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# Influence of abiotic factors on the incidence of brown plant hopper and its entomo pathogenic fungi in coastal agroecosystem of Tamil Nadu

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**Abstract**
Field incidence of Brown Plant Hopper (BPH) and entomopathogenic fungi of BPH were studied during Samba and Navarai seasons for two consequent years 2013-2015 in coastal saline soil at agriculture main farm, Annamalai University, Annamalainagar, Tamil Nadu, India. The peak BPH incidence during third week of November and the least number of *N. lugens* was recorded on second week of October 2013. The maximum number of fungal infested cadaver was recorded during third week of November and the least number of cadaver were recorded on third week of October 2013 during the Samba season. During Navarai season the maximum numbers of *N. lugens* incidence were recorded during second week of February and the least numbers of *N. lugens* was recorded during fourth week of March. The maximum number of cadaver was recorded during second week of February and the least number of cadaver was recorded during the first week of January. The relative humidity and rainfall showed significant positive correlation, while maximum temperature and minimum temperature exhibited negative correlation with BPH incidence. The entomopathogenic fungi incidence negatively correlated maximum temperature, minimum temperature whereas positively correlated with humidity and rainfall.

**Keywords:** Rice, BPH, temperature, humidity, Navarai

## 1. Introduction
Rice (*Oryza sativa* L.) is a stable food for millions of people all over the world. One fifth of the world population depends on rice cultivation for livelihood and rice farms cover 11 per cent of world's arable area (IRRI, 2011). India is the second largest producer of rice and occupying 22 per cent of the world production. The production of paddy affects by biotic and abiotic factors. The management of pests and diseases still makes profitable rice production as challenging. In fact most of high yielding varieties were found susceptible to major insect pests. This is because of change in the ecosystem resulting in unexpected variations in the pest fauna. It has also important socio economic impact since large number of the labour force employed in the rice sector (FAO, 2012). More than 100 pests associated with rice (Pathak and Khan, 1994) [10]. Among rice pests Brown plant hopper *Nilaparvata lugens* (Stal) is considered as major pest of rice and also causes serious outbreaks in several countries in Asia. In India also serious out breaks of this pest has been reported from paddy growing area, because of unpredictability of the infestation and the dramatically severe damage it causes (Dhaliwal *et al.* 2010) [9] The pest feed directly on growing plant resulted hopperburn and the grassy stunt disease is transmitted by BPH which can further reduce the yield (Du *et al*. 2007). Insects are vulnerable to the environmental factors (Isichaikul *et al.* 1993) [12]. The understanding of influence of abiotic factors on insect pest incidence will be helpful identification of vulnerable season and selecting the effective pest management tool (Manikandan *et al.* 2021) [13]. The entomopathogenic fungi is one of the effective management tool against BPH. Since, the entomopathogenic fungi are living organism identification of the favorable environment will be helpful make more effective utilization of entomopathogenic against BPH (Sain *et al.* 2021) [14]. Keeping this view, research aimed to record the incidence of BPH and its entopathogenic fungi and the influence of abiotic factors.

## 2. Materials and Methods
### 2.1 Study area
The paddy field was maintained in agriculture main farm, Annamalai University, Annamalainagar, Tamil Nadu, India. Its geographical coordinates are Latitude: 11.39 North

Longitude: 79.71 East, Altitude: 4.00m/13.12ft and elevation ranges from 7.34 Meters (24.09 Feet) above the mean sea level.

**2.2 Survey of seasonal incidence of Brown Plant Hopper and entomopathogenic fungi:** The survey conducted during *Samba* and *Navarai* seasons during 2013 to 2015. The field prepared and seedling transplanted and the proper agronomic practices were followed except pest management practices. The weekly interval survey conducted to record number of BPH, *Nilaparvata lugens* on randomly selected paddy plants in ten replications each replication includes five hills. The average was calculated and the results expressed as number of BPH per hill. The entomopathogenic fungi infested BPH identified based on mycelia growth on cadaver were recorded on randomly selected twenty five hills of paddy and expressed as number of cadaver per hill. The meteorological data on maximum temperature, minimum temperature, relative humidity and rainfall were collected from Agro-meteorological observatory, Department of Agronomy, Annamalai University for 2013 to 2015. During the course of investigation population of BPH and entomopathogenic fungi incidence correlated with abiotic factors.

## 3. Result and Discussion

### 3.1 Seasonal incidence of Brown Plant Hopper, *N. lugens* and entomopathogenic fungi

The pest incidence was observed from the first week of October 2013 to fourth week of January 2014, ranging from 2.33 to 24.60 BPH / hill. The maximum numbers of *N. lugens* incidence were recorded during third week of November (24.60 BPH / hill). Whereas, the least number of *N. lugens* was recorded on second week of October 2013 (2.33 BPH / hill). The incidence of *N. lugens* cadaver was also observed ranging from 1.01 to 15.66 cadaver / hill. The maximum number of cadaver was recorded during third week of November (15.66 / hill) and the least number of cadaver were recorded on third week of October 2013 (1.01 cadaver / hill). (Table. 1).

The pest incidence was noticed from the first week of January 2014 to fourth week of March 2014 ranging from 3.0 to 19.12 BPH / hill. The maximum numbers of *N. lugens* incidence were recorded during second week of February (19.12 BPH /hill). The least numbers of *N. lugens* was recorded during fourth week of March (3 BPH /hill). (Table.2) The incidence of *N. lugens* cadaver was also observed ranging from 2.00 to 10.01 cadaver / hill. The maximum number of cadaver was recorded during second week of February (10.01 cadaver/ hill) and the least number of cadaver was recorded during the first week of January (2.00 cadaver / hill). (Table.2)

The pest incidence was observed from the first week of October 2014 to fourth week of January 2015, ranging from 1.13 to 21.16 BPH /hill. The maximum numbers of *N. lugens* incidence were recorded during first week of December (21.16 BPH / hill). The least numbers of *N. lugens* was recorded during second week of October (1.13 BPH / hill). The incidence of *N. lugens* cadaver was also observed ranging from 1.01 to 15.66 cadaver / hill. the maximum number of cadaver was recorded during third week of November (15.66 / hill) and the least number of cadaver was recorded during first week of October 2013 (1.01 / hill) (Table.3).

These population dynamics studies revealed that maximum incidence of BPH and fungal infected cadavers recorded during the month of December in Samba season where temperature is minimum and RH is high. These findings were in line with Narayanasamy *et al*. (1993) [2], Yasodha (2002), Udayaprabhakar (1995) [3] Chinna Kannu (2014) [4] who also reported that higher population of BPH in Samba season compared to Kuruvai and Navarai seasons.

BPH is phototrophic and is considered as one of the serious pests on rice crop. As comparatively sensitive to weather factors the fluctuations in the incidence of hoppers were recorded in both the seasons.

### 3.2 Influence of weather parameters on Brown Plant Hopper population and entomopathogenic fungi

The result of correlation study revealed that relative humidity (r= 0.785) and rainfall (r= 0.345) showed significant positive correlation, while maximum temperature (r= -0.896) and minimum temperature (r= -0.509) exhibited negative correlation during Samba season (2013-2014) (Table.4).

The result of correlation study between the BPH and abiotic factors during Navarai 2014 revealed that relative humidity (r= 0.372) and rainfall (r= 0.276) showed significant positive correlation, while maximum temperature (r= -0.355) and minimum temperature (r= -0.502) exhibited negative correlation (Table.5).

The result of correlation study between abiotic factors and BPH population during Samba (2014-2015) revealed that relative humidity (r= 0.202) and rainfall (r= 0.048) showed significant positive correlation, while maximum temperature (r= -0.147) exhibited negative correlation. (Table.6).The results showed that the maximum temperature negatively correlated with entomopathogenic fungi incidence whereas positively correlated with humidity minimum temperature and rainfall. In case of minimum temperature it was positively correlated during samba season whereas negatively correlated during navari season.

Correlation coefficient between weather and BPH revealed that during Samba season of the 2013 – 2014 and 2014 – 2015 relative humidity and rainfall showed significant positive correlation, while maximum temperature exhibited negative correlation. These reports are in accardance with Chinna Kannu (2013) [4] that rain fall showed significant trelationship in Annamalinagar ecosystem maximum relative humidity and rainfall showed positive influence with RH increase in population. This is in agreement with the reports of Yadav *et al*. (2010) [5] that temperature variations in relative humidity played important role in BPH incidence.

During Navarai season (January – March 2014) the increased day temperature and decreased RH and rainfall acted as significant factors for the decline in the incidence of BPH and cadavers. As the RH is important contributing factor for the higher incidence of BPH and cadavers. These reports are in supporting to the above facts. Findings of Narayanasamy (1993) [2], Hariprasad (1999) [6] and Senthil Kumar (2013) also reported that the incidence of maximum rice pests during samba season compared to Navarai season. Higher percentage of humidity was favourable to incidence of rice pests and cadavers.

The above statement is in accordance with the studies of Cheng *et al*. (1992) [7] who reported that high affects of temperature on population dynamics of BPH. It was evident that a range 85 to 95 per cent would be conducive in the coastal region for the rapid build up of BPH during the month of December 2013 and 2014. However Sandeep Chowdary *et al*. (2014) [8] reports is not in agreement with present findings that the rainfall and humidity were negatively correlated in

Varanasi on the population of BPH where as temperature was positively correlated this may be due to variations in climatic conditions.

**Table 1:** Effect of weather factors on the incidence of *N. lugens* in rice during October 2013 – January 2014 (Samba season)

| Month 2013-14 | Standard week | No. of BPH/hill | No. of cadaver/hill | Mean temperature (°C) | | RH (%) | Rainfall (mm) |
|---|---|---|---|---|---|---|---|
| | | | | Max. | Min. | | |
| October | I | 0.0 | 0.0 | 35.0 | 25.1 | 80 | 000.0 |
| | II | 2.33 | 0.0 | 34.0 | 24.1 | 83 | 016.4 |
| | III | 7.50 | 1.01 | 30.8 | 23.8 | 90 | 099.4 |
| | IV | 10.3 | 3.12 | 32.0 | 25.1 | 86 | 000.8 |
| November | I | 13.0 | 5.13 | 31.2 | 20.6 | 89 | 038.0 |
| | II | 21.0 | 9.42 | 28.6 | 23.7 | 88 | 085.0 |
| | III | 18.10 | 9.51 | 28.3 | 22.4 | 90 | 120.4 |
| | IV | 18.00 | 8.23 | 29.0 | 23.2 | 92 | 059.3 |
| December | I | 20.10 | 13.0 | 29.2 | 22.6 | 89 | 022.0 |
| | II | 19.33 | 10.33 | 27.4 | 22.1 | 89 | 174.6 |
| | III | 24.60 | 15.66 | 29.0 | 21.4 | 90 | 040.6 |
| | IV | 22.30 | 15.33 | 7.6 | 20.0 | 87 | 000.0 |
| January | I | 17.5 | 8.00 | 27.8 | 22.0 | 88 | 000.0 |
| | II | 17.0 | 7.6 | 28.4 | 20.7 | 90 | 000.0 |
| | III | 16.8 | 7.0 | 28.7 | 21.0 | 90 | 000.0 |
| | IV | 16.0 | 7.0 | 28.4 | 20.5 | 89 | 006.3 |

**Table 2:** Effect of weather factors on the incidence of *N. lugens* in rice during January – March 2014 (Navarai season)

| Month 2014 | Standard week | No. of BPH/hill | No. of cadaver/hill | Mean temperature (°C) | | RH (%) | Rainfall (mm) |
|---|---|---|---|---|---|---|---|
| | | | | Max. | Min. | | |
| January | I | 6.33 | 2.00 | 27.8 | 22.0 | 88 | 000.0 |
| | II | 11.8 | 2.11 | 28.4 | 20.7 | 90 | 000.0 |
| | III | 15.66 | 4.20 | 28.7 | 21.0 | 90 | 000.0 |
| | IV | 18.0 | 5.33 | 28.4 | 20.5 | 89 | 006.3 |
| February | I | 18.35 | 8.0 | 28.8 | 20.2 | 87 | 000.8 |
| | II | 19.12 | 10.01 | 29.7 | 17.7 | 91 | 000.0 |
| | III | 18.55 | 9.15 | 30.2 | 21.3 | 88 | 000.0 |
| | IV | 18.0 | 8.18 | 29.2 | 21.6 | 87 | 025.0 |
| March | I | 17.6 | 8.0 | 30.2 | 21.7 | 89 | 000.0 |
| | II | 15.3 | 6.70 | 30.6 | 22.7 | 86 | 000.0 |
| | III | 10.5 | 2.32 | 30.4 | 21.2 | 87 | 000.0 |
| | IV | 3.0 | 0.0 | 33.1 | 22.5 | 86 | 000.0 |

**Table 3:** Effect of weather factors on the incidence of *N. lugens* in rice during October 2014 – January 2015 (Samba season)

| Month 2014-15 | Standard week | No. of BPH/hill | No. of cadaver/hill | Mean temperature (°C) | | RH (%) | Rainfall (mm) |
|---|---|---|---|---|---|---|---|
| | | | | Max. | Min. | | |
| Oct | I | 0.0 | 0.0 | 33.8 | 24.7 | 83 | 000.0 |
| | II | 1.13 | 0.0 | 34.0 | 24.7 | 85 | 029.8 |
| | III | 4.40 | 1.01 | 29.8 | 23.3 | 96 | 362.3 |
| | IV | 9.53 | 3.12 | 29.3 | 23.9 | 92 | 094.6 |
| Nov | I | 13.0 | 5.70 | 29.4 | 23.3 | 88 | 099.0 |
| | II | 17.10 | 6.32 | 31.2 | 22.7 | 89 | 000.0 |
| | III | 19.10 | 8.66 | 29.0 | 24.0 | 93 | 150.6 |
| | IV | 9.45 | 1.10 | 29.1 | 23.2 | 91 | 052.0 |
| Dec | I | 11.50 | 3.22 | 26.6 | 22.2 | 89 | 078.6 |
| | II | 18.73 | 7.53 | 33.8 | 24.7 | 83 | 000.0 |
| | III | 15.00 | 5.11 | 34.0 | 24.7 | 85 | 029.8 |
| | IV | 21.16 | 9.30 | 29.8 | 23.3 | 96 | 362.3 |
| Jan | I | 20.08 | 9.08 | 29.2 | 22.7 | 91 | 006.6 |
| | II | 7.50 | 1.6 | 28.6 | 20.5 | 88 | 001.0 |
| | III | 2.0 | 0.0 | 28.6 | 20.1 | 86 | 000.0 |
| | IV | 0.0 | 0.0 | 28.3 | 21.4 | 87 | 000.0 |

**Table 4:** Simple correlation matrix between incidence of *N. lugens* and weather factors during October 2013 - January 2014 (Samba season)

| | | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ |
|---|---|---|---|---|---|---|---|
| $X_1$ | BPH population | 1.000 | | | | | |
| $X_2$ | Entomopathogenic fungi incidence | 0.940 | 1.000 | | | | |
| $X_3$ | Maximum temperature | -0.896 | -0.747 | 1.000 | | | |
| $X_4$ | Minimum temperature | 0.509 | 0.359 | 0.675 | 1.000 | | |
| $X_5$ | Relative Humidity | 0.785** | 0.683* | -0.770 | -0.531 | 1.000 | |
| $X_6$ | Rainfall | 0.345* | 0.369 | -0.289 | 0.124 | 0.351 | 1.000 |

** Significant at 0.05 probability level *Significant at 0.01 probability level

**Table 5:** Simple correlation matrix between incidence of *N. lugens* and weather factors during January – March 2014

| | | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ |
|---|---|---|---|---|---|---|---|
| $X_1$ | BPH population | 1.000 | | | | | |
| $X_2$ | Entomopathogenic fungi incidence | 0.903 | 1.000 | | | | |
| $X_3$ | Maximum temperature | -0.355 | -0.149 | 1.000 | | | |
| $X_4$ | Minimum temperature | -.502** | -0.454 | 0.336 | 1.000 | | |
| $X_5$ | Relative Humidity | 0.372* | 0.218 | -0.0 | -0.73 | 1.000 | |
| $X_6$ | Rainfall | 0.276* | 0.256 | -0.167 | 0.079 | -0.189 | 1.000 |

* Significant at 0.05 probability level * Significant at 0.01 probability level

**Table 6:** Simple correlation matrix between incidence of *N. lugens* and weather factors during October 2014 – January 2015

| | | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ |
|---|---|---|---|---|---|---|---|
| $X_1$ | BPH population | 1.000 | | | | | |
| $X_2$ | Entomopathogenic fungi incidence | 0.966 | 1.000 | | | | |
| $X_3$ | Maximum temperature | -0.147 | -0.151 | 1.000 | | | |
| $X_4$ | Minimum temperature | 0.216* | 0.243* | 0.721 | 1.000 | | |
| $X_5$ | Relative Humidity | 0.202* | 0.133 | -0.554 | -0.101 | 1.000 | |
| $X_6$ | Rainfall | 0.048* | 0.027 | -0.204 | 0.1599 | 0.805 | 1.000 |

** Significant at 0.05 probability level *Significant at 0.01 probability level

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