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Seasonal incidence of different insect pests of tomato (*Lycopersicon esculentum* Mill.) and their correlation with abiotic factor in lateritic zone of West Bengal

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Abstract
Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and commercially important vegetable crop cultivated throughout the India. Among the factors responsible for the lower yield, insect pests are the major one. The results revealed that the population of aphid initiated on second week of January while it disappeared from end of March. Among abiotic factors rainfall (r= -0.104) showed negatively non-significant effect on aphid population build up. Population of white fly initiated on first week of February while the population disappeared from 15th standard week onward. Correlation of weather parameter with white fly population revealed non-significant effect against maximum temperature (r=-0.010) and rainfall (r=0.007). In case of tomato fruit borer, population initiated in the 7th standard week and disappeared on 15th standard week in the year. However, rain fall (r= -0.208) showed negatively non-significant correlation with *H. armigera* population build up. The percentage contribution of all the weather parameters over *H. armigera* population was 18.6% (R^2= 0.186). The higher natural enemy population were found simultaneously with higher insect pest population recorded in field i.e. during February to March.

Keywords: Tomato, *Helicoverpa armigera*, aphid, white fly, seasonal incidence

Introduction
Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and widely grown vegetable crops in the world. In India, it occupies an area of 0.88 million hectares with an annual production of 18.7 million MT. The major tomato producing states are Bihar, Karnataka, Uttar Pradesh, Odisha, Andhra Pradesh, Maharashtra, Madhya Pradesh and West Bengal. In West Bengal, tomato cultivation occupies an area of 56,000 hectare with an annual production of 1,141,000 MT [1] and in Birbhum the total cultivated area of tomato is 1740 hectare with the production of 23.1 thousand tonne (WBSMB, 2015-16).

Tomato production has been intensified over the years, however, yields continue to be low due to several production constraints such as pests, diseases and environmental factors [2]. The incidence of insect-pests may vary from season to season and crop growth stages. The population fluctuation of the insects largely governed by different weather factors prevail during the crop growing period. India, about 16 pests reportedly feed on tomato, commencing from germination to harvesting stage which reduces its yield and also degrades quality [3]. The major pests attacking tomatoes are fruit borer *Helicoverpa armigera* Hubner (Lepidoptera: Noctuidae), whitefly *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae), thrips *Frankliniella occidentalis* Trybom (Thysanoptera: Thripidae), red spider mites *Tetranychus evansi* Baker (Acarina: Tetranychidae), leaf miners *Liriomyza trifoli* Burgess (Diptera: Agromyzidae), cutworms *Agrotis segetum* Denis and Schiffermuller (Lepidoptera: Noctuidae) and aphids *Aphis gossypii* Glover (Hemiptera: Aphididae) [5]. Tomato fruit borer, *Helicoverpa armigera* is an important pest which causes considerable losses in quantity as well as quality of tomato fruits. The monetary loss due to this pest in India has been estimated over rupees one thousand corer per year and yield losses ranged from 14 – 100 percent on different crops [6, 7]. In our study, mostly the sucking pests found in the tomato are whitefly (*Bemisia tabaci* Gennadius.) and aphid (*Aphis gossypii* Glover.). These two are the most serious pests, which have been reported to cause about 45%and 34% [4] yield loss in tomato, respectively [4, 6].

So, before execution of any management strategies to manage these three hazardous pests we

need to have full knowledge on the population dynamics and seasonal incidence of those target pests. As because, abiotic factors play important roles in population development of the insect species and their subsequent damage on crop plants and hence, correlation of the weather parameters and incidence of the important pests (whitefly, aphid and fruit borer) were the prime purpose of this study.

Materials and methods:

The field experiment was conducted during rabi season of the year 2015-2016 at Binuria village of Sriniketan, Birbhum, West Bengal. The field is situated at 23.39^0N latitude, 87.42^0F longitude and at an average altitude of 58.90 m above mean sea level. The test variety was selected for the study was Patharkuchi, a promising local variety was sown in a Randomized Block Design with nine treatments including control and replicate three times during the season. Seeds were collected from the local sources and these were sown separately on raised seedbeds of 1m x 2m area in lines with a gap of about one foot to avoid any hazards of mix up of the main experimental field. Sampling of insect pests started one week after transplanting and it continued till harvesting of the crop at each meteorological week. The inner rows leaving the border one in each plot were considered for sampling the insects. Five plants were selected at random from each plot. Three leaves from upper, middle and lower canopies from each sampled plants were collected and observed very carefully and minutely with the help of magnifying glass (10x) for the presence of insect. Mean population of the insects was expressed as number of insect/leaf/plant in each replication.

To study the population density of fruit borer, five plants were selected randomly from inner rows in each plot. Observation for larval population were examined carefully and mean was calculated to get number of larvae/ plant. These observations were recorded in different standard weeks at seven days interval starting from the initiation of infestation of insect till the harvesting of the crop.

Results and discussion:

Effect of weather factors on population dynamics of insect pests of tomato

Seasonal incidence of sucking pests of tomato

The population dynamics of important sucking insect pests of tomato viz. *A. gossypii* and *B. tabaci* during different period of the crop growing season was examined critically in relation to some important climatic factors viz. temperature (maximum and minimum), rainfall and relative humidity as they have significant role on the biology of insects.

Perusal of Table 1 and Fig. 1 revealed that population of aphid during field trial initiated on or before the 2nd week of January at very early stages of the crop (6-8 leaves). Population builds up gradually increased and attained the peak (9.58 aphid/leaf/plant) on the 4th week of February during fruiting initiation period of the crop. In this period, population was recorded considerably higher than rest of the period. Thereafter, the population gradually decreased and disappeared after 3rd week of April. Besides, during field trial, among various weather parameters viz. maximum temperature (r=0.132), minimum temperature (r= 0.244) and relative humidity (r=0.111) shows positive but non-significant correlation with the aphid population while rain fall (r= -0.104) shows negatively non-significant effect on aphid population (Table 2). The coefficient of determination (R^2=0.203) between aphid population and independent variables indicated that 20.3% variation in aphid population was caused due to the abiotic factors.

Whitefly is another important sucking pest of tomato in lateritic region of Birbhum. Unlike aphid its population was initiated on or before 1st week of February but increased steadily and attained the peak during fruiting stage of the crop. Maximum population (6.21whitefly/leaf/plant) was recorded during 2nd week of March. However, in later period white fly population declined at regular interval. After the 4th week of April no population was observed due to ageing of the leaves (Table 1 and Fig. 2). Correlations of weather parameters with white fly population revealed negatively non-significant effect of maximum temperature (r = -0.010) and rainfall (r = -0.007). Whereas, minimum temperature (r =0.113) and relative humidity (r = 0.311) showed a positive but non-significant correlation with population build-up of the whitefly (Table 2). The coefficient of determination (R^2) between white fly population and weather factors was 0.295 which indicated 29.5% variation happened due to the combined effect of abiotic factors (Table 2).

Seasonal incidence of fruit borer of tomato

The field trial was also conducted to study the seasonal incidence of tomato fruit borer. Results revealed that the incidence of *H. armigera* was first noticed during peak flowering stage of the crop i.e. on 3rd week of February. Initially, the population of the borer larvae was very low but the population build up increased steadily with the availability of the fruits and presence of congenial weather condition. The borer population reached peak at 4th week of March during peak fruiting stage. Observations on fruit damage caused by *H. armigera* followed the same trend (Table 1 and Fig. 3).

During the crop growing period, weather parameters viz. maximum temperature (r = 0.025), minimum temperature (r = 0.098) and relative humidity (r = 0.177) showed positive but non-significant correlations with *H. armigera* population and percent fruit damage, respectively (Table 2). However, rain fall (r = -0.208) showed negative but non-significant correlation with *H. armigera* population. Similarly, the percentage contribution of all the weather parameters on population fluctuation of *H. armigera* was 18.6% (R^2 = 0.186) (Table 2). Present findings indicated that multiple interactions of abiotic factors with the population fluctuation of insect pests of tomato failed to show any significant results.

Seasonal incidence natural enemy in tomato:

Regarding natural enemy study it was observed that lady bird beetle and spider population was found from initial vegetative stage upto last fruit harvest stage in tomato. The highest lady bird population was found during the 13th standard week while the spider population was found highest during the 12th standard week. It also seemed that the higher natural enemy population found to be correlated with the pest population in the field.

Table 1: Incidence of insect-pests of tomato at different growth stages of the crop during 2015-16

Meteorological standard week (Month)	Crop growth stages	No. of Aphids/ leaf/ plant	No. of White fly/ leaf/ plant	No. of *H. armigera* larvae/ plant	Lady Bird Beetle	Spider	Max. Temperature (^{0}C)	Min Temperature (^{0}C)	Rainfall (mm)	RH (%)
1 (1st week January)	4-6 leaf	0.00	-	-	0.0	0.10	26.46	10.81	0.00	84.00
2 (2nd week January)	6-8 leaf	0.60	-	-	0.10	0.16	26.66	11.04	0.00	77.43
3 (3rd week January)	Branching Initiation	0.98	-	-	0.14	0.20	24.30	13.40	5.64	77.57
4 (4th week January)	Vegetative	2.07	0.00	-	0.26	0.30	22.93	9.17	0.00	82.86
5 (1st week February)	Peak vegetative	2.99	0.52	-	0.51	0.36	27.54	13.46	0.00	76.57
6 (2nd week February)	Flowering initiation	4.83	1.59	0.00	0.64	0.40	28.30	16.34	3.57	83.29
7 (3rd week February)	Peak flowering	6.76	3.52	0.60	0.90	0.45	33.27	18.87	0.00	72.71
8 (4th week February)	Flowering + Fruiting	9.58	4.90	2.00	1.0	0.50	30.17	18.44	0.91	73.71
9 (1st week March)	Fruiting	8.35	5.62	3.53	1.2	0.40	34.13	19.84	0.00	77.57
10 (2nd week March)	Fruiting	6.88	6.21	4.53	1.1	0.50	33.96	21.21	0.10	68.43
11 (3rd week March)	Peak Fruiting	4.64	5.23	5.60	1.3	0.70	35.29	20.69	0.07	70.71
12 (4th week March)	Peak Fruiting	2.88	4.11	5.67	1.3	0.90	36.07	18.11	0.00	49.00
13 (1st week April)	Peak Fruiting	1.54	2.69	5.27	1.4	0.60	36.46	24.13	0.00	67.86
14 (3rd week April)	Fruiting+ Senescence	0.45	1.12	3.73	1.2	0.75	41.96	24.90	0.00	42.43
15 (4th week April)	Senescence	0.00	0.25	1.78	0.9	0.80	41.23	26.43	0.00	67.29
16 (1st week May)	Harvesting	0.00	0.00	0.00	0.9	0.60	41.80	26.80	0.00	66.80

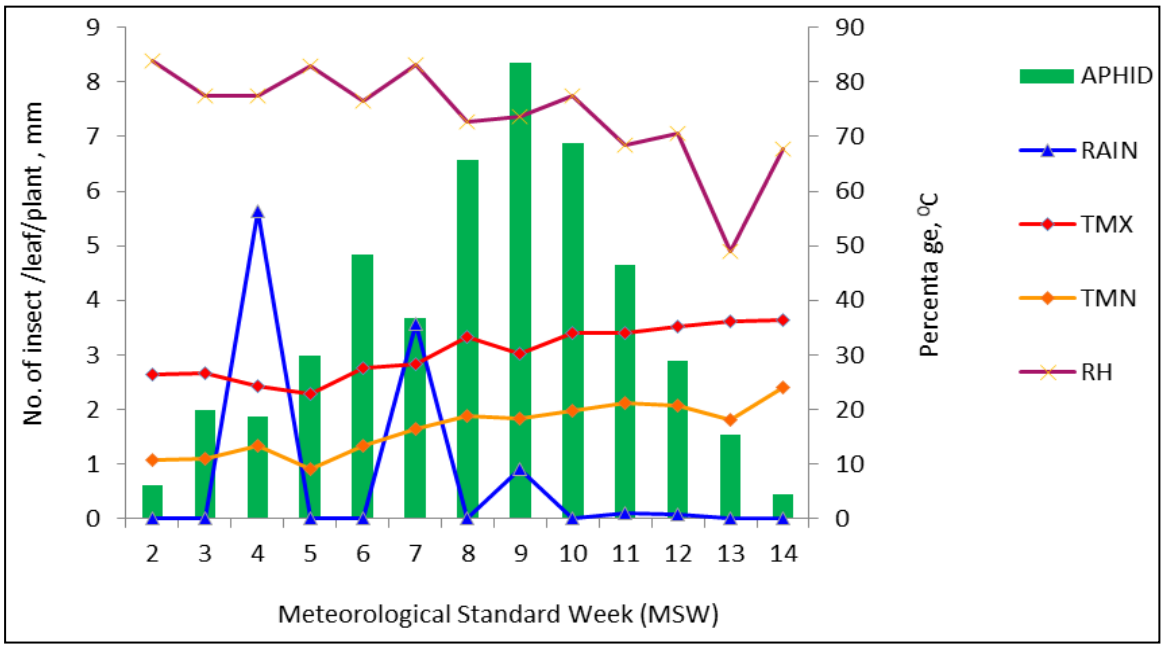

Fig 1: Population fluctuation of aphid at different MSW during 2015-16

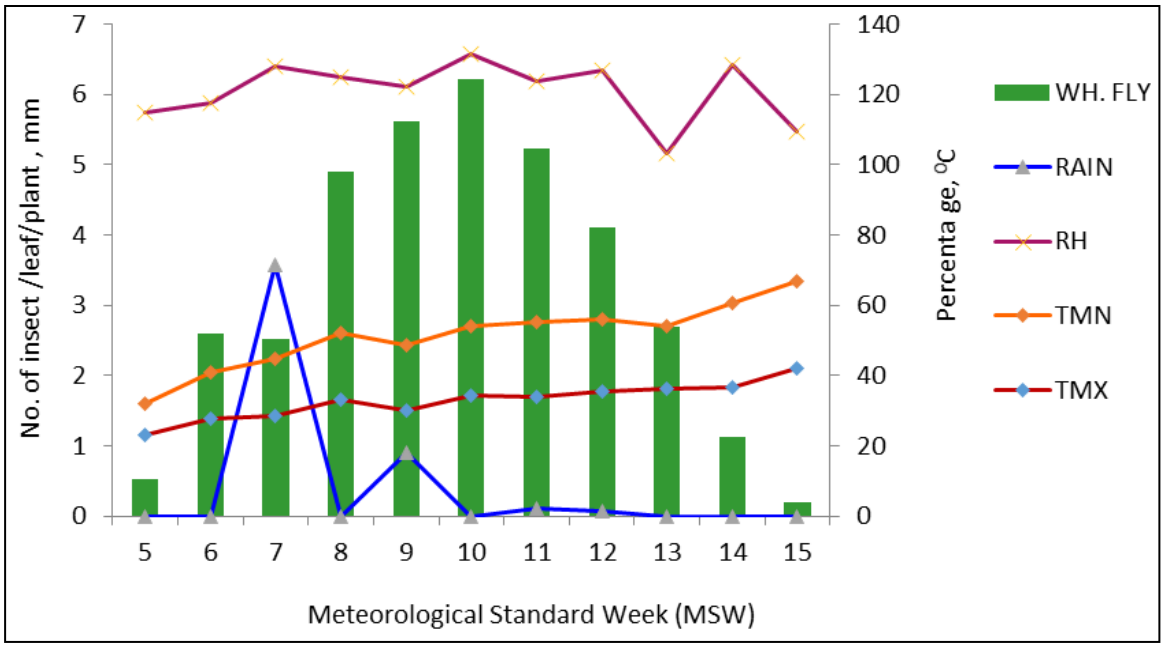

Fig 2: Population fluctuation of white fly at different MSW during 2015-16

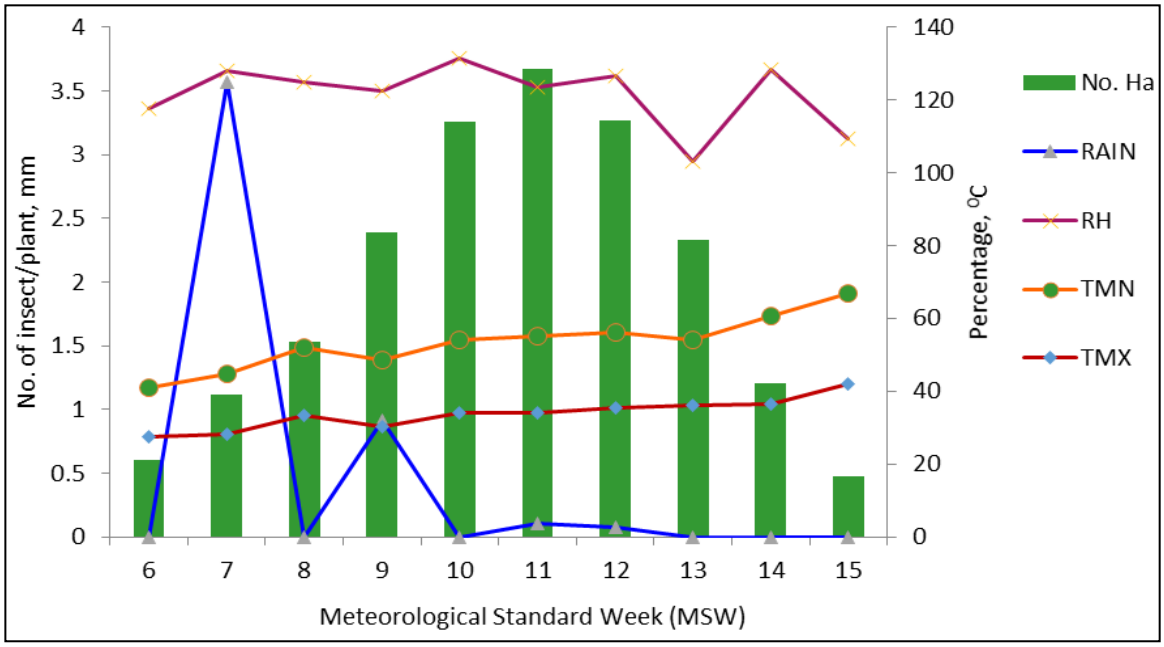

Fig 3: Population fluctuation of *H. armigera* at different MSW during 2015-16

Table 2: Correlation coefficients and Regression equation between different weather parameters and mean population of major insects-pests of tomato during 2015-16

Insect pests /Natural enemies	Minimum Temperature	Maximum Temperature	Rainfall	Relative Humidity	Coefficient of determination (R^2)	Regression equation ($Y= A+Bx_1+Cx_2+Dx_3+Ex_4$)
Aphid	0.132	0.244	-0.104	0.111	0.203^{NS}	$Y= 6.010-0.491X_1+0.600X_2-0.442X_3+0.041X_4$
Whitefly	-0.010	0.113	-0.007	0.311	0.295^{NS}	$Y= -18.980+0.361X_1-0.055X_2-0.250X_3+0.166X_4$
Fruit borer	0.025	0.098	-0.208	0.177	0.186^{NS}	$Y= -6.424+0.143X_1- 0.030X_2 -0.290X_3+0.063X_4$
Lady bird beetle	0.83	0.78	-0.001	-0.80	0.74^{NS}	Y = 3.25-0.10x1+0.14x2-0.10x30.02x4
Spider	0.77	0.79	-0.007	-0.64	0.78^{NS}	Y=0.09-0.001x1+ 0.01x2 -0.01x3-0.01x4

Conclusion

The study revealed that population of aphid initiated on second week of January while it disappeared from end of March while white fly initiated on first week of February while the population disappeared from end of April for rabi season tomato. Initiation of Tomato fruit observed from third

week of February correlated with peak flowering stage while disappeared on end of April in the year and maximum larva population was observed 5.67/plant at end of March. Among them fruit borer seemed to be caused heavy damage in tomato production.

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