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Sahdev Nag
M. Sc. Research Scholar
Department of Agrometeorology,
Indira Gandhi Agricultural
University, Raipur,
Chhattisgarh, India

JL Chaudhary
Senior Scientist, Department of
Agrometeorology, Indira Gandhi
Agricultural University, Raipur,
Chhattisgarh, India

Sakha Ram Shori
M. Sc. Research Scholar
Department of Agrometeorology,
Indira Gandhi Agricultural
University, Raipur,
Chhattisgarh, India

Jeetendra Netam
M. Sc. Research Scholar
Department of Agrometeorology,
Indira Gandhi Agricultural
University, Raipur,
Chhattisgarh, India

Hemant Kumar Sinha
M. Sc. Research Scholar
Department of Agrometeorology,
Indira Gandhi Agricultural
University, Raipur,
Chhattisgarh, India

Correspondence
JL Chaudhary
Senior Scientist, Department of
Agrometeorology, Indira Gandhi
Agricultural University, Raipur,
Chhattisgarh, India

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Influence of weather parameters on population dynamics of yellow stem borer (YSB) in rice crop at Raipur

Sahdev Nag, JL Chaudhary, Sakha Ram Shori, Jeetendra Netam and Hemant Kumar Sinha

Abstract
A field experiment was carried out during *kharif* season 2016 at Indira Gandhi Krishi Vishwavidyalaya, Raipur. Yellow stem borer is major insect pest always causing damage to the rice crop resulting in considerable yield losses. The present study aimed to find out the effect of these environmental factors on the severity of insect pest. These finding may give reliable methods to identify environmental condition that are conducive for the development of a particular insect pest. Correlation study of present field population observed data of yellow stem borer and weather parameters the adult population of YSB showed non-significant positive correlation with maximum temperature (r = 0.07) and wind velocity (r = 0.57) whereas, minimum temperature (r = 0.83**), morning relative humidity (r = 0.80**), evening relative humidity (r = 0.82**), rainfall (r = 0.64*), and sunshine hours (r = - 0.88**) had a significant positive correlation. Diurnal variation (DV) (r = 0.83**), heat sum (HS) (0.75**) and night temperature regime (0.72*) showed positive correlation with the moth population. Among all the weather parameters diurnal variation and minimum temperature showed highest degree of correlation with YSB.

Keywords: Rice, Yellow stem borer, Population dynamic, Weather parameter

Introduction
Rice (*Oryza sativa L.*) is the world's most important food crop and is the staple food for 50% of the global population (Barrion *et al.*, 2007) [3]. Globally, rice is the second most widely consumed cereal next to wheat and it has occupied an area of 163.2 million hectares, with a total production of 719.7 million tonnes (Anonymous, 2014) [1]. India ranks 1st in area (43.95 million ha) and 2nd in production (103.61 million tonnes) after China (2nd advance estimate, 2015-16, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture, GOI). Rice being the main source of livelihood for millions of rural household is the backbone for Indian agriculture. The rice plays a very vital role in the national food security; even the rice self-sufficiency in India is precarious. Chhattisgarh, the central eastern state called as the "Rice bowl of India". The total estimated area of Rice in C.G. is 3.76 million ha, production is 7.71 million tonnes and productivity is 2050 kg/ ha, in the year 2014-15 (Krishi Darshika, 2016) [12].

The yellow stem borer (YSB) *Scirpophaga incertulas* Walker (Pyralidae: Lepidoptera) of rice is one of the major pests in all rice growing regions of Asia (Listinger J. A. 1979) [16], South East Asian region (Banerjee and Pramanik, 1967) and India in particular (**C**helliah *et al*., 1989) [6]. Yellow stem borer (YSB), *Scipophaga incertulas* (Walker.) is most destructive and widely occurring insect pest of rice that attacks all stages of crop (Banding and Listsinger, 2005). The damage caused by stem borer varied from 80 to 93% (Sharma *et al* 1996) [22] Feeding by YSB larvae causes death of affected tillers (dead heart symptom) in the vegetative; chaffy and unfilled panicle (white ear symptom) in reproductive phases of crop growth. Yield loss estimate across India varied from 11.2 to 40.1% due to dead heart and 27.6 to 71.7% due to white ears, respectively (Krishnaiah and Varma, 2012) [13, 14]. The occurrence of insect pests in paddy fields is influenced by various factors including weather components, cultivation.

methods and rice varieties. Among these weather component temperature and humidity are the most important factors.
According to Ramasubramaniun *et al*., (2006) [20] rainfall and relative humidity played a significant role in the population build up of yellow stem borer and rice gundhi bug apart from these no other meteorological variables were found to be significant. Therefore the present study aimed to find out the effect of weather parameter on the severity of insect pest.

Materials and Methods

1.1 Geographical Situation

Raipur situated in Eastern Central part of Chhattisgarh at latitude of 21^0 16' N, longitudes 81^0 36'E and altitude 289.5 m above mean sea level.

1.2 Weather condition during crop period

During the crop gro38wth period the maximum temperature ranged from 29 ^{0}C to 42.1 ^{0}C where as minimum temperature ranged from 14.4 ^{0}C to 29.5 ^{0}C. The total rainfall recorded 1124.2 mm during the crop period of month of June to September 2016, the morning relative humidity varied from 57 to 94 per cent while in after noon it varied from 25 to 80 per cent.

1.3 Experiment details

The experiment was conducted at the research farm of IGKV Raipur (CG) during Kharif 2016. Stem borer (YSB) was found most active in kharif season. The maximum YSB adult population was observed through light trap daily observation at growing stages of rice crop. The experimental field was free from insecticide sprays. The pest succession of major insect pests of rice was co- related with weather parameters to observe the effect of individual parameters on pest incidence. An field experiment of department of entomology Raipur with rice variety swarna was taken under observation under different damage levels at different stages of crop growth. Damage is caused by the caterpillars by producing dead hearts. The larva feeds inside the stem causing drying of the central shoot or 'dead heart' in young plant and drying of the panicle or 'white ear' in older plant.

1.2.1 Infestation of Yellow stem borer

The infestation of yellow stem borer (*Scirpophaga incertulas* Walker) was recorded on 10 hills randomly in a plot by counting total number of tillers and "Dead hearts" on each hill then the % was calculated by using following formula-

$$\text{Dead heart\%} = \frac{\text{Number of Dead hearts}}{\text{Total Number of tillers}} \times 100$$

1.4 Different indices

For this study daily rainfall, maximum temperature and minimum temperature data were collected from the Department of Agrometeorology IGKV Raipur (Chhattisgarh). Using meteorological data derived indices like day temperature (DT), night temperature (NT), diurnal variation (DV) and heat sum (HS) were calculated as per Venkataraman and Krishnan (1992) formula which given below-

DT = Tmax – 0.4 (Tmax – Tmin)
NT = Tmin + 0.4 (Tmax – Tmin)
DV = DT – NT

$$\text{HS} = \sum \frac{\text{Tmax} + \text{Tmin}}{2} - \text{Base temperature}$$

GDD = Σ [(Tx + Tn)/2 – Base temperature]

Where,
Tx = Daily maximum temperature
Tn = Daily minimum temperature
The base temperature is defined as, "The temperature below which no plant physiological activity takes place" which is considered 10 ^{o}C for *Kharif* crops.

Result and Discussion

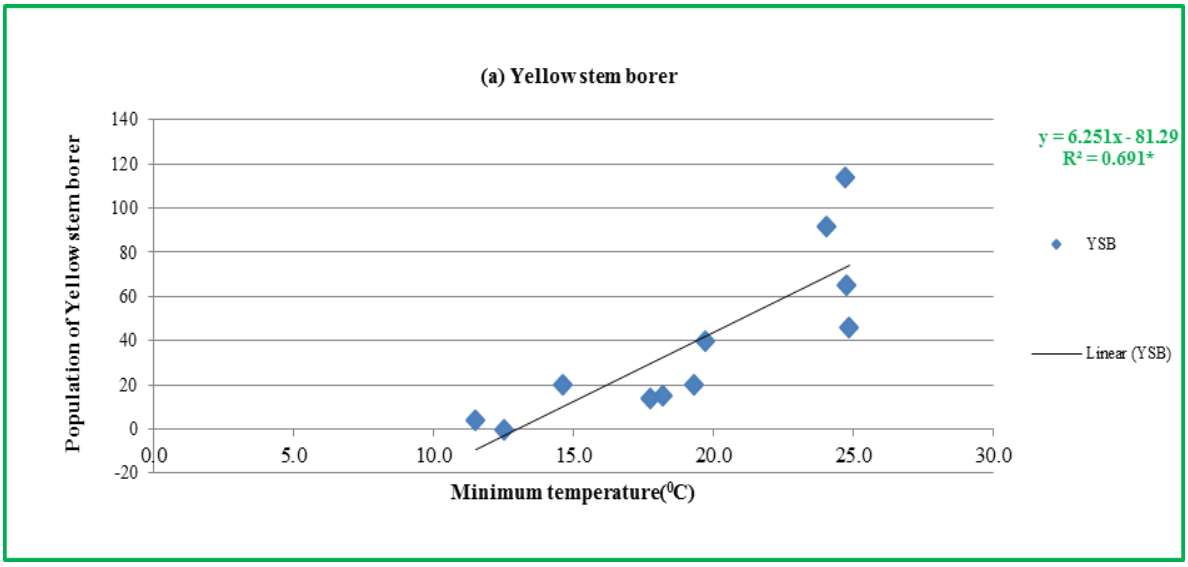
2.1 Correlation between weather parameters and Rice yellow stem borer

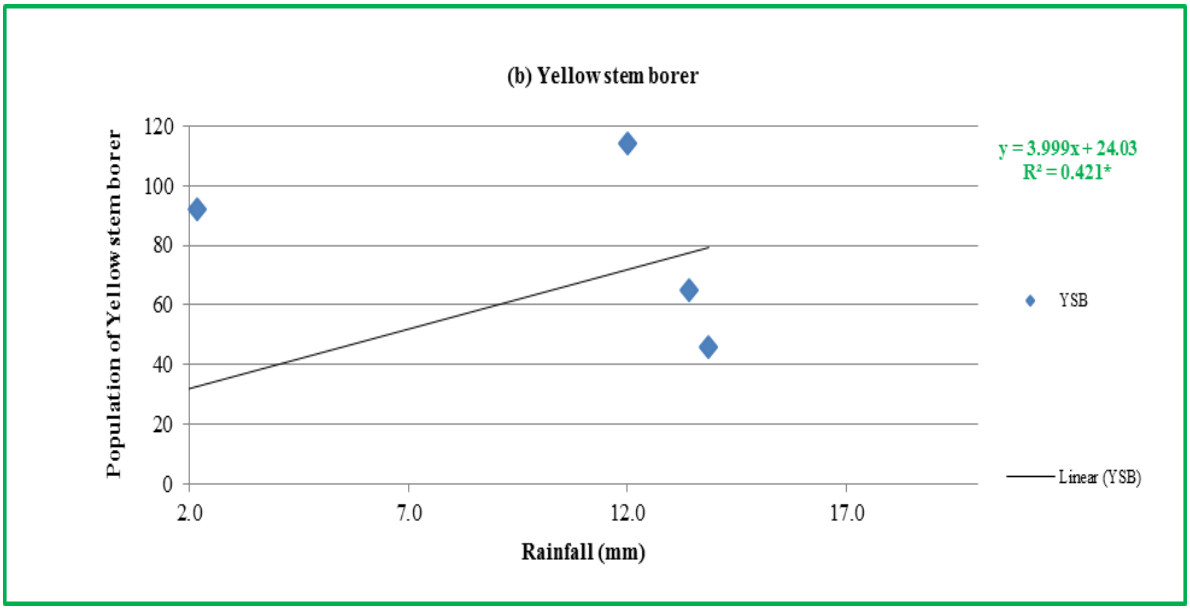
The maximum activity of rice yellow stem borer was recorded during the fourth week of September. The correlation worked out between monthly weather parameters YSB population through "SPSS" **(**Statistical Package for the Social Sciences). Adult population of yellow stem borer showed non-significant positive correlation with maximum temperature (r = 0.07) and wind velocity (r = 0.57) whereas, minimum temperature (r = 0.83**), morning relative humidity (r = 0.80**), evening relative humidity (r = 0.82**), rainfall (r = 0.64*), and sunshine hours (r = - 0.88**) had a significant positive correlation with adult population (Table 2.1). Results revealed that the YSB population build up is favoured under wet, humid and cloudy weather conditions. In present investigation the weather parameters there was found favourable effect of morning relative humidity, evening relative humidity and minimum temperature on YSB population where show significantly negative effect on YSB of sunshine hours. Low temperature and high relative humidity created favourable climatic condition for adult and larval development resulting in maximum population during kharif season. There after decreasing adult population due to increasing sunshine hours during the study period.
Similarly Kumar *et al.,* (2015) found the weather parameters on maximum temperature (°C), minimum temperature (°C), morning relative humidity (%), evening relative humidity (%), rainfall (mm) and evaporation (mm) were positively correlated with the population of male moth of yellow stem borer, whereas, sunshine (hr) was negatively correlated (-0.453). They also found that weather parameters contribute 34.60 per cent fluctuation of population male moths (*Scirpophaga incertulas).* Similarly result found by Chakraborty and Rath (2013) [5].

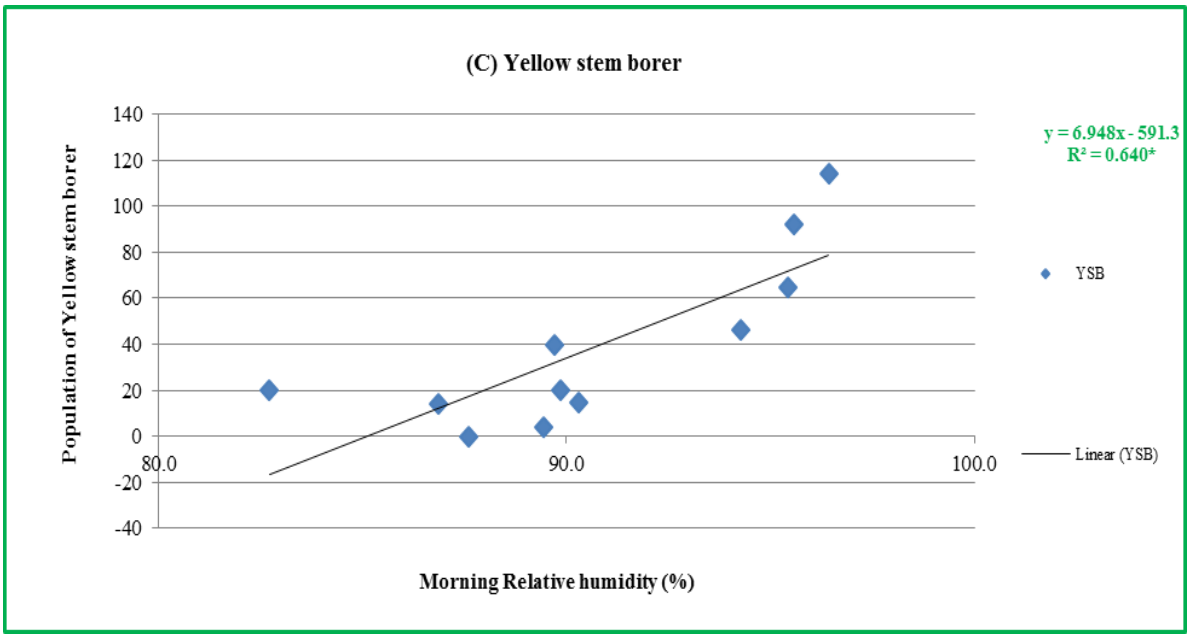
Table 2.1: Correlation studied on the incidence of rice Yellow stem borer with weather parameters.

Weather parameter	Correlation coefficients (r)
Maximum Temperature (^{0}C)	0.07
Minimum Temperature (^{0}C)	0.83**
Rainfall (mm)	0.64*
Morning Relative humidity (%)	0.80**
Evening Relative humidity (%)	0.82**
Wind velocity (km/h)	0.57
Sunshine hours (hours)	-0.88**

*. Correlation is significant at 5% level (2-tailed)
**. Correlation is significant at 1% level (2-tailed)


(a) Yellow stem borer
Population of Yellow stem borer
Minimum temperature(0C)
y = 6.251x - 81.29
R² = 0.691*
YSB
Linear (YSB)


(b) Yellow stem borer
Population of Yellow stem borer
Rainfall (mm)
y = 3.999x + 24.03
R² = 0.421*
YSB
Linear (YSB)


(C) Yellow stem borer
Population of Yellow stem borer
Morning Relative humidity (%)
y = 6.948x - 591.3
R² = 0.640*
YSB
Linear (YSB)

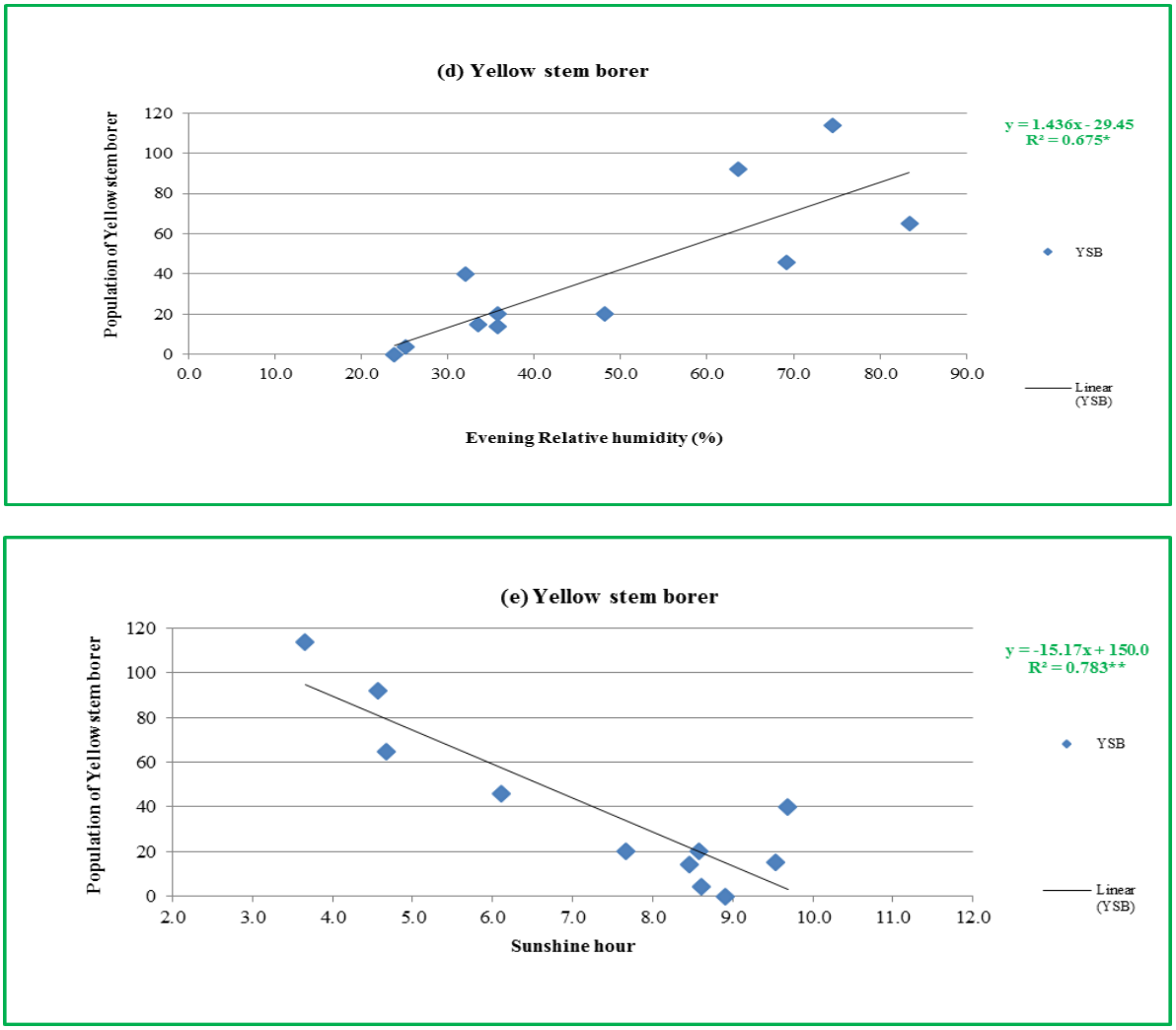


Fig 1(a-e): Scattered diagram and regression line showing the relation between population of insect pests of rice yellow stem borer and significant weather parameters

2.2. Dead heart infestation of Yellow stem borer, *Scirpophaga incertulus* (Walker)

The incidence of moths was abundant during the rice growing season for yellow stem borer infection. Initiation of dead heart at 36th standard week (1st week of September) and reached the peak at 39th standard week (4th week of September). Dead heart infestation ETL under Raipur conditions is considered as 10% and in experimental studies was found to varying between 5% to 13.4%. Week wise distributions are 35 SMW (5%), 36 SMW (6%), 37 SMW (9%), 37 SMW (12%), 38 SMW (12%), 39 SMW (13.4%), 40 SMW (11%), 41 SMW (9%), 42 SMW (6%), 43 SMW (4%) and 44 SMW (4.6%) respectively. Accumulated growing degree days (AGDD) and Accumulated helio thermal unit (AHTU) were ranging from 1237.9-1614.7& 1736.5-1963.7 and 3705.1-5354.0 & 5914.3-7655.7 respectively during initiation and peak period of moth. Infestation by the YSB was severe at a range of 1614.7-1963.7 ^{0}C AGDD and 5354.0 -7655.7 AHTU. During the crop period weathers parameters played a major key role in the population dynamics.

The weekly average field population was found to have significant and possible correlation with weekly mean R.H, and accumulated Helio thermal unit (AHTU) and negative correlation with difference of maximum and minimum temperatures, weekly Sunshine hour (SH). The multiple correlation and regression of moth population with the weather parameters was developed as an equation.

TP/week = -52.8767 + 0.001427 (AHTU) + 0.009327(RAIN) + [-0.71335(MAX.T-MINI.T)] + 0.602506 (RH-I)

The coefficient of determination (R^2) between light trap catches of *S. incertulus* and weather parameters were 0.83 Adjusted R = 0.78, Standard Error = 1.88, TP = total population

The correlation and regression analysis clearly indicated that the population build up was dependent on weathers factors. The correlation coefficient (r) between field population of *S. incertulus* and weather parameters were found significant (Table 2.2) based on observed data. The conclusion/interpretation then AHTU are directly related to weekly moth population. It means all three weather parameters Max. T, Mini. T and sunshine hours an which AHTU is based is related with population build-up of YSB moths. Similarly mean weekly RH is meeting conducive environment for YSB population build-up.

Mandal *et al.*, (2011) [17] reported that the catching of moth in the trap was commenced as early as 32 standard week (2nd week of August) with its peak during 37 standard week while incidence of dead heart started at 34 standard week (4th week of August) and reached the peak at 38 standard week (3rd week of September). Similarly Sujithra *et al.*, (2010) also reported that the higher trap catches during standard week 37 seemed to justify the more stem borer damage in the field in standard week of 38 and 39. They also observed the pest severe damage the crop data range was 1203.1-1967.8^{0}C AGDD and 6539.9-9180.8 AHTU.

Table 2.2: Relationship between weather variable and field population of yellow stem borer.

Variable	Weekly AHTU	Weekly (Max. T-Min. T)	Weekly total (RF)	Weekly mean (RH)
Moths population weekly	0.50*	0.19	-0.10	0.51*

*. Correlation is significant at 5% level (2-tailed)
**. Correlation is significant at 1% level (2-tailed)

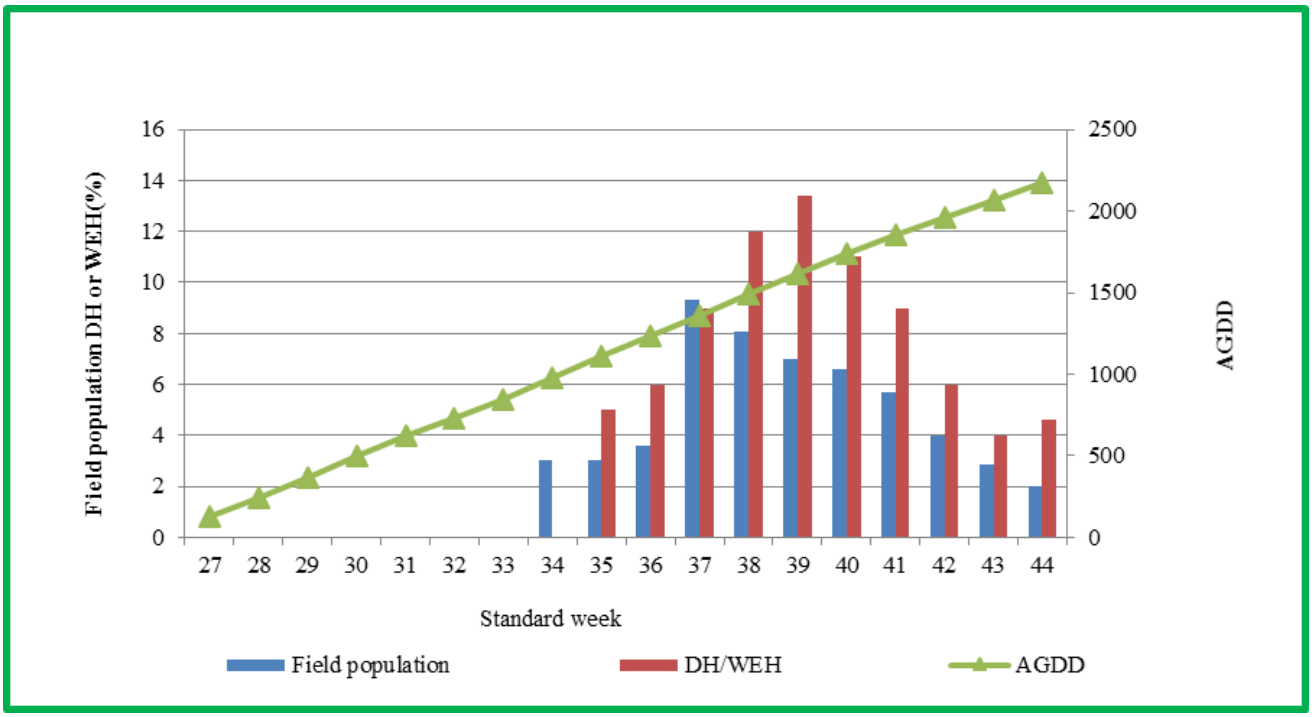


Fig 2: Effect of accumulated GDD on occurrence of *Scirpophaga incertulus* in *kharif* rice 2016.

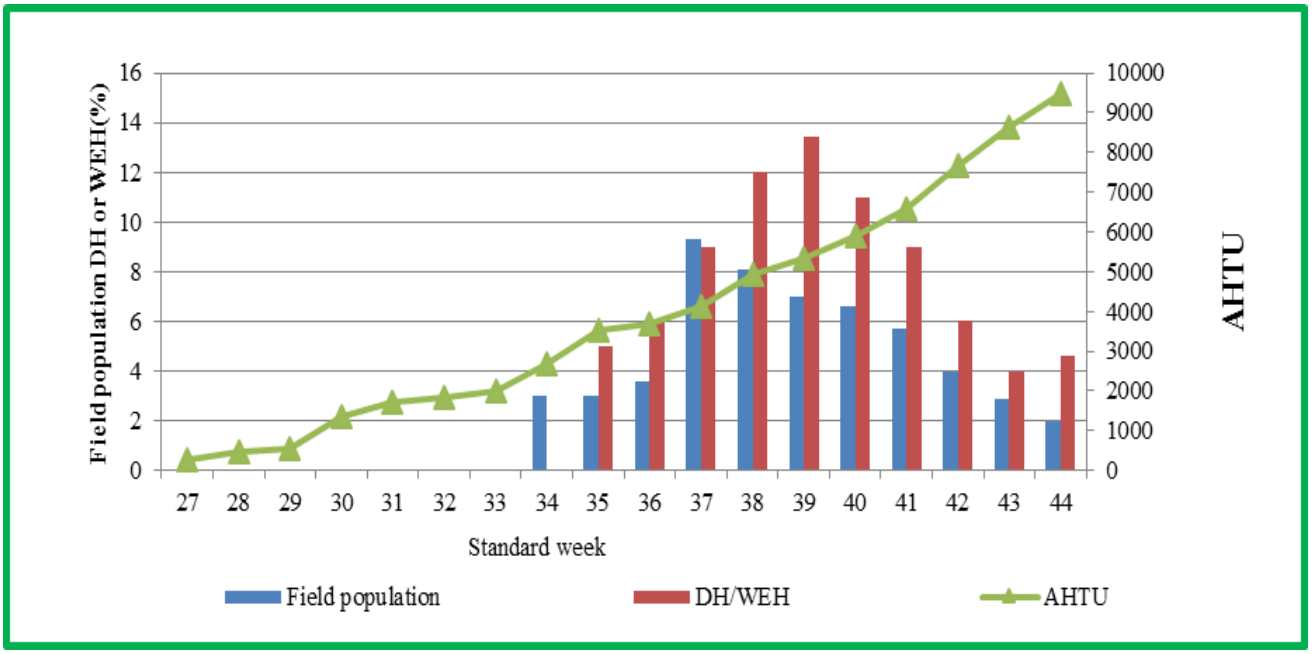


Fig 3: Effect of accumulated HTU on occurrence of *Scirpophaga incertulus* in *kharif* rice 2016.

2.3 To derive indices like day and night time, temperature, diurnal variation and heat sum in rice crop.

Populations of rice yellow stem borer, *Scirpophaga incertulus* (Walker) were studied in Swarna variety of rice. The observations recorded from fourth week of August (35th standard week) to harvest of the crop. The pest population recorded as number of moth per week during the crop season *Kharif* 2016. The moth population was low during August to second week of September. Experimentation revealed that the peak population of YSB in the month of September the pest population declined thereafter. The correlation between weakly mean population of YSB and meteorological parameters was worked out. Result revealed that average minimum temperature (Tmin) (r = 0.83**) diurnal variation (DV) (r = 0.88**) showed a higher positive significance correlation with the moth population. Through day temperature regime (0.58) and maximum temperature (0.07) show positive and non-significant with yellow stem borer population.

Scattered diagram as well as trend line was made to analyze the degree of relationship between moth population and significant weather parameter (Fig.4 a-d), which also indicated the strong positive correlation between the two variables.

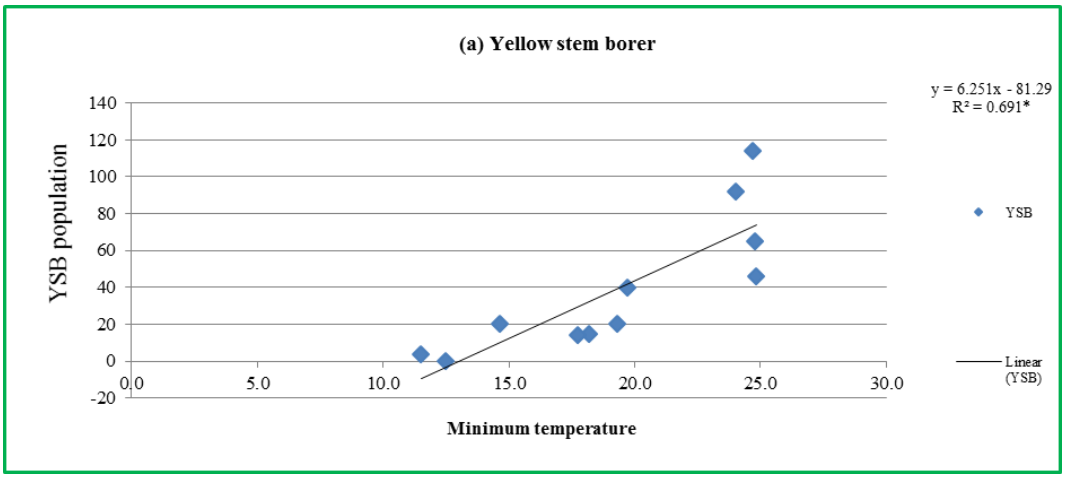
In present investigation result revealed that maximum temperature and day temperature are having non-significant correlation with YSB population.

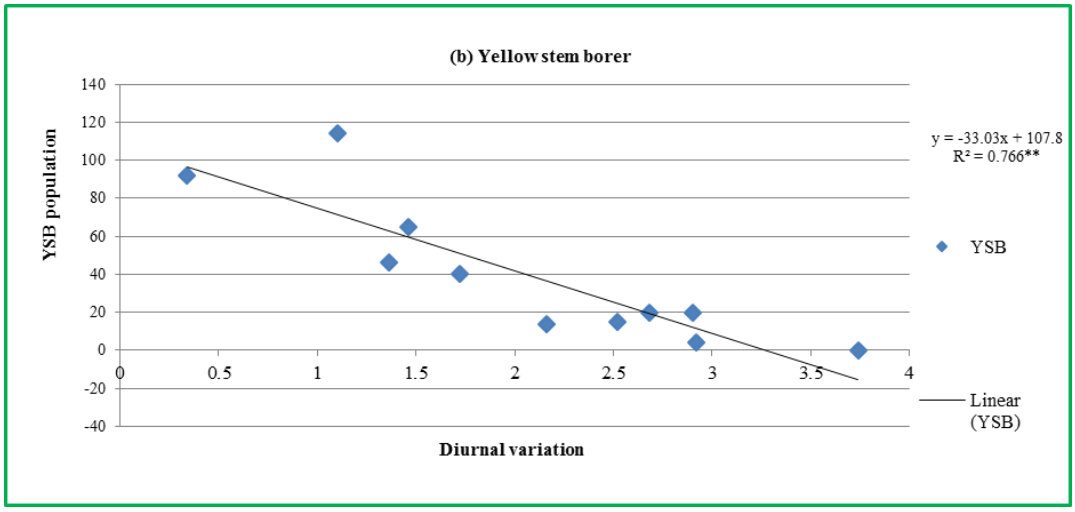
Sahoo *et al.*, (2016) [21] reported that average maximum temperature (Tmax) and heat sum (HS) showed higher correlation (r = 0.87*) with the hopper population. It was also observed that diurnal variation (DV) was almost positively and significantly correlated with mango hopper population. Though day temperature regime showed better correlation with hopper population than night temperature regime, however these two derived indices did not show any better degree of association than the recorded Tmax values.

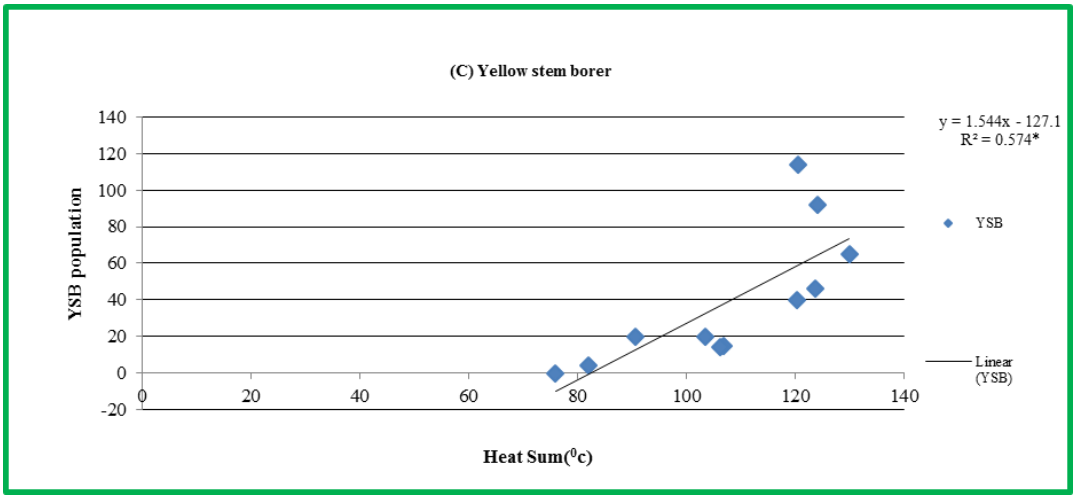
Table 2.3: Correlation studies between incidence of insect-pests of Yellow stem borer and weather indices.

Weather indices	Yellow stem borer population
Maximum Temperature (°C)	0.07
Minimum Temperature (°C)	0.83**
Day Temperature (°C)	0.58
Night Temperature (°C)	0.72*
Diurnal variation	0.88**
Heat Sum	0.75**

*. Correlation is significant at 5% level (2-tailed)
**.Correlation is significant at 1% level (2-tailed)







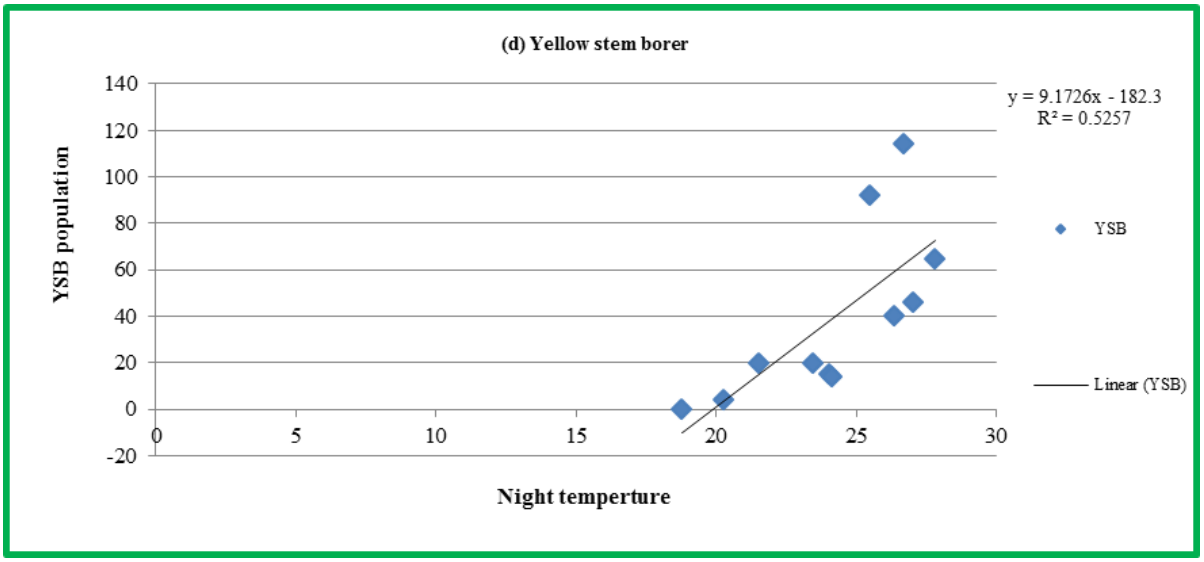


Fig 4(a-d): Scattered diagram and regression line showing the relation between population of insect pests of rice yellow stem borer and significant weather parameters

Conclusions

It was concluded from the result that relative humidity and minimum temperature was favorable for YSB population build-up. The initiation of dead heart and white earhead was found in 34 SMW and peak during 38 to 40 SMW. During this period AHTU and AGDD value varied from 533.4-781.7 and 3971.4- 5145.6 respectively.

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