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Seasonal Incidence of Insect Fauna Associate with Rice Ecosystem

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***Abstract*:** Experiment was carried out at ICAR-National Rice Research Institute Cuttack, Odishato observe the insect fauna associated with the *kharif* rice ecosystem. Rice crop provide shelter to a number of insect species. The harmful species mainly belong to insect order of Lepidoptera (stem borer, leaf folder) and Hemiptera (plant hopper, gundhi bug) whereas the beneficial one includes several species of dragonflies, damselflies, predatory bug, predatory beetle and spider, a non-insect arthropod species. The incidence of harmful species was observed starting from August to November. The duration of sunshine hours plays an important and significant role in the incidence of yellow stem borer whereas maximum temperature plays a prime role in the incidence of leaf folder and plant hopper population. Minimum temperature and rainfall were negatively and significantly correlated with the population fluctuation of gundhi bug. The populations of predatory fauna such as dragonflies, damselflies, predatory bug, predatory beetle as well as spider fluctuate over a mean value throughout the cropping season. The population of dragonflies and damselflies were known to be more prevalent during the early growth period of the crop whereas the population of predatory bug and beetle were known to be more prevalent during the later period of growth. Spider populations were constant throughout the cropping season.The incidence of adult moth of yellow stem borer started at the end of August which reaches its peak during the third week of October. Similarly, the incidence of leaf folder started during the first week of August with its peak during the second week of September. The incidence of the hopper population started during the second week of August. The population of brown plant hopper was maximum during the third week of September as compared to that of green leaf hopper which reaches maximum during the beginning of October. The incidence of gundhi bug started during the second week of October as the crop enters into the reproductive stage and continued up to the harvesting of the crop.

Keywords: Yellow stem borer, Leaf folder, Plant hopper, Gundhi bug, Dragonflies, Damselflies, Spider

Rice (*Oryza sativa* L.) is one of the most important and widely cultivated crops throughout the world (Mohanta et al 2020) and occupies a pivotal place in Indian agriculture as a source of livelihood for about two-third of rural households. In India, paddy was grown under widely varying conditions of altitude and climate, extends from 8 to 35^0 N latitude and as high as 3000 meters from mean sea level. In India, paddy occupies an area of 41.1 mha with a production of 106.31 mt (Anonymous 2023). Among the several limiting factors,insect pests are the major biotic constraints in the production of the rice throughout the region (Mohapatra et al 2022). The rice plant is liable to attack by more than 100 species of insects and 20 of them can cause economic damage all over the world causing 30 % yield loss from seedling to maturity (Mohanta et al 2020). These includes yellow stem borer *(Scirpophaga incertulas),* leaf folder *(Cnaphalocrocis medanalis),* gall midge *(Orseolia oryzae),*brown plant hopper *(Nilpravata lugens),*green leaf hopper *(Nephotettix nigropictus Nephotettix nigropictus),* gundhi bug *(Leptocorisa acuta)* and case worm *(Nymphula depunctalis)* (Mohanta et al 2020, Sharma and Nayak 2005). Yellow stem borer is considered as a major pest in South East Asia (Giri et al 2022). There are several beneficial species that are always associated with the rice ecosystem. Some of them are dragonflies, damselflies, predatory bug, predatory beetle etc. Spider is one of the most abundant beneficial arthropod species associated with each and every rice ecosystem. The relationship between weather parameters and the population dynamics of the insect pests and their natural enemies may be a strong basis to know the status of pest occurrence with a time of incidence along with population level. This will help in pest forecasting as well as to take proper decisions regarding the management of insect pests.

MATERIAL AND METHODS

The experiment was conducted at ICAR-National Rice Research Institute, Cuttack, Odisha which is situated at 20° N latitude 86° E longitude and is at an elevation of 23.5 m above the mean sea level (MSL) during *kharif*2018-19.. The nursery was raised in the first week of July and 25-30 days old seedlings were transplanted in an area of 30 x 20 m^2 during the last week of July at a distance of 20 x 15 cm^2. All the

recommended agronomic practices were followed to raise the healthy crop except the plant protection measures required to manage the insect-pest for assessment of yield losses in protected plots. The population of insect pest (yellow stem borer, leaf folder, brown plant hopper, green plant hopper, gundhi bug) as well as their natural enemies (dragonfly, damselfly, predatory bug, predatory beetle and spider) were regularly monitored from seedling stage to harvesting at a weekly interval

Yellow stem borer: The population of YSB moth was monitored by using light trap as well as pheromone trap whereas the population of the larva was recorded in terms of % dead hearts and white ear heads at vegetative and reproductive stage, respectively. Light trap was installed with 200 W electric bulb at a height of 1.5 m from a ground-level near the paddy field. It was operated every night between 6 pm to 6 am. Daily catches of *stem borer* moths were recorded on the next day and data were collected and documented as weekly frequency of moth capture during the study period. Similarly, the pheromone traps (funnel traps) with scripolure were installed 200 m away from the source of light. Ten traps were placed in different locations at a distance of 300 m away from each other with in the research station. The traps were placed at 30 m above the crop canopy. Each trap contained one lure tube which was impregnated with a mixture of (Z)- 11 hexadecenal and (Z)-9 hexadecenal in a 3:1 ratio. The scripolure was changed at every 15 days interval after the first installation which was done after 15 days of transplanting of rice. The weekly trap catches of *S. incertulas* were recorded. Dead heart or white ear heads/10 hills during respective meteorological weeks of the season were also recorded to determine the correlation with abiotic factors.

Leaf folder: The observation regarding the leaf folder was taken by counting the number of larvae present in five plant and expressed as no. of larvae per plant.

Brown plant hopper and green leaf hopper: The number of adult and nymph were counted from five hills and expressed as number per plant.

Gundhi bug: The observation regarding gundi bug was taken by counting the number of adult and nymph from 5 sweep and expressed as number caught per sweep net.

Predatory arthropods: The population of predatory arthropods such as dragonflies, damselflies, and spiders was taken in one-meter square area whereas the population of predatory bug, predatory beetle was taken from the light trap at a weekly interval.

RESULTS AND DISCUSSION

Regular monitoring was carried out throughout the cropping season starting from the sowing of seed in the nursery to harvesting at a weekly interval (Table 1 and 2).

Yellow stem borer: During the season, the incidence of this pest was started during the 34th SMW (Aug 19-25) and continued up to the last week of November (Nov 26-Dec 2). In light trap, the maximum number of moths (10.26 per trap) was during the 43 SMW (Oct 21-27) whereas in pheromone

Table 1. Pearson correlation co-efficient between weather parameters and insect fauna associated with rice ecosystem

Weather parameters / Insect		T_{Max} (ºc)	T_{Min} (ºc)	RF (mm)	RH – I (%)	RH-II (%)	Wind (kmph)	Eva (mm)	SS Hrs	R^2
Yellow stem borer	LT	0.10	-0.13	-0.08	-0.18	-0.58**	-0.03	0.09	0.56**	0.54
	PT	0.03	-0.17	-0.15	-0.21	-0.54**	0.19	0.05	0.55**	0.61
	DH	0.45*	0.22	0.27	-0.04	-0.35	-0.52**	0.45*	0.32	0.64
	WEH	-0.24	-0.48*	-0.29	-0.13	-0.48*	0.19	-0.34	0.38	0.43
Leaf folder		0.54**	0.24	0.33	-0.12	-0.29	-0.64**	0.55**	0.24	0.79
Brown plant hopper		0.53**	0.27	0.27	-0.08	-0.20	-0.76**	0.53*	0.20	0.77
Green leaf hopper		0.49*	0.21	0.29	-0.04	-0.41*	-0.48*	0.45*	0.37	0.66
Gundhi bug		-0.38	-0.52**	-0.42*	-0.34	-0.37	0.25	-0.30	0.38	0.54
Dragon fly		0.33	0.86**	0.33	0.47**	0.77**	-0.06	0.30	-0.37	0.92
Damsel fly		0.39	0.79**	0.51**	0.36	0.70**	-0.19	0.42*	-0.30	0.92
Predatory bug		0.54**	0.45**	-0.07	0.34	0.20	-0.16	0.53**	0.17	0.45
Predatory beetle		0.31	0.46*	0.42*	-0.09	0.23	-0.50**	0.44*	0.01	0.64
Spider		0.36	0.09	0.10	-0.05	-0.47**	-0.20	0.37	0.66**	0.77

*. Correlation is significant at the 0.05 level , **. Correlation is significant at the 0.01 level.
YSB: Yellow stem borer, LT: Moth captured in light trap, PT: Moth captured in pheromone trap, DH: Dead heart, WEH: White earhead, LF: Leaf folder, BPH: Brown plant hopper, GLH: Green leaf hopper, GB: Gundhi bug
Tmax: Maximum temperature, T min: Minimum temperature, RF: Rainfall, RH-I: Morning relative humidity, RH-II: Evening relative humidity, Eva: Evaporation, SS Hrs: Sunshine hours

trap maximum number of moth (6.71 per trap) was during the 44th SMW (Oct 28-Nov 3). The formation of dead hearts was started from the 35th SMW whereas the formation of white ear heads was observed during the 41st SMW as the crop entered into the reproductive phase. Maximum dead heart per 10 hills was during 40th SMW with weather parameters of 34.60°C maximum temperature, 24.76°C minimum temperature, 90.71 % morning RH, 61.57 % evening RH, wind speed of 2.03 km/hand week, 6.06 hour of sunshine per day. The white ear head was maximum during the 46th SMW with weather parameters of 30.5°C maximum temperature, 18.5°C minimum temperature, 92.29 % morning RH, 66.29 % evening RH and wind speed of 2.17 km/h. However, during this week, there was no rainfall with 4.16 hour of sunshine per day. Joshi et al (2009) also observed the peak population of yellow stem borer during the third week of October indicating that population builds up late in the season at Hissar.

Leaf folder: During the season, the incidence of leaf folder was started from the 33rd SMW (Aug 12-18) as 0.73 larvae per hill and continued up to 45th (Nov 4-Nov 10). At the time of initial infestation, maximum and minimum temperatures prevailed were 31.4°C and 23.8°C, respectively with 13.86 mm rainfall and 2.59 hour of sunshine, the wind speed was 1.83 km/h with 94.57 % morning and 81.57 % evening RH. Thereafter, the population was increased at a steady rate and reached to peak (3.73 larvae per hill) during 40th SMW (Sep 30- Oct 6) with weather parameters of 34.60°C maximum temperature, 24.76°C minimum temperature, 90.71 % morning RH, 61.57 % evening RH, and wind speed of 2.03 kmph. Thereafter, a decline in the pest population was observed. Alvi *et al*. (2003) reported similar results that activity of *C. medinalis* lasted from second week of August to the third week of October at Punjab-Lahore whereas Hafeez et al. (2010) reported peak larval population during the first week of October under Varanasi conditions.

Brown planthopper: The incidence of BPH was started from the 33rd SMW (Aug 12-18) as 2.53 numbers of adult and nymph per hill and continued up to 44th (Oct 28- Nov 30). At the time of initial infestation, maximum and minimum temperatures prevailed were 31.4 °C and 23.8°C respectively with 13.86 mm rainfall and 2.59 hour of sunshine, the wind speed was 1.83 km/h with 94.57 % morning and 81.57 per cent evening RH. Thereafter, the population was increased at a steady rate and reached to peak (13.40 adult and nymph per hill) during 39th SMW (Sep 23-29) with weather parameters of 33.7°C maximum temperature, 23.7°C minimum temperature, 92.43 % morning RH, 69.43 per cent evening RH, 5.86 mm rainfall, 5.13 hours sunshine and wind speed of 0.86 km/h. Thereafter, there was observed a downfall in the pest population. Firake et al. (2010) also observed that,the most favorable period for brown plant hopper was from last week of August up to last week of September under Pantnagar conditions.

Green leaf hopper: The incidence of GLH was started during the 33rd SMW (Aug 12-18) as 1.00 numbers of adult and

Table 2. Regression equations between weather parameters and insect fauna associated with rice ecosystems

Y= Moth captured in light trap	$y = 26.23 - 0.38 X_1 + 0.31 X_2 + 0.05 X_3 - 0.2 X_4 - 0.13 X_5 + 1.66 X_6 + 0.54 X_7 + 0.97 X_8$	0.54
Y= Moth captured in pheromone trap	$y = 41.31 - 0.62 X_1 + 0.49 X_2 + 0.07 X_3 - 0.23 X_4 - 0.22 X_5 + 0.98 X_6 + 0.77 X_7 + 1.16 X_8$	0.61
Y= % dead heart formation	$y = 12.02 - 0.12 X_1 + 0.23 X_2 + 0.06 X_3 - 0.06 X_4 - 0.1 X_5 - 0.69 X_6 + 0.83 X_7 + 0.21 X_8$	0.64
Y= % white ear head formation	$y = 3.86 - 0.03 X_1 + 0.08 X_2 + 0.02 X_5 + 0.30 X_6 - 0.54 X_7 + 0.28 X_8$	0.43
Y= Number of larvae per hill	$y = 6.95 - 0.05 X_1 + 0.09 X_2 + 0.04 X_3 - 0.06 X_4 - 0.05 X_5 - 0.62 X_6 + 0.54 X_7 + 0.03 X_8$	0.79
Y= Number of nymph and adult per hill	$y = 20.07 - 0.19 X_1 + 0.32 X_2 + 0.07 X_3 - 0.16 X_4 - 0.15 X_5 - 3.63 X_6 + 1.42 X_7 - 0.10 X$	0.77
Y= Number of nymph and adult per hill	$y = 43.94 - 0.01 X_1 + 0.01 X_2 + 0.24 X_3 - 0.33 X_4 - 0.5 X_5 - 2.67 X_6 + 2.82 X_7 + 1.0 X_8$	0.66
Y= Number of nymph and adult per sweep net	$y = 34.44 - 0.62 X_1 + 0.01 X_2 - 0.05 X_3 - 0.14 X_4 - 0.04 X_5 + 0.73 X_6 - 0.11 X_7 + 0.66 X_8$	0.54
Y= Number of dragon flies per m^2 area	$y = -13.28 - 0.01 X_1 + 0.20 X_2 + 0.01 X_3 + 0.06 X_4 + 0.07 X_5 - 0.03 X_6 + 0.15 X_7 + 0.03 X_8$	0.92
Y= Number of damsel flies per m^2 area	$y = -19.00 - 0.12 X_1 + 0.07 X_2 + 0.07 X_3 + 0.04 X_4 + 0.11 X_5 + 0.04 X_6 + 0.47 X_7 + 0.30 X_8$	0.92
Y= Number of predatory bug captured in light trap	$y = -44.94 + 0.45 X_1 + 0.14 X_2 + 0.01 X_3 + 0.24 X_4 + 0.13 X_5 - 0.06 X_6 + 1.35 X_7 + 0.62 X_8$	0.45
Y= Number of predatory beetle captured in light trap	$y = 16.23 - 0.36 X_1 + 0.32 X_2 + 0.09 X_3 - 0.16 X_4 + 0.03 X_5 - 1.01 X_6 + 1.19 X_7 + 0.48 X_8$	0.64
Y= Number of spider per m^2 area	$y = 3.54 - 0.05 X_1 + 0.07 X_2 + 0.05 X_3 - 0.04 X_4 - 0.02 X_5 + 0.33 X_6 + 0.46 X_7 + 0.63 X_8$	0.77

X_1: Maximum Temperature (°C)
X_2: Minimum Temperature (°C)
X_3: Rainfall (mm)
X_4: Morning Humidity (%)
X_5: Evening Humidity (%)
X_6: Wind velocity (kmph)
X_7: Evaporation
X_8: Sunshine hours

nymph per hill and continued up to 45th SMW (Nov 4-Nov 10). At the time of initial infestation, maximum and minimum temperatures prevailed were 31.4°C and 23.8°C, respectively with 13.86 mm rainfall and 2.59 hour of sunshine; the wind speed was 1.83 km/h with 94.57 % morning and 81.57 per cent evening RH. Thereafter, the population was increased at a steady rate and reached to peak (24.73 adult and nymph per hill) during 40th SMW (Sep 30- Oct 6) with weather parameters of 34.6°C maximum temperature, 24.76°C minimum temperature, 90.7 per cent morning RH, 61.57 per cent evening RH, and wind speed of 2.03 km/h. However, during this week, there was no rainfall with 6.06 hour of sunshine per day. Thereafter, a decline in the pest population was observed. Choudhary et al (2014) also reported that, population of plant hoppers reaches its maximum during the first week of October at Varanasi.

Gundhi bug: The incidence of gundhi bug was started during the 41st SMW (Oct 7-13) as 0.40 numbers of adult and nymph per sweep and continued up to harvesting of the crop. At the time of initial infestation, maximum and minimum temperatures prevailed were 31.1°C and 21.9°C respectively with 39.71 mm rainfall and 1.71 hour of sunshine, the wind speed was 2.61 km/h with 90.71 % morning and 62.29 % evening RH. Thereafter, the population was increased at a steady rate and reached to peak (9.07 adult and nymph per sweep net) during 44th SMW (Oct 28- Nov 3) with weather parameters of 34.6°C maximum temperature, 24.7°C minimum temperature, 90.71 % morning RH, 61.57 % evening RH, and wind speed of 2.03 kmph. Thereafter, a decline in the pest population was observed. Kalita et al.(2015) also observed that the population of gundhi bug was found maximum when the crop attained the milky stage in the last week of October.

Predatory insects: During the period of study, several beneficial insects were found to be associated with rice ecosystems. Some of them were dragonflies, damselflies and several predatory bugs and beetle. The population of this insect fluctuateover mean value during the entire cropping season (Table 2). The population of dragonflies and damselflies varies from 0.33 to 4.33 and 0.33 to 4.67 respectively throughout the entire season. Similarly, the population of predatory bug ranges from 1.00 to 12.00 per

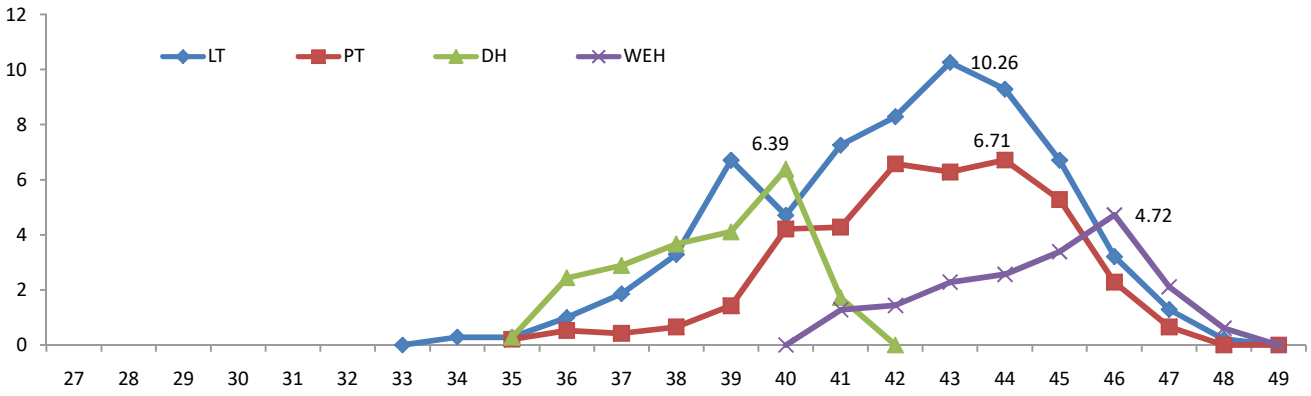

Fig. 1. Seasonal incidence of yellow stem borer (LT: Light trapped moth; PT: Pheromone trapped moth, DH: Dead Heart; WEH: White earhead) associated with rice ecosystem

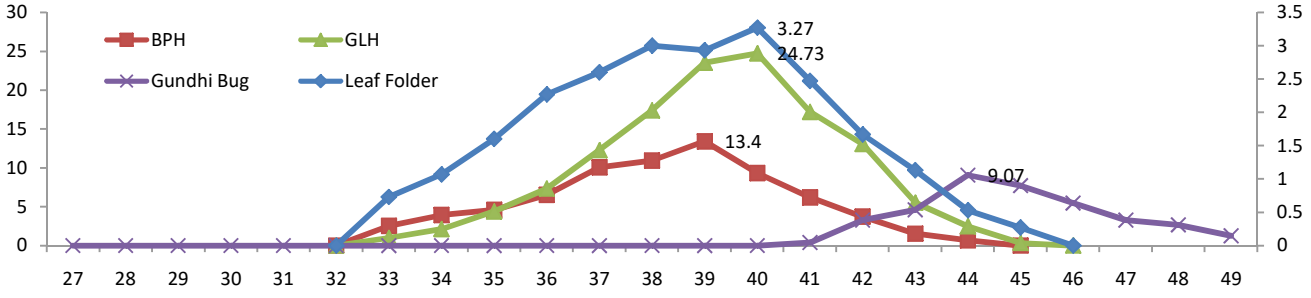

Fig. 2. Seasonal incidence of leaf folder (Number of larvae/plant), Brown plant hopper (BPH), Green leaf hopper (GLH) and Gundhibug associated with rice ecosystem

trap per week and that of predatory beetle ranges from 1.00 to 8.00 per trap per week. However, these above insects are more prevalent during the early growth period particularly from July to September because of cloudy weather and frequent rainfall. Their population tends to be decline during the month of October and November because of the decline of maximum temperature.

Spider: This non-insect arthropod is very common in rice ecosystems throughout the growing period and varied in their number and diversity. The number of spiders varied from 0.33 to 3.66 per m^2 area. They are known to be parasitized the egg as well as early instar nymph of various harmful insects associated with the crop.

Correlation coefficients and regression equations between population of insect fauna and different abiotic parameters indicate that the population of leaf folder (number of larvae per plant), brown plant hopper, green leaf hopper and predatory bug as well as per cent dead heart formation had a positive and significant correlation with maximum temperature whereas the population of dragonflies, damselflies, predatory bug and beetle had a positive and significant correlation with minimum temperature. The population of damselfly and predatory beetle had positive and significant relation with rainfall whereas that of gundhi bug was found negative and significant with the same. The population of yellow stem borer as well as per cent white ear head formation, population of green leaf hopper, dragonflies, damselflies and the spider had a negative and significant correlation with the evening relative whereas that of dragonflies had a positive and significant correlation with morning relative humidity. The population of major pests such as brown plant hopper, green leaf hopper, leaf folder, yellow stem borer (per cent dead heart formation) and predatory beetle had a negative and significant correlation with wind speedwhereas that of adult moth of yellow stem borer and the spider had a positive and significant correlation with duration of sunshine hours. The population of leaf folder, brown plant hopper, green plant hopper, damselflies, predatory bug and beetle as well as per cent dead heart formation had positively and significantly correlated with it. Mohanta et al (2020) also reported that leaf folder and brown plant hopper population had a positive and significant relation with maximum

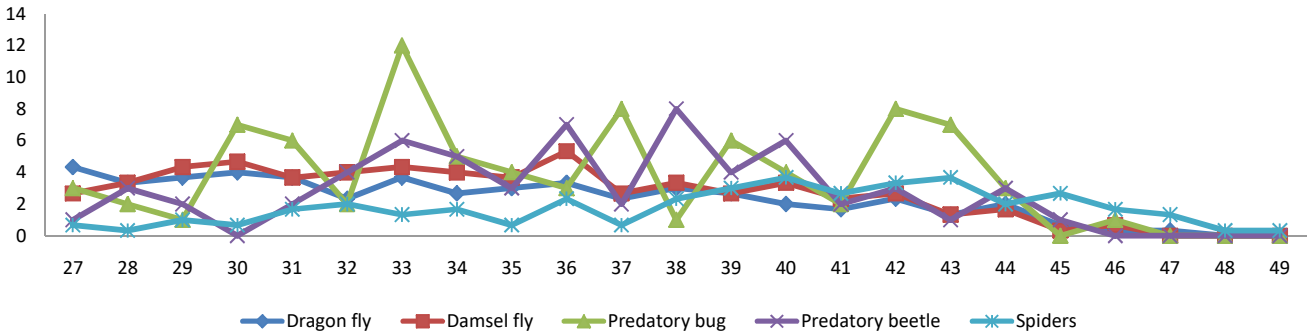

Fig. 3. Seasonal incidence of beneficial insect fauna and other arthropod species associated with rice ecosystem

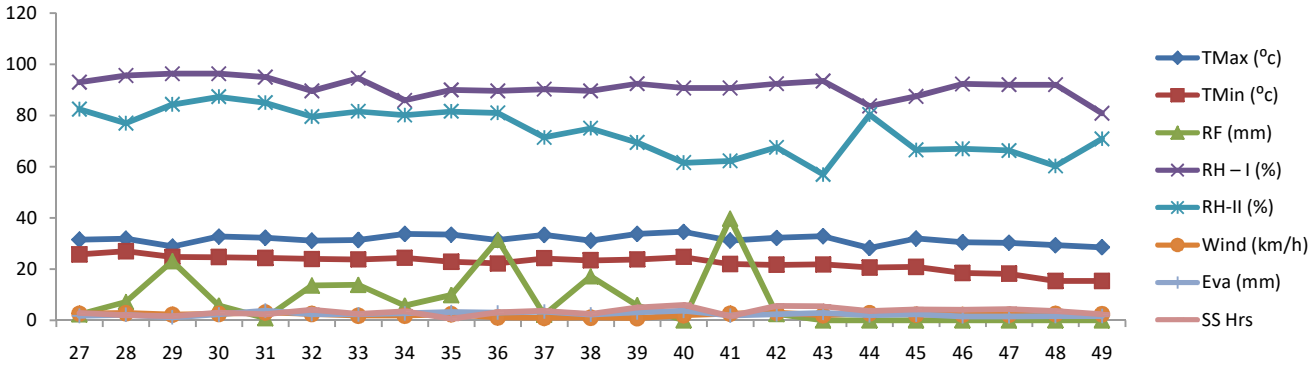

Fig. 4. Graphical representation of prevailing weather parameters during study period (Tmax: Maximun Temperature, T min: Minimum Temperature, RF: Rainfall, RH-I: Morning Relative Humidity, RH-II: Evening Relative Humidity, Eva: Evaporation, SS Hrs: Sunshine hours)

temperature whereas per cent white ear head formation and gundi bug population had a negative and significant relation with minimum temperature. Gundi bug, yellow stem borer and green leaf hopper had a negative and significant relation with rainfall and evening relative humidity, respectively.

CONCLUSION

The incidence of yellow stem borer, leaf folder and plant hopper were started during the month of August and continued up to the October. The formation of the dead heart reaches its maximum during the end of September whereas the formation of white ear head reaches its maximum during the first week of November. The population of brown plant hopper reaches its maximum earlier i.e during the third week of September as compared to that of green leaf hopper which reaches its maximum during the beginning of October. The incidence of gundhi bug started during the second week of October as the crop enters into the reproductive stage and continued up to the harvesting of the crop. During the period of investigation, it was found that the duration of sunshine hours plays an important and significant role in the incidence of yellow stem borer whereas maximum temperature plays a prime role in the incidence of leaf folder and plant hopper population.

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