population again started increasing and reached the highest level of 13.80 white flies / leaf during last week of March, 2017 followed by a slight reduction (13.57 white fly/ leaf) during 1st week of April, 2017 (Fig. 3). The pooled data on white fly population exhibited highly significant (0.1%) positive correlation with maximum and minimum temperature and wind speed. Sunshine hour showed significantly positive correlation with whitefly population. The correlation with rainfall was positive but non-significant. Morning and evening relative humidity showed negative correlation with white fly population, whereas evening relative humidity exhibited highly significant correlation (Table 1).

3D. Chilli Mite (*Polyphagotarsonemus latus* Banks): Chilli mite population was recorded in early growth stage of the crop, whereas they were almost absent during later stages in both the seasons. Mite population first recorded on sample plants on 15th November in both the seasons with an average population of 0.14 and 0.95 mites / leaf in 2016-17 and 2015-16, respectively. In 2015-

16, mite population reached its peak during 1st week of December, 2015 (3.33 mites/ leaf) which gradually declined to nil during last week of January, 2016. In 2016-17, however, highest mite population was recorded during 2nd week of December, 2016 (2.77 mites/ leaf) and the population gradually disappeared during 1st week of February, 2017 (Fig 4). The population exhibited non- significant negative correlation with maximum and minimum temperature, sunshine hour, wind speed and rainfall, whereas the correlation was positive with morning and evening relative humidity of which the effect was significant in case of evening humidity only (Table 1).

3E. Fruit borer (*Helicoverpa armigera* Hubner): Fruit borer larvae appeared on the crop during first week of February in both the seasons following fruit formation. Larval population reached to maximum level during middle of March, 2016 (2.76 larvae/ plant) in 2015-16 and first week of March, 2017 (2.83 larvae/ plant) in 2016-17 crop seasons. In 2015-16, larval population was maintained almost at the same level till the end of the season, whereas in 2016-17 population started to decline and reached to 2.14 larvae/ plant at the end of the cropping season (Fig-5). Fruit borer population had highly significant positive correlation with maximum and minimum temperature, significant positive correlation with wind speed and sunshine hour but non- significant positive correlation with rainfall. Fruit borer showed significant negative correlation with morning and evening relative humidity, of which evening relative humidity was significant at 1% level (Table1).

Among the insect and mite pests of bell pepper, chilli mite was mostly active during early stage of crop growth i.e. November to middle of December. Aphids and white fly were present throughout the crop season, though the population of white fly reduced during later part of December to early January when the temperature was low. Thrips appeared after middle of January and population increased with rise in atmospheric temperature. Fruit borer, *Helicoverpa armigera* Hubner infested the crop only following fruit setting from February. Earlier Patel *et al*. (2009) [16] and Zainab *et al*. (2016) [17] observed that thrips population varied positively with maximum temperature and sunshine hours but negatively with relative humidity and rainfall which is in agreement with the present findings. Meena *et al* (2013) [13] observed positive correlation of whitefly population with both temperature and relative humidity but in the present investigation, relative humidity was negatively correlated with the whitefly population. It is generally agreed that, moderate to high temperature and relative humidity favours population buildup of white fly. It is quite obvious that during the period of high whitefly population (February to April) frequent irrigation given to the crop, made the relative humidity of microclimate favourable for the pest though outside relative humidity was low. This may have resulted in a negative correlation between whitefly population and relative humidity of macroclimate. Mites showed significant positive correlation with evening relative humidity only which is in complete agreement with (Roopa *et al*, 2014) [18]. The present findings are confirmed with Sunita TR. (2007) [5] who reported that Sucking pests *viz.*, thrips, mites and aphids were observed during vegetative to reproductive stage ,whereas, fruit borer (12.50% fruit damage) was noticed during reproductive stage of the capsicum. The population of *M. persicae* in bell pepper planted in kharif, 2012 exhibited a negative correlation with maximum and minimum temperature and sunshine hours whereas, positive correlation was observed with the morning and evening relative humidity, rainfall [18]. The population of aphid in chilli crop planted in 15th July exhibited a negative correlation with maximum temperature while, the correlation was positive with minimum and mean temperature, maximum, minimum and mean relative humidity and average rainfall [13] but in the present study, relative humidity was negatively correlated with the aphid population. It is generally decided that, moderate to high temperature and relative humidity favours population buildup of aphid. But it had happened due to seasonal variation where temperature was low and weather was dry.

Table 1: Correlation Study between Different Climatic Parameters and Pest of Bell Pepper.

Variable	Thrips			Aphid			Mite			White fly			Fruit borer		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
Max-temp	0.736**	0.819**	0.769**	0.649**	0.823**	0.683**	-0.091	-0.363	-0.191	0.611*	0.672**	0.585**	0.756**	0.800**	0.764**
Min-temp	0.737**	0.796**	0.758**	0.645**	0.796**	0.661**	-0.047	-0.342	-0.156	0.609*	0.550*	0.505**	0.770**	0.681**	0.706**
Wind-spd	0.676**	0.769**	0.501**	0.749**	0.742**	0.704**	-0.387	-0.056	-0.175	0.586*	0.527*	0.551**	0.606*	0.490	0.440*
Rainfall	0.324	0.136	0.279	0.235	0.183	0.141	-0.247	-0.226	-0.212	0.380	-0.002	0.162	0.401	0.152	0.293
Sunshine	0.587*	0.181	0.334	0.515*	0.158	0.342	-0.231	-0.107	-0.203	0.440	0.325	0.409*	0.563*	0.241	0.387*
RH-morn	-0.351	-0.133	-0.166	-0.168	-0.176	-0.219	0.104	0.386	0.264	-0.102	-0.358	-0.332	-0.412	-0.377	-0.368*
RH-even	-0.530*	-0.292	-0.312	-0.411	-0.312	-0.369*	0.623*	0.307	0.409*	-0.622*	-0.578*	-0.611**	-0.569*	-0.568*	-0.530**

Max-temp = Maximum temperature (In degree Celsius). **: $P< 0.01$ = highly significant
Min-temp = Minimum temperature (In degree Celsius). *: $P<0.05$ = Significant
Wind-spd = Average wind speed (In KMPH).
Rainfall = 24 hours daily rainfall (In mm.).
Sunshine = Sunshine hour.
RH-morn = Relative humidity at 0830 hrs IST (In %).
RH-even = Relative humidity at 1730 hrs IST (In %).

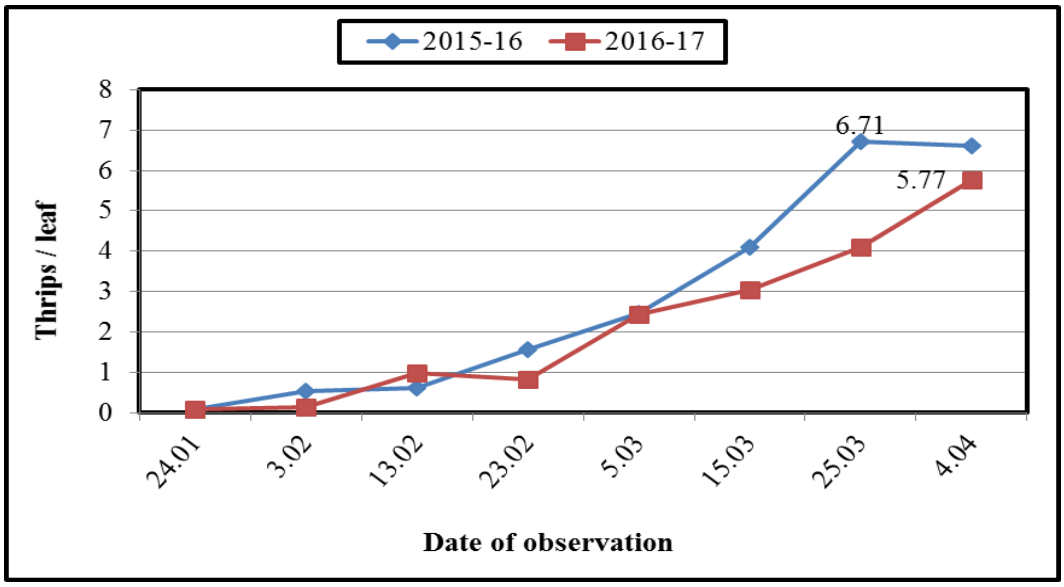

Fig 1: Seasonal incidence of thrips on bell pepper

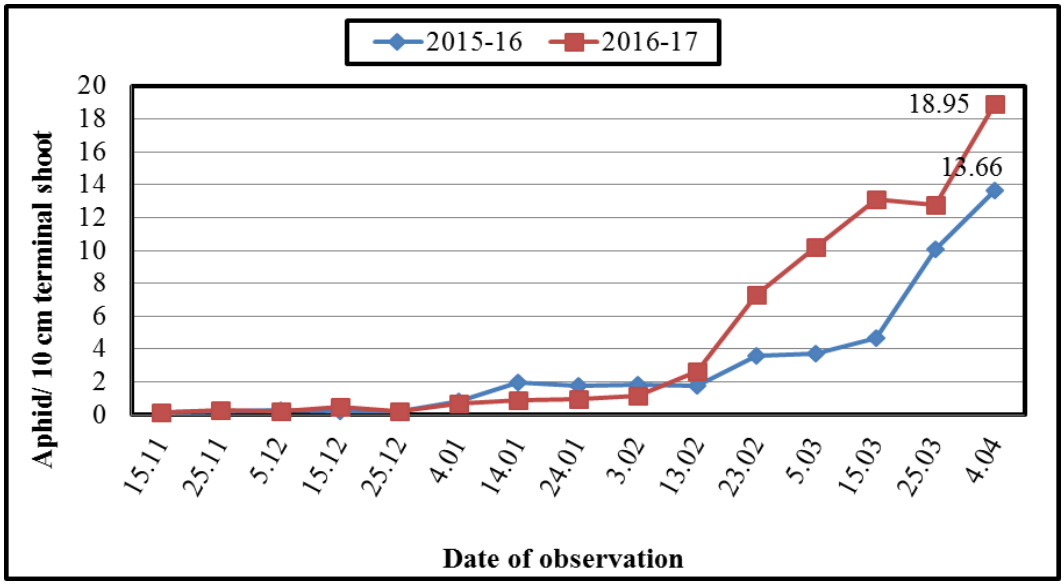

Fig 2: Seasonal incidence of aphids on bell pepper

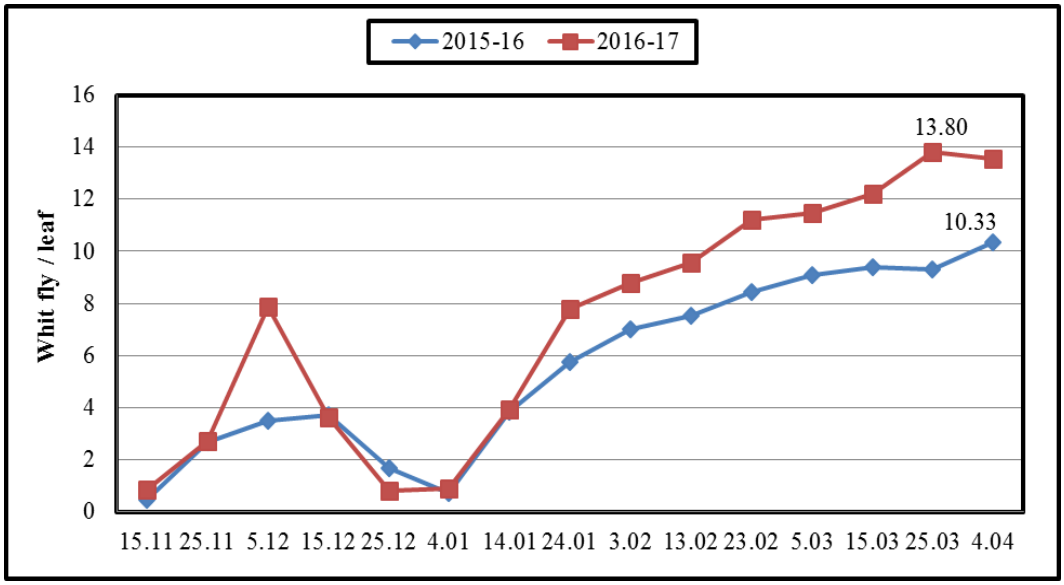

Fig 3: Seasonal incidence of white fly on bell pepper

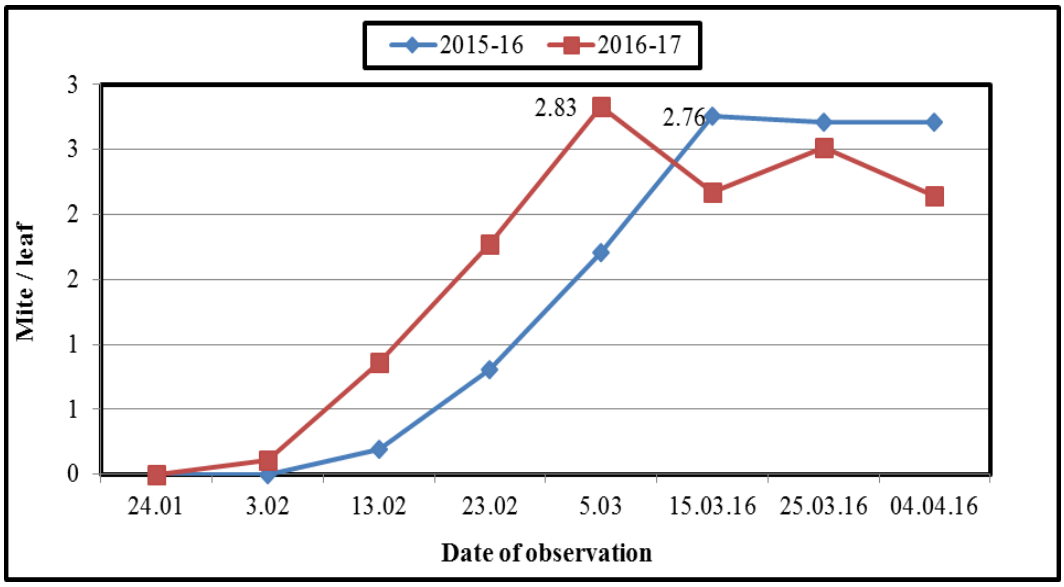

Fig 4: Seasonal incidence of mite on bell pepper

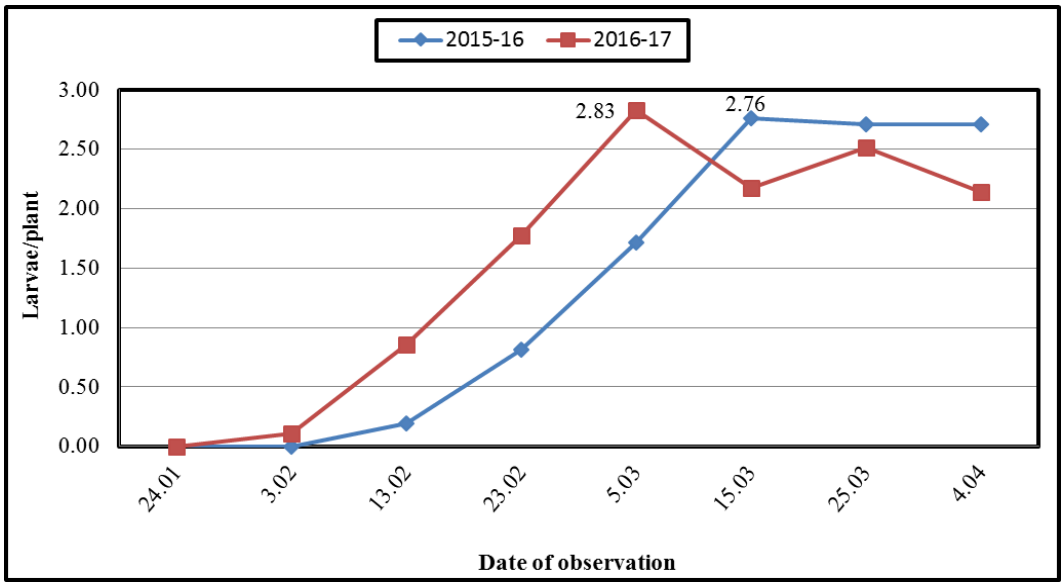

Fig 5: Seasonal incidence of fruit borer larvae on bell pepper

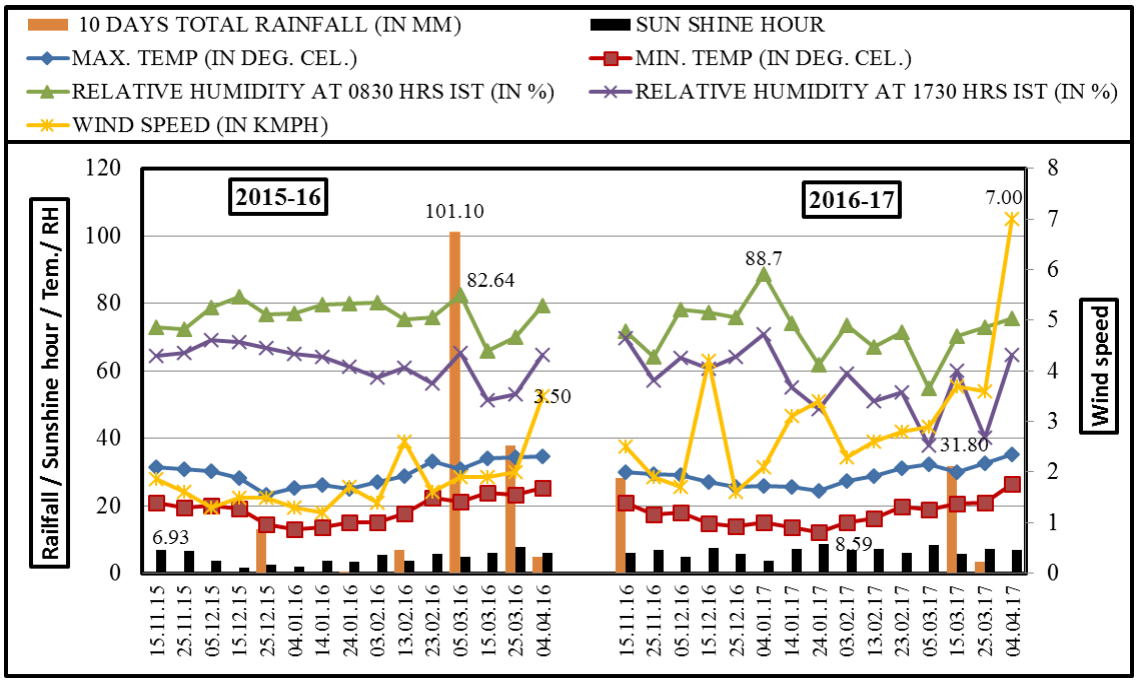

Fig 6: Meteorological Data Pertaining To the Period of Experimentation (November 2015 to April 2016 & November 2016 to April 2017)

Conclusion

Among the bell pepper pests, the incidence of whitefly, aphid and mite appeared soon after planting, while the thrips and fruit borer emerged late in both the years. Correlation coefficient values worked out for pest incidence and weather parameters showed that maximum and minimum temperature, wind speed, rainfall and sunshine hour had positive correlation with thrips, aphids, white fly nd fruit borer population, while negatively correlated with mite population. Morning and evening humidity had positive correlation with mite population buildup while negatively correlated with thrips, aphid, white fly and fruit borer population.

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