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Study on population dynamics of early shoot borer in sugarcane ecosystem at Pantnagar

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Abstract
The studies on diversity of insect fauna and the population dynamics of early shoot borer in sugarcane ecosystem were carried out for two seasons during 2014-15 and 2015-16 at Norman E. Borlaug Crop Research Centre of G.B.P.U.A & T. Pantnagar, Uttarakhand, India. Early shoot borer or shoot borer, *Chilo infuscutellus* (Pyralidae: Lepidoptera) is spread extensively in all sugarcane growing areas of the country including Uttarakhand. The incidence of the Shoot borer was observed from 14th standard meteorological week (SMW) to 26th standard meteorological week, during both the crop seasons of 2014-15 and 2015-16. The population reached its maximum in the month of May; however the peak activity recorded in the 21st and 22nd SMW during both the first and second seasons, respectively. The Pearson correlation coefficient obtained between the weather parameters and early shoot borer population during season 2014-15 revealed that, there was positive non-significant correlation with T_{max} and T_{min}; negative and highly significant with RH_{max}, and negative significant with RH_{min}; while, it was non-significantly correlated with rainfall, respectively. Whereas, during the season 2015-16 there was positive and highly significant correlation with T_{max}; positive and non-significant correlation with T_{min}; negative significant with RH_{max}; negative and highly significant with RH_{min}, and it was negative significantly correlated with rainfall, respectively. Thus the study exhibited that the peak activity of early shoot borer was from 15th to 24th and 15th to 23rd SMW during 2014-15 and 2015-16 crop seasons, respectively.

Keywords: Sugarcane, Early Shoot Borer, Weather Correlation and Population Dynamics

Introduction
Cultivation of sugarcane in India dates back to the Vedic period. The earliest mention of sugarcane cultivation is found in Indian writings of the period 1400 to 1000 B.C. It is now widely accepted that India is the original home of *Saccharum* species (*Saccharum barberi*) whereas the New Guinea is the centre of origin of *Saccharum officinarum*. It belongs to class monocotyledon of family Gramineae (Poaceae) (Directorate of Sugarcane Development, 2013) [4].

This long duration of crop matching with a long diversity of conditions under which sugarcane is grown in the world; there is a wide spectrum of pests and diseases which have come to acquire a place of priority thereby causing economic loss to growers in terms of quality and quantity both. Thus, the crop is reported to attack by as many as 125 species of major insect pests across many parts of the world causing economic loss to the extent of 20 and 15 percent in terms of yield and sugar recovery respectively. Whereas, in India it is suffering from more than 289 different pests, out of which 213 are insect pests. Of these, 20 species considered as major pests including borers, white grubs, termites, *Pyrilla*, coccids, whiteflies, mealy bugs, army worm etc. (Patil *et al.*, 2004) [8]. The losses caused by various pests are mostly influenced by sugarcane genotype, pest severity, nature of crop-plant or ratoon, time of planting, climatic and edaphic factors (Rai, 1997) [10].

Worldwide sugarcane occupies an area of 27.10 mha with a total production of 1880.00 million tonnes at a productivity rate of 70.77 tonnes per ha, whereas, in India, sugarcane occupies an area of 5.012 million hectares with an annual production 352.00 million tonnes achieving a productivity of 70.23 tonnes per ha during 2014-15 and globally holding the second rank among the sugarcane growing countries with a share of 18.72%. Even though we are second in area and production still far behind the Brazil country as its share is more than

double of our country *i.e.* 39.15% with an annual production of 736.00 million tonnes holding the largest area of 10.4 million hectares during 2014 (Pocket Book of Agricultural Statistics, 2016) [9]. In India, Uttar Pradesh leading in sugarcane production and area with 145.39 million tonnes and 2.17 million hectares respectively, by contributing 24.64% share in India's production whereas Uttarakhand, still lagging behind, with an annual production of 5.98 million tonnes with an area of 0.10 million hectares during 2015-16 (Agriculture statistics at a glance, 2016) [1].

Early shoot borer or shoot borer, *Chilo infuscutellus* (Pyralidae: Lepidoptera) is a wide spread pest in all sugarcane growing areas of the country. This pest attacks the crop at early periods of growth with its peak activity during May-June in places like Punjab, Haryana and Uttar Pradesh (Butani, 1969) [3]. The larva of shoot borer starts damage by boring on the lateral side of the plant to make a way to the base of the stalk through a bored entry hole and inside the plant it bores downwards or upwards killing the growing point. This would sever the central leaf spindle which dries up to form dead heart symptom that can be pulled out effortlessly (Srikanth, 2012) [12].

The need for the study on population dynamics of pests of sugarcane is increased considerably during present era is a pre-requisite for control and forecasting system. Keeping the above points in view the present work conducted on "Study on population dynamics of early shoot borer in sugarcane ecosystem at Pantnagar"

Materials and methods

The experiments conducted in the Norman E. Borlaug Crop Research Centre and Department of Entomology at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar Udham Singh Nagar, Uttarakhand, India, during *kharif*-2014 and 2015 to study on population dynamics of early shoot borer in sugarcane ecosystem. It is located at 29° N latitude and 79.3° E longitude at an elevation of 243.84 m above the mean sea level (MSL). The sugarcane variety (CoPant 90223) was planted on 26th March and 02nd March during the year 2014 and 2015 respectively, at 90 cm inter row spacing. The plot size was kept 5.0 × 5.0 m. All recommended package and practices were followed to raise the crop organically. Systematic survey was taken to assess the diversity of major insect pest population of Sugarcane at N. E. B. C. R. C. Pantnagar. The observations were made at weekly intervals, starting from the first week of April, 2014 onwards till harvest of the crop. The data obtained were further transformed to square root transformation for statistical analysis.

The shoot borer infestation was estimated by recording the number of 'dead-hearts' in the field (Fletcher and Ghosh, 1920) [5] and measured in terms of percentage of canes attacked (Ramkrishna Ayyar and Margabandhu, 1935) [11]. Per cent shoot borer infestation calculated by following formula:

$$\text{Percent shoot damage} = \frac{\text{Damaged shoots}}{\text{Total no. of shoots observed}} \times 100$$

Statistical analysis

The populations of insect were correlated with average maximum, minimum temperature (°C), relative humidity (%) at 0700 hrs and 1400 hrs; total rainfall (mm) and sunshine hours to observe the influence of abiotic factors on pest population. The meteorological data during crop season were recorded from Meteorological Observatory of GBPUA&T Pantnagar. The observational data were subjected to Pearson's Correlation Coefficient in SPSS software.

Results and Discussion

The incidence of *Chilo infuscatellus* Snellen was observed from 14th to 26th standard meteorological week (SMW), in sugarcane during 2014-15 crop season (Table 1.). Perusal of data revealed that the per cent infestation by shoot borer varied from 3.50 to 22.27 per cent during the course of investigation. The pest marked its first appearance by an average of 3.50 per cent dead heart symptoms in the 14th standard week when the maximum and minimum temperature, morning and afternoon relative humidity (RH) ranged from 32.5 ^{0}C to 15.1 ^{0}C, 82.4 (0712 hrs) to 31 per cent (1412 hrs), respectively, with rainfall of 2.2 mm. The population gradually increased and the maximum infestation of shoot borer was observed in the month of May, however the peak activity recorded (22.27 per cent) in the 21st standard week when the maximum and minimum temperature, morning and afternoon relative humidity (RH) ranged from 37.4 ^{0}C to 25.4 ^{0}C, 68.1 (0712 hrs) to 38.1 per cent (1412 hrs), respectively, with negligible rainfall. Thereafter, the pest gradually decreased in population till 26th standard week.

Pearson correlation coefficient worked out between the weather parameters and Shoot borer population during 2014-15 (Table 1, Graph 1 and 2) revealed that there was positive non significant correlation with T_{max} and T_{min}; whereas, it is negative highly significant with RH_{max} and negative significant with RH_{min}, while, non-significantly correlated with Rainfall, respectively.

The infestation of the shoot borer on sugarcane during subsequent year, 2015-16 crop season, was observed from 14th to 26th standard meteorological week, 2015 (Table 2). Perusal of data revealed that the per cent infestation by shoot borer varied from 3.30 to 20.43 per cent during the course of investigation. The pest marked its first appearance by an average of 3.30 per cent infestation in the 14th standard week when the maximum and minimum temperature, morning and afternoon relative humidity (RH) ranged from 29.2 ^{0}C to 15.8 ^{0}C, 86.4 (0712 hrs) to 44.7 per cent (1412 hrs), respectively, with rainfall of 18.9 mm. The population gradually increased and the maximum infestation of shoot borer was observed in the month of May, however the peak activity recorded in the (20.43%) in the 22nd standard week when the maximum and minimum temperature, morning and afternoon relative humidity (RH) ranged from 39.6 ^{0}C to 22.2 ^{0}C, 62.6 (0712 hrs) to 30.7 per cent (1412 hrs), respectively with 0.00 mm rainfall. Thereafter, the pest gradually decreased in population till 26th standard week.

The correlation worked out (Table 2, Graph 3 and 4) during 2015-16, indicates there was positive highly significant correlation between the Shoot borer population/ infestation with T_{max} while, positive non-significant correlation with T_{min}, whereas it is negative significant with RH_{max} and negative highly significant with RH_{min}, and negative significant with rainfall respectively.

These findings are in accordance with Bhawar *et al.* (2015) [2], who observed the incidence of shoot borer at 10th SMW and reached its peak infestation during 13th to 14th SMW. The correlation of population with T_{max} shown highly significant whereas, negatively correlated with minimum temperature, humidity and rainfall. Varadharajan *et al.* (1971) [13] also observed that the pest activity was higher during the period of March to June when the maximum temperature is relatively high (30.2-35.3 ^{0}C) whilst, with low relative humidity (76.8-

89% RH) and scanty rain. The pest reached its peak activity during April, May and June months and the population declined in the month July whilst, the onset of South-west monsoon. Whereas, the pest seemed to be completely inactive during the period of October-November due to low temperature accompanied with high relative humidity (86.9-90.2% RH) and heavy rainfall (198.8-314.3 mm); Bhatti *et al*. (2008) observed population of *Chilo maximu*m appeared during April and infestation increased gradually up to 21.44 per cent in September.

The above findings are also supported by Pandey *et al.* (1996) [6] who observed that the incidence of early shoot borer started from the time of germination and continued up to the month of July**.** Similarly, Pandey and Kumar (2014) [7] also reported that the highest incidence of *C. infuscatellus* during 21st standard week (8.8 per cent) at 43.1ºC maximum temperature, 28.4ºC minimum temperature, 57.0 per cent maximum relative humidity, 21.0 per cent minimum relative humidity and 9.1 sun shine hours. The results were in agreement with the Vijay Laxmi (2014) [14] who reported that the infestation of *C. infuscatellus* was recorded in sugarcane from first week of May (18th SMW) to second week of July (27th standard week) with its peak activity in the month of May. The per cent infestation varied from 1.78 to 23.70 per cent recording highest infestation in the fourth week of May (23.70 per cent) when the weather recorded maximum and minimum temperature ranged from 38.4 to 39.2°C and 19.1 to 29.1°C, accompanied with maximum of 56.7 to 70 per cent and minimum of 23 to 44.4 per cent RH, respectively, with traces of rainfall.

Table 1: Population fluctuation of early shoot borer in relation to weather parameters in sugarcane crop grown at NEBCRC, Pantnagar, during 2014-15.

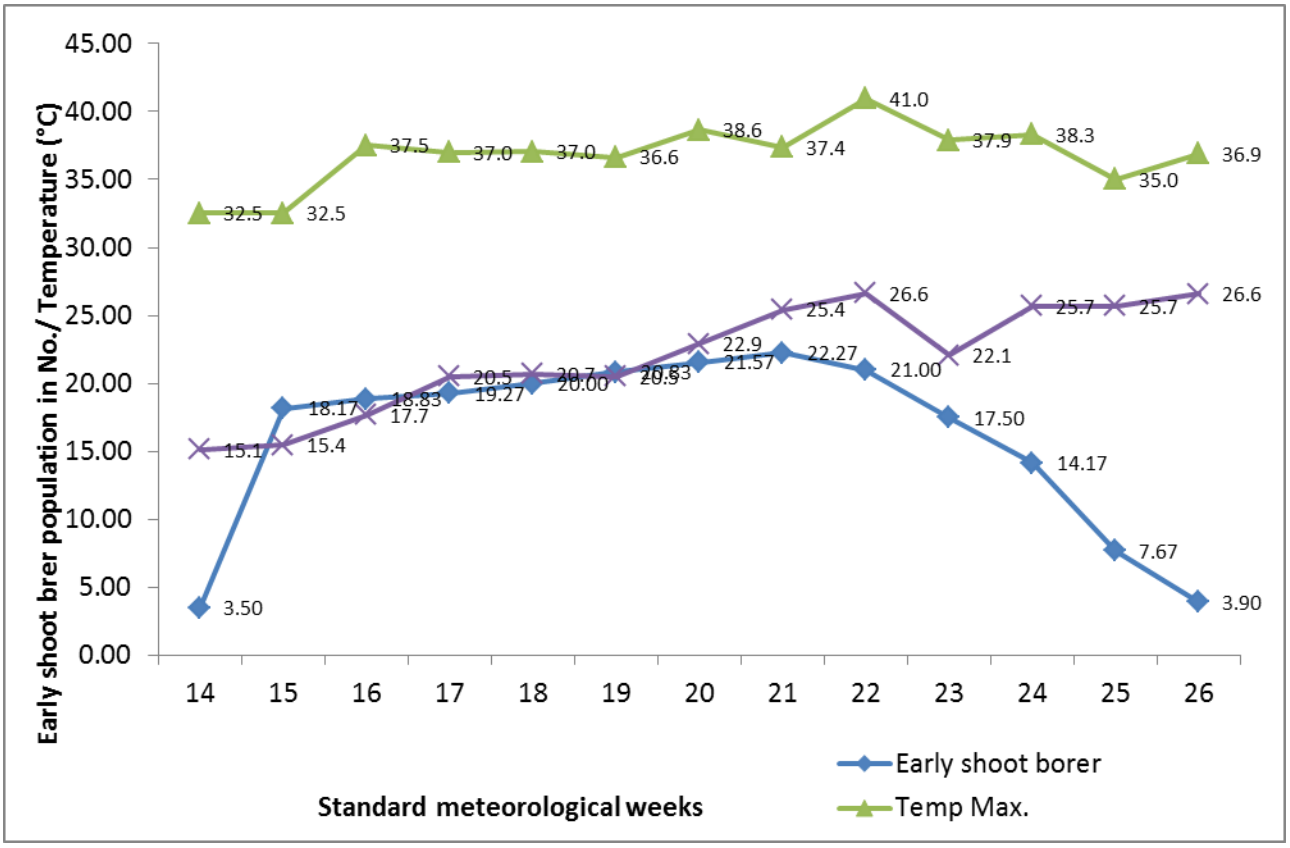
Month	Date	SMW	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	% early shoot borer/10 tillers
			Max.	Min.	0712 am	1412 pm		
April	02-08	14	32.5	15.1	82.4	31.0	2.2	3.50 (2.00)
April	09-15	15	32.5	15.4	75.1	28.7	0.6	18.17 (4.32)
April	16-22	16	37.5	17.7	66.9	19.0	10.2	18.83 (4.40)
April	23-29	17	37.0	20.5	62.4	29.6	2.1	19.27 (4.45)
April-May	30-06	18	37.0	20.7	62.6	26.1	14.4	20.00 (4.53)
May	07-13	19	36.6	20.5	67.0	23.4	3.4	20.83 (4.62)
May	14-20	20	38.6	22.9	59.0	27.9	0.0	21.57 (4.70)
May	21-27	21	37.4	25.4	68.1	38.1	0.0	22.27 (4.77)
May-June	28-03	22	41.0	26.6	65.0	33.9	21.2	21.00 (4.64)
June	04-10	23	37.9	22.1	64.4	28.3	0.0	17.50 (4.24)
June	11-17	24	38.3	25.7	71.0	45.0	23.6	14.17 (3.83)
June	18-24	25	35.0	25.7	83.0	55.0	67.0	7.67 (2.86)
June-July	25-01	26	36.9	26.6	78.0	53.0	2.8	3.90 (2.10)
Pearson Correlation			0.51	0.00	-0.86**	-0.63*	-0.30	
Sig. (2-tailed)			0.08	0.99	0.00	0.02	0.31	

*Significant at 0.01 level; ** Significant at 0.05 level; Max- Maximum temperature; Min. - Minimum temperature; SMW- Standard Meteorological Week

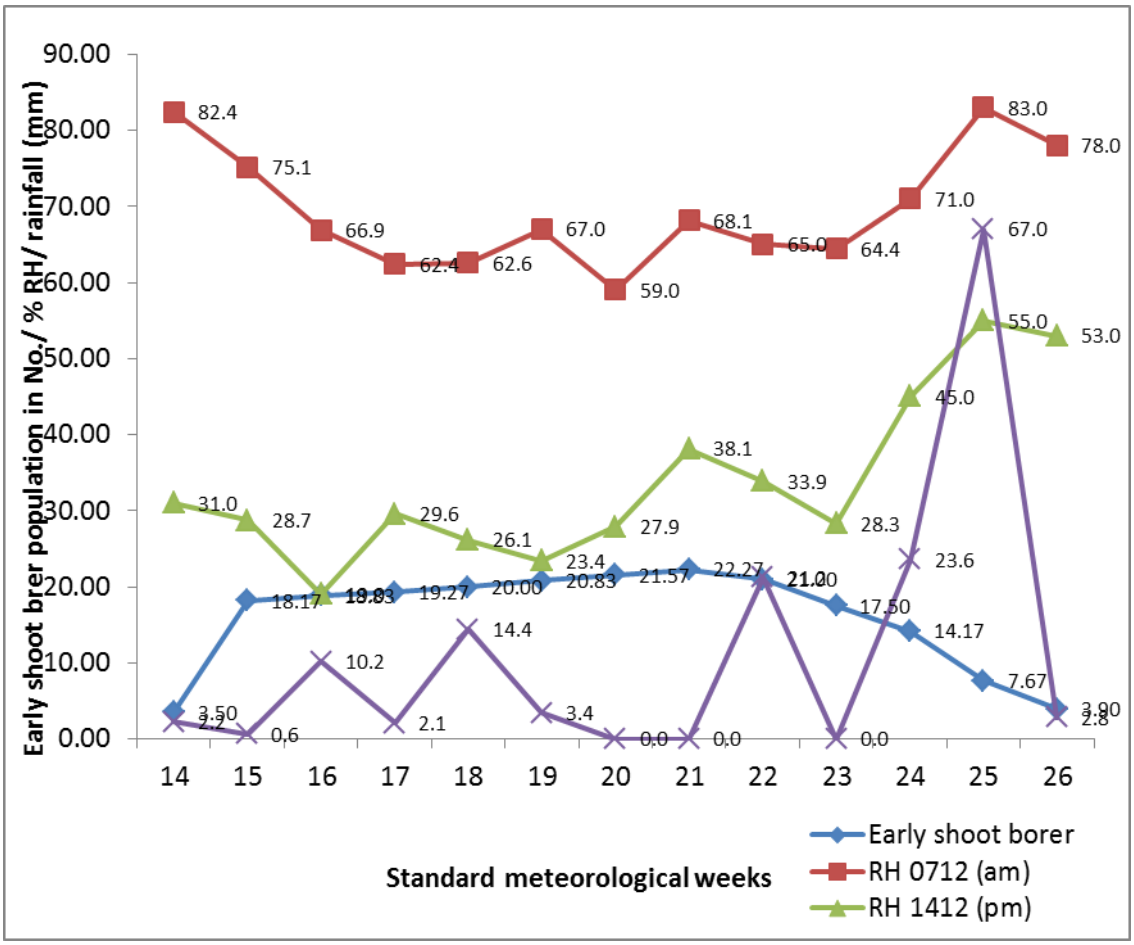
Table 2: Population fluctuation of early shoot borer in relation to weather parameters in sugarcane crop grown at NEBCRC, Pantnagar, during 2015-16.

Month	Date	SMW	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	% early shoot borer/10 tillers
			Max.	Min.	0712 am	1412 pm		
April	02-08	14	29.2	15.8	86.4	44.7	18.9	3.30 (1.95)
April	09-15	15	31.9	16.6	82.3	35.7	0	11.90 (3.52)
April	16-22	16	34.5	18.5	74.4	35.0	0	12.17 (3.56)
April	23-29	17	34.1	19.2	64.9	33.6	1.2	12.47 (3.60)
April-May	30-06	18	35.4	18.3	70.0	28.7	18.4	12.67 (3.63)
May	07-13	19	37.9	24.5	68.6	39.3	9	13.17 (3.70)
May	14-20	20	36.8	22.5	69.7	37.3	1.8	18.00 (4.30)
May	21-27	21	41.1	22.5	67.1	30.7	0.9	18.80 (4.39)
May-June	28-03	22	39.6	22.2	62.6	30.7	0	20.47 (4.58)
June	04-10	23	40.9	24.5	62.3	30.1	0	13.17 (3.70)
June	11-17	24	38	25.5	62	38	0.8	8.47 (2.99)
June	18-24	25	35.1	26.5	73	53	72.2	5.53 (2.46)
June-July	25-01	26	32	23.8	90	76	324.8	3.60 (2.02)
Pearson Correlation			0.71**	0.03	-0.65*	-0.72**	-0.55*	
Sig. (2-tailed)			0.007	0.927	0.015	0.006	0.05	

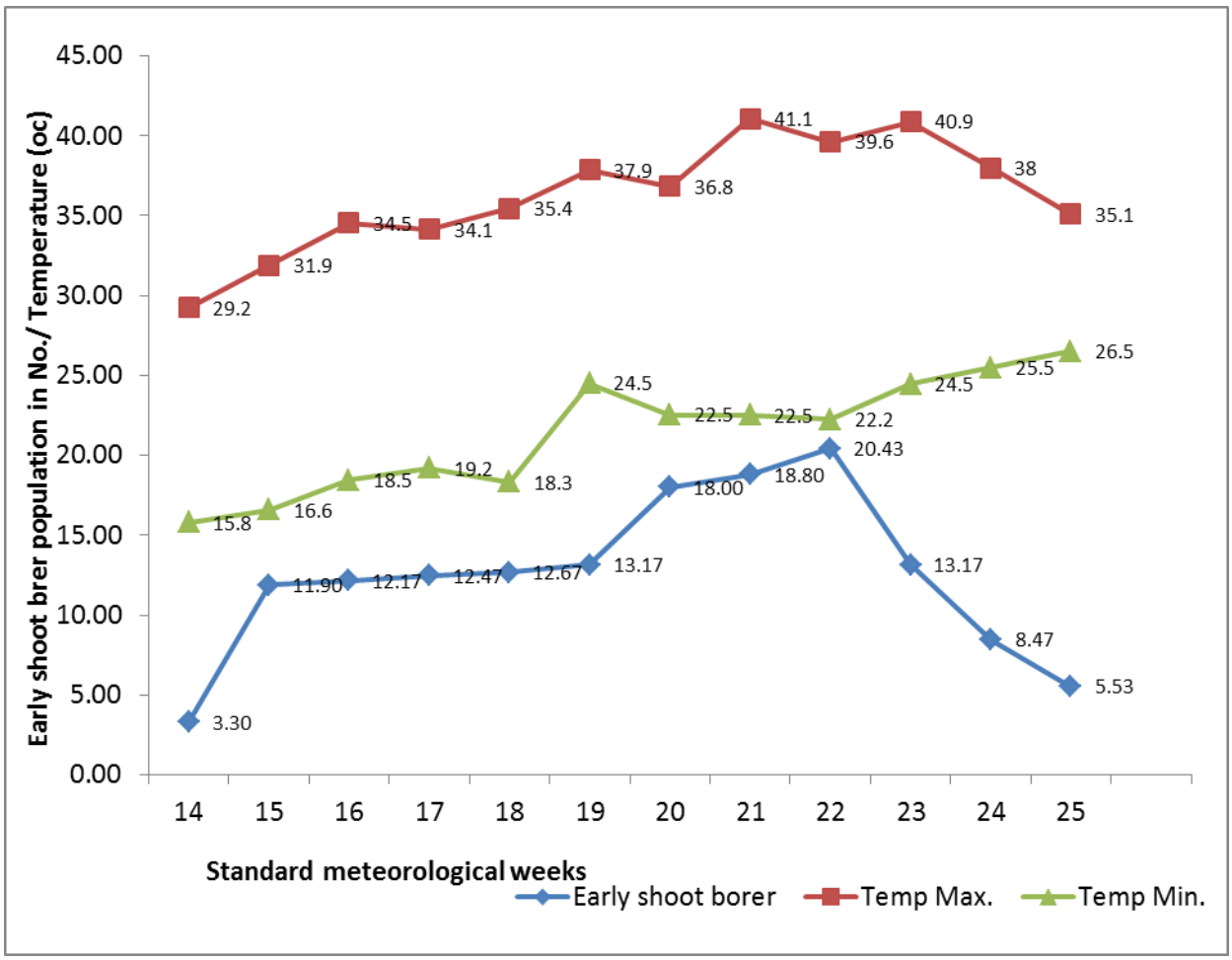
Significant at 0.01 level; ** Significant at 0.05 level; Max- Maximum temperature; Min. - Minimum temperature; SMW- Standard Meteorological Week



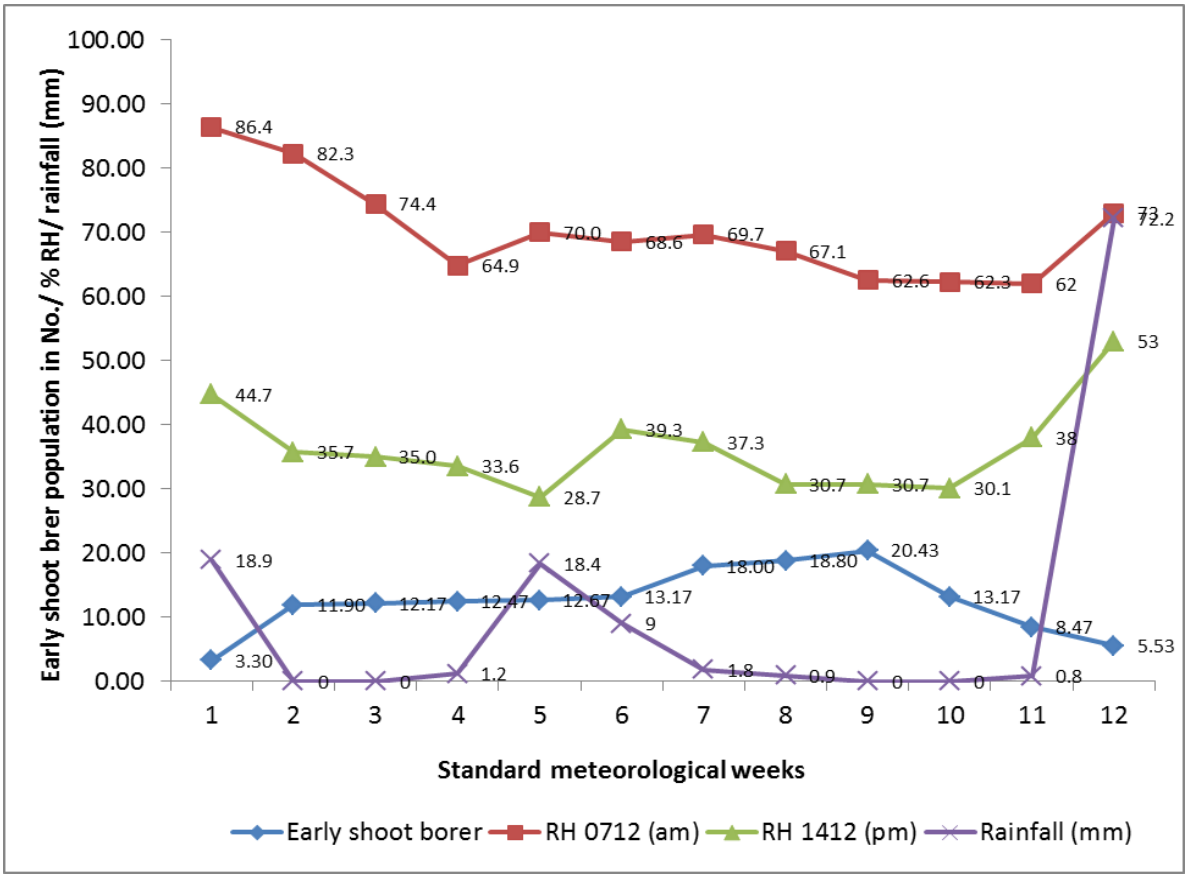
Graph 1: Early shoot borer population vs. weather parameters (Temperature) 2014-15



Graph 2: Early shoot borer population vs. weather parameters (RH, Rainfall) 2014-15



Graph 3: Early shoot borer population vs. weather parameters (Temperature) 2015-16



Graph 4: Early shoot borer population vs. weather parameters (RH, Rainfall) 2015-16

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