# POPULATION DYNAMICS OF RICE INSECT PESTS THROUGH LIGHT CATCHES AND ITS RELATION TO ABIOTIC FACTORS IN HIGH ALTITUDE TRIBAL ZONE OF SEETHAMPETA IN ANDHRA PRADESH

**Abstract:**

Studies were carried out at Agricultural Research Station, Seethampeta in Andhra Pradesh during the kharif season for three consecutive years starting from 2017 to 2019 on the population dynamics of insect pests occurring in paddy and also to assess the influence of weather parameters on insect pests. The insect pests observed in the light trap catches were, Yellow Stem borer, Gall midge, Leaf folder, Green leafhopper, Plant hopper (BPH/WBPH) and Grasshoppers. The light trap catches of rice insect pests were recorded at weekly interval during 32nd Standard Meteorological Week (SMW) to 52nd Standard Meteorological Week (SMW) and the data were correlated with the weather parameters. The results revealed that more number of adults of yellow stem borer were noticed during the year 2019 from 45th to 48th SMW and the correlation studies revealed that that maximum temperature, minimum and maximum relative humidities had significant positive influence and regression value of $R^2$ (743, 638 and 726 during 2017, 2018 & 2019). The population of gall midge was negligible during the 2017 and 2018. Whereas, in 2019 peak was notice during 38th SMW (15 No's) maximum relative humidity has positive relation with increase in the gall midge population. Leaf folder adults were trapped more in the light traps during the year 2019 with peak catches of 11.00 No's on 42nd SMW and were positively correlated with maximum temperature, minimum and maximum relative humidities. Similarly leafhopper, brown leaf hopper, grass hoppers were positively correlated with the relative humidity.

**Introduction:**

Agriculture is the base of our civilization and the vital food source of Asia (especially India) is rice. The vital parameters of rice such as size, volume and eminence are highly influenced by pest attack. There are varieties of pests which are damaging the quality of rice and the insects are available in different sizes. The degree of destruction in the paddy fields due to pest insects should be reduced and hence pest management becomes vital in agriculture. Many of the insect species, mostly nocturnal are known to be positively phototrophic and are attracted towards artificial light in large numbers. Gardens may utilize this phenomenon to capture night flying insects in a device called light trap. Light trap is an important tool for minimizing the insect pests damage without any toxic hazards (Sharma *et al.,* 2004). Other than this light trap has been used to supplement the knowledge of pest fauna of given locality, geographical distribution and their seasonal activity etc. (Sharma *et al.,* 2010). The insect pests of all cereal crops, pulse crops, vegetable crops as well as horticultural crops can be mass trapped by using light traps. Light trap is also useful to know the effect the weather factors on species abundance (Jonason *et al.,* 2014). Many insects are positively phototrophic in nature and use of light traps for insect catches produces valuable faunistic data. This data can be seen as a parameter of health of biodiversity of the concerned vicinity. The data provided by light trap catches could throw light on period of maximum activity of insects (Dadmal and Khadakkar, 2014; Ramamurthy *et al.,* 2010). Rice (*Oryza sativa* L.) is one of the most important cultivated plants of tropics and subtropics, it occupies third place in global cereals production and is the most important staple food crop with more than half of the world's population relying on rice as the major daily source of calories and protein (Tiwari *et al.,* 2014).

Rice (*Oryza sativa* L.) is one of the most important crops of the world and provides food to more than 50% global population .More than 90% of the world's rice is grown and consumed in Asia, where 60% of the earth's people live .It was estimated that 35-60% of the calories consumed by 3 billion Asians comes from rice. India continues to remain the fastest growing major economy in the world in 2018- 19, despite a slight moderation in its GDP growth from 7.2 per cent in 2017-18 to 6.8 per cent in 2018-19. Real growth in 'Agriculture & allied' sector was lower in 2018-19 at 2.9 per cent, after two years of good agriculture growth . As per the 3rd Advance Estimates released by Ministry of Agriculture & Farmers Welfare, the total production of food grains during 2018-19 is estimated at 283.4 million tonnes, as compared to 285 million tonnes in 2017-18. Agriculture sector in India typically goes through cyclical movement in terms of growth and production (Anon, 2018).

Green leafhopper Nephotettix virescens (Cicadellidae, Hemiptera) and plant hoppers *Cofana spectra* (Delphacidae, Hemiptera) and C. yasumatsui Young (Kolla mimica, Hemiptera) are important insect pests of rice. These insects are serious pests in Asia, where not only cause direct damage by removing plant sap, but also act as vectors of rice virus diseases, such as rice tungro virus. Meteorological factors play an important role in seasonal abundance, distribution and population build up of insect pests. It is difficult to find direct cause and effect relationship between any single factor and pest activity because the impact of meteorological factor on pests is usually compounded (Harinkhere *et al.,* 1998). Abiotic factors affect the light trap of the insect directly and indirectly. Bhatnager and Saxena (1999) reported that minimum temperature played an important role in the population build up of green leafhopper and rice gundhi bug, besides evening relative humidity and rainfall.

The term „Light trapping‟ refers to "attracting moths with light, but sampling them by hand or net". Light can be assumed to sample the community more „neutrally‟ than using food or pheromones, where specializations are more likely to occur (Southwood and Henderson, 2000). The use of artificial light sources is a commonly employed technique to attract night-active insects for the study of taxonomy, biogeography and biodiversity (Holloway *et al.,* 2001; IntachatandWoiwod,1999). Collections of a light trap provide significant clue to the diversity of insects active even at night (Southwood and Henderson, 2000), their respective affinity to light and to understand and predict how populations function (Southwood and Henderson,2000). Therefore, the present investigation is proposed to observe the " Seasonal incidence and fluctuation of insect pest species of paddy collected through light trap and the influence of the weather parameters.

**Materials and Methods:**

A light trap (Agricultural Research Station, Seethampeta, Andhra Pradesh), fitted with 200-watt electric bulb, is an indigenous device. It had been installed long ago at the Crop Research Station, during the period between first week of June and last week of December, 2017, 2018 and 2019. It is made up of 24 gauge GI sheet consisting of a funnel (40 cm top diameter), baffle plates each 30 x 12 cm in size. In this design long funnel stem (pipe) is provided in place of collection chamber which is directly attached to collection trey.

It is made up of 24 gauge GI sheet 40 cm x 40 cm x 15 cm in size with cupboard and built-in locking system. The insects collected in the chamber of light trap were killed by the exposure of Chlorpyriphos 20% EC which is directly placed in collection tray for instant killing of trapped insects.

Seasonal activity studies of major insect pest species of paddy was recorded by operating the light trap in Kharif season from the year 2017 to 2019 for major and minor pests of paddy which were observed on daily basis. In order to study the seasonal activity, daily trap catch was converted into weekly total and mean per day per week (weekly mean/day).

Weekly observation are based on standard meteorological week (SMW). Observations of weather data (Maximum temperature, Minimum temperature, relative humidity morning and evening, rainfall, number of rainy days, sunshine hours, wind velocity, morning and evening vapour pressure and evaporation etc.) were recorded on daily basis from meteorological observatory. The correlation coefficient and regression between major insect pests of paddy and various weather parameters was calculated by using the correlation regression analysis (Snedecor and Cochran, 1967).

**Results and Discussion:**

**Yellow stem borer:**

During, Kharif 2017 in light trap catches peak incidence of yellow stem borer adult moth population (1.7 Nos.) in $46^{th}$ SMW ($12^{th}$ to $18^{th}$ November). In Kharif 2018, the light trap catches peak incidence of yellow stem borer (YSB) was observed in $45^{th}$ SMW (5th to 11th November) (18.0 Nos.). Similarly, during the year Kharif, 2019 peak incidence of yellow stem borer adult moth population (18.00 Nos.) recorded in $45^{th}$ SMW (Table 1). Influence of weather parameters on the moth trap catches of yellow stem borer was also tabulated with weather parameters which revealed that maximum temperature, minimum and maximum relative humidities had significant positive influence on yellow stem borer (Table 2a,2b & 2c) and the regression value ($R^2$) was 0.743, 0.638 and 0.726 during 2017, 2018 and 2019 kharif season respectively. Path analysis revealed that the direct contribution of maximum temperature and rainfall on population build up.

Present results are in conformity with Mubashar Hussain *et al.* (2019) reported that weather conditions specially temperature and relative humidity, it was detected that insect trap catches noted inside a certain range of temperature that varies from 17-34°C for Yellow stem borer of rice. Extreme catches were documented in September inside a temperature range of 26-32°C considering it ideal series of temperature for insect light trap catches and activity of yellow and white stem borer.

**Gall midge:**

Adults of gall midges were also trapped in the light trap and the population of gall midge adults during the year 2017 kharif observed peak during $37^{th}$ SMW (0.4 Nos.) and the incidence during the year was very negligible. In the year the peak trap catches was recorded in $47^{th}$ (1.0 Nos.) and $46^{th}$ (1.2 No's.) SMW. Gall midge damage in paddy was highest during the year 2019 where the light trap catches population ranged from 2.00 to 15.00 Nos. and the peak activity was observed on $38^{th}$ SMW (15.00 No's.) (Table 1). With respect to the influence of weather parameters maximum relative humidity has positive relation with increase in the gall midge population and there was no much influence of other weather parameters (Table 2a,2b & 2c). Similar results were also explained by Sable *et al.* (2010) that rice gall midge and army warm outbreaks tend to follow high rainfall early in the wet season and also the relative humidity.

**Leaf folder:**

Rice leaf folder was first recorded during $34^{th}$ SMW in light trap. The activity period of *C. medinalis* was observed from $34^{th}$ to $47^{th}$ SMW during the year 2017 and the peak catches was observed during $43^{rd}$ SWM. During *Kharif*, 2018 the activity period was noticed from $40^{th}$ SMW and continued upto $52^{nd}$ week which is last week of December and the highest trap catches was observed during $43^{rd}$ SMW with 2.8 No's. Compared to all the three years the leaf folder adults were trapped more in the light traps during the year 2019 with peak catches of 11.00 No's on $42^{nd}$ SMW (Table 1). August. Patel *et al.*, (2011) also reported that rice leaf folder, *C. medinalis* reached its peak level during $34^{th}$ SW and only one distinct peak was recorded by Khan and Ramamurthy (2004). In contrast with the present findings, Harinkhere *et al.*, (1998) who reported that first appearance of *C. medinalis* in trap catches started from 2nd week of August. Similarly Manisegaran and Letchoumanane (2001) reported that weekly catches of rice leaf folder were highest during October and November in Tamil Nadu. Sharma *et. al.* (2013) recorded 3 distinct peaks of rice leaf folder during the main cropping season of paddy in which highest weekly peaks were observed during the 4rth week of September and October and Correlation between various weather parameters and adults of rice leaf folder catches were found significant.

**Green leaf hopper:**

Green leaf hopper was first appeared during $37^{th}$ SMW in light trap during kharif, 2017. Major activity period was from $40^{th}$ to $47^{th}$ SMW with highest peak was recorded during $43^{rd}$ (69 No's). During the year. During Kharif 2018, Leaf hopper population per week (56.00 Nos.) in 44th

SMW and later the incidence was reduced. The leafhopper population in the light trap during the year 2019 kharif observed from 34th SMW and peak catches was noticed of (56 Nos.) in 44th SMW (29th to 04th November) (Table 1). Maximum temperature had significant positive influence on green leafhopper during the year 2019 and in rest of the years there was no relation with the weather parameters (Table 2a, 2b & 2c).

Sharma *et. al.* (2004) who also reported that maximum population of *N.virescens* was recorded during the 3rd week of October. On the contrary Rai *et al.,* (2002), Manimaran and Manickavasagam (2000) and Sabale *et al.,* (2010) reported First peak was observed for both the species during 38th to 41st standard meteorological week, the second peak was observed during 45th std. week and the third peak was observed during 52nd to 2nd std. week (i. e. from last week of December to 2nd week of January of the succeeding year) for all study years. Kathirvelu and Manickavasgam (2007) also recorded green leafhopper (GLH) during the 33rd and 35th SW respectively through trap catches. Regression analysis revealed that the direct contribution of maximum temperature and rainfall on population build up of male green leafhopper. But, indirect contribution of rainfall through maximum temperature on population build up.

**Plant hopper:**

Brown plant hopper population during the year 2017 Plant hoppers (BPH/WBPH) in. In the year 2017 the BPH/WBPH population started trapping in light trap from 36th SMW and the highest traps catches was observed during 42nd SMW (15th to21st October) with (57.3 Nos.). In the year 2018 the peak population activity was recorded during 47th SMW (46.5 No's). The highest BPH/WBPH population was observed during the year 2019 wherein the population of plant hoppers were observed from 33rd SMW to 52nd SMW and highest was observed during 43rd SMW (608 No's) (Table 1). With respect to the influence of weather parameters on the BPH population revealed that temperature and relative humidity had positive impact on the population in all the three years of observation (Table 2a,2b & 2c).

Prasanna Kumar and Subhash Chander (2014) observed that observed peaks between October 4thweekand November 3rd week during different years, exhibited significant correlation with Tmax, RH1 and RH2 of October 2nd week, rainfall (RF)of July 2nd week, SSH of October 1st week and Tmin of August 2nd week. Weather-based prediction model for BPH was developed by regressing peaks of BPH light trap catches on mean values of different weather parameters. Of the weather parameters, only Tmax, RF and RH2 were found to be relevant through stepwise regression. Chander and Palta (2010) observed that early commencement of rainfall in summer and its intermittent distribution with more number of rainy days that led to higher relative humidity could contribute to BPH outbreak.

**Grasshoppers:**

Population of grass hopper was recorded in third week of October and it was found that meteorological parameters do not play any significant role in the population build up. The highest peak was observed 40$^{th}$ SMW (3.3 No's) during Kharif, 2017. During the year 2018 the peak activity of Grasshoppers was observed on 46$^{th}$ SMW (2.1 No's) and population of grasshoppers was were trapped more during the Kharif, 2019 from 38$^{th}$ to 41$^{st}$ SMW and highest trap catches was recorded during 41$^{st}$ SMW (27.00 No's) (Table 1). There was impact of weather parameters on the grasshopper activity in particular with temperature and relative humidity (Table 2a, 2b & 2c).

Sharma (2006) observed two species of grass hopper viz. *Trilophidia cristella S. and Gastrimargus transversus* in light trap catches in paddy field during 2002 (kharif season) at Jabalpur, while similar to the present findings, Singh and Ramaneek (2007) reported that population fluctuations of twenty four species of orthopterans, were correlated with temperature and relative humidity.



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**Table: 1 Weekly Light trap collection of insect pest and weather parameters during kharif 2017-2019**

| SMW | Yellow stem borer (Male/Female) | | | Gall midge | | | Leaf folder | | | Green leaf hopper (NV/NP) | | | Plant hopper (BPH/WBPH) | | | Grass hopper | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 | 2017 | 2018 | 2019 |
| 32 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 2.0 |
| 33 | 0.3 | 0.1 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 0.1 | 0.1 | 0.0 |
| 34 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 3.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 9.0 | 0.0 | 0.0 | 7.0 | 0.4 | 0.2 | 4.0 |
| 35 | 0.1 | 0.1 | 6.0 | 0.0 | 0.0 | 2.0 | 0.1 | 0.0 | 2.0 | 0.0 | 0.0 | 5.0 | 0.0 | 0.0 | 21.0 | 0.0 | 0.1 | 1.0 |
| 36 | 0.6 | 0.1 | 7.0 | 0.3 | 0.0 | 9.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 7.0 | 0.6 | 0.0 | 42.0 | 0.4 | 0.4 | 7.0 |
| 37 | 0.6 | 0.1 | 11.0 | 0.4 | 0.1 | 11.0 | 0.9 | 0.0 | 5.0 | 0.1 | 0.0 | 14.0 | 2.3 | 0.0 | 64.0 | 0.4 | 0.1 | 9.0 |
| 38 | 0.7 | 0.1 | 9.0 | 0.3 | 0.1 | 15.0 | 0.7 | 0.0 | 3.0 | 0.9 | 0.0 | 12.0 | 10.6 | 0.1 | 145.0 | 1.6 | 0.4 | 15.0 |
| 39 | 0.9 | 0.2 | 7.0 | 0.0 | 0.4 | 7.0 | 1.6 | 0.0 | 6.0 | 4.7 | 0.0 | 21.0 | 19.3 | 0.2 | 192.0 | 1.6 | 0.2 | 21.0 |
| 40 | 0.9 | 0.0 | 6.0 | 0.0 | 0.2 | 6.0 | 1.4 | 0.2 | 5.0 | 20.9 | 0.1 | 16.0 | 44.4 | 0.7 | 274.0 | 3.3 | 0.4 | 19.0 |
| 41 | 0.7 | 0.2 | 9.0 | 0.0 | 0.5 | 2.0 | 1.6 | 0.5 | 9.0 | 17.0 | 0.8 | 22.0 | 48.6 | 3.5 | 315.0 | 2.4 | 0.2 | 27.0 |
| 42 | 1.0 | 0.4 | 5.0 | 0.0 | 0.1 | 0.0 | 1.3 | 0.7 | 11.0 | 34.7 | 0.8 | 19.0 | 57.3 | 7.5 | 558.0 | 2.9 | 0.1 | 7.0 |
| 43 | 1.3 | 0.4 | 12.0 | 0.0 | 0.1 | 0.0 | 2.0 | 2.8 | 7.0 | 69.6 | 2.3 | 42.0 | 51.3 | 18.0 | 608.0 | 2.3 | 0.1 | 6.0 |
| 44 | 0.6 | 0.5 | 9.0 | 0.0 | 0.0 | 0.0 | 1.4 | 0.8 | 6.0 | 28.9 | 0.5 | 56.0 | 51.3 | 15.5 | 480.0 | 1.4 | 0.2 | 11.0 |
| 45 | 0.4 | 0.4 | 18.0 | 0.0 | 0.5 | 0.0 | 0.6 | 0.7 | 2.0 | 17.6 | 1.7 | 38.0 | 38.0 | 17.5 | 370.0 | 1.0 | 0.7 | 5.0 |
| 46 | 1.7 | 1.0 | 16.0 | 0.0 | 1.2 | 0.0 | 1.0 | 1.8 | 1.0 | 28.9 | 12.2 | 28.9 | 39.7 | 43.8 | 210.0 | 1.4 | 2.1 | 7.0 |
| 47 | 1.0 | 1.0 | 14.0 | 0.0 | 1.0 | 0.0 | 0.7 | 1.5 | 1.0 | 15.9 | 10.2 | 15.0 | 20.3 | 46.5 | 96.0 | 0.7 | 1.1 | 4.0 |
| 48 | 0.7 | 0.8 | 11.0 | 0.0 | 0.2 | 0.0 | 0.9 | 0.8 | 0.0 | 6.6 | 15.4 | 9.0 | 4.1 | 35.0 | 56.0 | 0.6 | 0.5 | 6.0 |
| 49 | 0.0 | 0.7 | 7.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.8 | 4.0 | 0.0 | 21.8 | 6.0 | 0.0 | 14.1 | 22.0 | 0.0 | 0.8 | 1.0 |
| 50 | 0.0 | 1.0 | 4.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 1.0 | 0.0 | 29.7 | 11.0 | 0.0 | 26.7 | 19.0 | 0.0 | 1.1 | 2.0 |
| 51 | 0.0 | 0.1 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 10.1 | 0.0 | 0.0 | 17.0 | 9.0 | 0.0 | 0.5 | 0.0 |
| 52 | 0.0 | 0.4 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 3.4 | 0.0 | 0.0 | 8.8 | 4.0 | 0.0 | 0.1 | 0.0 |

**Table 2a: Correlation & Regression between weather parameters and incidence of insect pests (*Kharif* 2017)**

| Insect pests | Correlation coefficient values | | | | | $R^2$ |
|---|---|---|---|---|---|---|
| | Min. Temp. ($^{O}C$) | Max. Temp. ($^{O}C$) | Min. RH (%) | Max. RH (%) | Rainfall (mm) | |
| Yellow Stem borer | 0.391 | 0.610** | 0.453* | 0.521* | -0.189 | 0.743 |
| Gall midge | 0.265 | 0.232 | 0.250 | 0.271 | 0.213 | 0.199 |
| Leaf folder | 0.402 | 0.607** | 0.507* | 0.558** | -0.184 | 0.843 |
| Green leafhopper | 0.203 | 0.410 | 0.263 | 0.297 | -0.238 | 0.783 |
| Plant hopper (BPH/WBPH) | 0.281 | 0.520* | 0.369 | 0.729* | -0.232 | 0.803 |
| Grasshopper | 0.400 | 0.572** | 0.570* | 0.529* | -0.067 | 0.804 |

**Table 2b: Correlation & Regression between weather parameters and incidence of insects (*Kharif*, 2018)**

| Insect pests | Correlation coefficient values | | | | | $R^2$ |
|---|---|---|---|---|---|---|
| | Min. Temp. ($^{O}C$) | Max. Temp. ($^{O}C$) | Min. RH (%) | Max. RH (%) | Rainfall (mm) | |
| Yellow Stem borer | -0.372 | 0.145 | -0.424* | 0.119 | -0.062 | 0.638 |
| Gall midge | -0.101 | -0.207 | -0.057 | -0.002 | 0.291 | 0.355 |
| Leaf folder | -0.074 | 0.070 | -0.076 | 0.142 | 0.235 | 0.283 |
| Green leafhopper | -0.487* | 0.074 | -0.495* | 0.092 | -0.226 | 0.358 |
| Plant hopper (BPH/WBPH) | -0.454* | 0.931* | -0.474* | 0.694** | -0.026 | 0.416 |
| Grasshopper | -0.328 | -0.241 | -0.293 | -0.058 | 0.263 | 0.554 |

**Table 2c: Correlation & Regression between weather parameters and incidence of insects (*Kharif*, 2019)**

| Insect pests | Correlation coefficient values | | | | | $R^2$ |
|---|---|---|---|---|---|---|
| | Min. Temp. ($^{O}C$) | Max. Temp. ($^{O}C$) | Min. RH (%) | Max. RH (%) | Rainfall (mm) | |
| Yellow Stem borer | -0.132 | 0.340 | -0.249 | -0.192 | -0.206 | 0.726 |
| Gall midge | 0.440* | 0.349 | 0.465* | 0.544* | 0.269 | 0.316 |
| Leaf folder | 0.296 | 0.602** | 0.387 | 0.517* | 0.426 | 0.604 |
| Green leafhopper | 0.127 | 0.579** | -0.008 | 0.150 | 0.036 | 0.650 |
| Plant hopper (BPH/WBPH) | 0.212 | 0.652** | 0.171 | 0.246 | 0.198 | 0.609 |
| Grasshopper | 0.353 | 0.565** | 0.434* | 0.540* | 0.464* | 0.513 |

Note: *Significant at 5% level **Significant at 1%