

**SEASONAL OCCURENCE OF MAJOR INSECT PESTS OF RICE GROWN IN  
KRISHNA DELTA REGION OF ANDHRA PRADESH**

**ABSTRACT:**

The investigation on seasonal occurrence of major insect pests of rice grown in Krishna Delta of Andhra Pradesh was conducted during *kharif* 2023-24. Weekly observations on pest population in relation with abiotic factors revealed that the initial and peak incidence of yellow stem borer (YSB) as dead hearts was observed at vegetative stage during SMW 30 and SMW 38 with 0.30% and 5.56% respectively, whereas at reproductive stage the highest and lowest incidence in the form of white ears was observed after panicle emergence at SMW 44 and SMW 42 *i.e.*, 0.33% and 2.20%, respectively. The highest rice leaf folder incidence was recorded at SMW 39 (9.21%) and lowest at SMW 44 (1.00%). The highest and lowest brown planthopper (BPH) mean population was recorded at SMW 39 and SMW 31 and it was 9.60 hoppers/hill and 0.20 hoppers/hill, respectively. On the other hand, highest and lowest white backed planthopper (WBPH) mean population was recorded during SMW 38 and SMW 32 and it was 3.70 and 0.40 hoppers/hill respectively. The YSB showed non-significant negative correlation with maximum temperature and rainfall, while showed non-significant positive correlation with minimum temperature, morning and evening relative humidity. The rice leaf folder population showed non-significant negative correlation with minimum temperature and non-significant positive correlation with maximum temperature, morning and evening relative humidity and rainfall. BPH population showed non-significant negative correlation with maximum and minimum temperature and rainfall, while it was non-significant positive correlation with morning and evening relative humidity. WBPH population showed significant positive correlation with morning relative humidity, non-significant positive correlation with maximum temperature and evening relative humidity and non-significant negative correlation with minimum temperature.

**Keywords:** Abiotic factors, Brown planthopper, Rice leaf folder, Seasonal occurrence and Yellow stem borer.

## 1. INTRODUCTION

Rice, *Oryza sativa* (Poaceae) is the most important crop of the world and second largest cultivated cereal crop after wheat which occupies foremost status in human food requirement. It is cultivated in almost all tropical, subtropical and temperate countries and is the staple food of over half of the world's population and 90 per cent of Asians (Kumar *et al.*, 2023). Raw rice is a good source of nutrients, which contains 7-8% protein, 3% fat, 77-84% carbohydrate, 3% fibre and a good source of thiamine (Vitamin B<sub>1</sub>) and riboflavin (Vitamin B<sub>2</sub>) together with eight essential amino acids (Chaudhari *et al.*, 2018). India is amongst the top most rice producers in the world, second only to China. In AP, paddy cultivation in Krishna district is highly significant growing in an area of 0.31 Mha out of 2.35 Mha in AP. The significant contributions of Krishna rice farmers in food production are recognized by production and productivity of 1.89 MT and 6006 kg ha<sup>-1</sup> respectively (Directorate of Economics and Statistics, 2023).

From seedling to maturity, rice crop is affected by number of various insect pests which causes the severe quantitative and qualitative loss in yield (Patil *et al.*, 2020; Lou *et al.*, 2013). About 100 species of insects have been reported to attack on rice crop in India, out of which, yellow stem borer (YSB) (*Scirpophaga incertulas* Walker), brown planthopper (BPH) (*Nilaparvata lugens* Stal), white backed planthopper (WBPH) (*Sogatella furcifera* Horvath), leaf folder (*Cnaphalocrocis medinalis* Guenee) are very important and can cause 21 to 51 per cent yield loss in different rice agro ecosystems. (Nikhil *et al.*, 2021). The yield loss estimates due to yellow stem borer, leaf folder and brown plant hopper are 25, 10 and 30%, respectively. Among the insect pests, yellow stem borer (YSB), *S. incertulas* (Walker) is the most destructive pest of rice, causing yield losses to the tune of 10-60 per cent every year (Dhaliwal and Singh, 1996).

Weather conditions also play an important role for determining the geographical distribution and periodic abundance of major insect pests in rice (Varsha *et al.*, 2022; Chaturvedi *et al.*, 2024). The infestation of major insect pests of rice depends on the prevailing weather conditions in an area and it also depends on type of variety used. Among the weather factors; temperature, rainfall, relative humidity plays the crucial role in insect life (Yadav *et al.*, 2023). Hence it is necessary to quantify and verify, by the critical experiments, the theoretical relationships, normally proposed in rice insects between the abiotic factors and the population dynamics (Anil kumar *et al.*, 2020). The knowledge of insect-pests population dynamics is essential for developing sustainable

crop protection strategies. Hence, population dynamics of major pests of rice were studied and correlated with the different weather parameters.

## 2. MATERIALS AND METHODS

### Sampling procedure

The study was carried out in Krishna Delta area of Krishna district of Andhra Pradesh during *kharif* 2023-2024. Krishna district is located between 15°-43' and 17°-10' of the Northern Latitude and 80°-0' and 81°-33' of the Eastern Longitude, which occupies first position in the rice growing area across the state (2.45 lakh hectares out of 22 lakh hectares in AP). The data was collected at weekly intervals from sowing to harvesting in 30 farmer fields from five mandals viz., Kankipadu, Penamaluru, Vuyyuru, Thotlavalluru, Gannavaram (Table 1 and Figure 1). Random sampling was done in fixed plots to record the occurrence of various pests in rice ecosystem for the entire crop growth period. For this, each field was hypothetically assumed and marked with X path for collection of data from ten random sampling spots (1 square metre each) using quadrant, and leaving 3 metres distance from the field borders. From each spot all the hills were observed for recording infestation level.

**Recording of Observations:** In terms of standard meteorological weeks (SMWs), the observations on pest data was recorded from 30-45 SMWs (July to November) of 2023 during the crop season and expressed as per cent or number per hill (mean) of all 30 farmer fields. As the farmers have applied pesticides continuously, the correlation of insect pest populations with weather parameters does not yield any clear-cut correlation. But, for general comprehension, the pest data was analysed for their incidence at weekly intervals throughout the season and was correlated with weather parameters. The effect of various weather parameters such as maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall on the incidence of various insect pests was correlated and presented below. For the combined data, multiple linear regression models were also carried out. The weather data during *kharif* 2023-24 was obtained from Agricultural Research Station, Vuyyuru (Table 5).

Rice transplantations was carried out by all farmers in the study area at almost the same time (SMW-28) during *kharif* 2023-24 within a gap of 2-3 days.

**Paddy Yellow Stem Borer (YSB):** The incidence of YSB was recorded in terms of per cent damage by counting the damage done *i.e.*, dead hearts and white ears to total number of tillers and panicles per hill in vegetative and reproductive stages, respectively. The per cent damage was calculated using the below mentioned formula (Justin and Preetha, 2013).

$$\text{Per cent damage (\%)} = \frac{\text{Number of dead hearts or white ears per hill}}{\text{Total number of tillers or panicles per hill}} \times 100$$

**Leaf Folder:** The leaves that had damage symptoms like folded leaves and scratching of chlorophyll by larva were considered to record per cent damage infestation. The extent of damage caused by leaf folder was calculated using the formula presented below (Kumar *et al.*, 1996).

$$\text{Per cent damage (\%)} = \frac{\text{Number of damaged leaves per hill}}{\text{Total number of leaves per hill}} \times 100$$

**Planthoppers (Brown Planthoppers (BPH) and White Backed Planthoppers (WBPH):** The number of nymphs and adults per hill were counted to record the abundance of BPH and WBPH in the field and expressed as population per hill (Justin and Preetha, 2013).

### 3. RESULTS AND DISCUSSION

**Incidence of Yellow Stem Borer:** The incidence of YSB started at tillering stage of the crop and continued till harvest.

**Per cent Dead Hearts during *kharif* 2023-24:** The dead hearts caused due to YSB incidence presented in (Table 2) revealed that, the initial record of dead hearts (0.30 %) was noticed during SMW 30 (23 Jul - 29 Jul 2023) and gradually increased reaching highest per cent of damage (5.56%) during SMW 38 (17 Sep - 23 Sep 2023), during which maximum and minimum temperature ranged from 34.00<sup>0</sup>C and 23.90<sup>0</sup>C, morning and evening relative humidity ranged from 91.43% and 74.00% and rainfall 71.5mm (Table 5). Studies conducted by Kumar *et al.*, (2013), Patel and Singh (2017), Tandon and Srivastava (2018), Pallavi *et al.*, (2018), Jasrotia *et al.*, (2019), Patil *et al.*, (2020),

Sreelatha *et al.*, (2022), Varsha *et al.*, (2022) also reported the peak infestation of YSB (dead hearts) during SMW 38.

The correlation results of dead hearts caused due to YSB with abiotic factors (Table 3) revealed non-significant positive correlation with minimum temperature (0.264), morning relative humidity (0.227) and evening relative humidity (0.449), while showed non-significant negative correlation maximum temperature (-0.084), and rainfall (-0.100). The incidence of dead hearts and abiotic factors were subjected to MLR analysis and the results revealed coefficient of determination ( $R^2$ ) value of 0.715, which indicates that the weather parameters could cause 71.5 % variation in occurrence of dead hearts (Table 4). The above discussed results were in agreement with the findings of Rana *et al.*, (2017), Sreelatha *et al.*, (2022) and Kumar *et al.*, (2023) who reported that minimum temperature, morning and evening relative humidity showed non-significant positive correlation. Similar findings were also reported by Nikhil *et al.*, (2021) and Devi and Varma (2022) who stated that maximum temperature and rainfall showed non-significant negative correlation.

**Per Cent White Ears:** The incidence of white ears (0.70 %) was first noticed after emergence of panicles during SMW 37 (10 Sep - 16 Sep 2023) and reached the peak incidence (2.20 %) during SMW 42 (15 Oct - 21 Oct 2023) (Table 2), during which maximum and minimum temperature ranged from 34.71<sup>0</sup>C and 25.57<sup>0</sup>C, morning and evening relative humidity ranged from 86.86% and 54.86% and rainfall 4.6mm (Table 5). The present results were conferred by Das (2020), Paramasiva *et al.*, (2021), Sreelatha *et al.*, (2022) and Yadav *et al.*, (2023) who also reported the peak infestation of YSB (white ears) during SMW 42.

The correlation results of per cent white ears caused by YSB with abiotic factors (Table 3) revealed non-significant negative correlation with minimum temperature (-0.253), evening relative humidity (-0.150) and rainfall (-0.112), while maximum temperature (0.325) and morning relative humidity (0.329) showed positive non-significant correlation. The incidence of white ears and abiotic factors were subjected to MLR analysis and the results revealed coefficient of determination ( $R^2$ ) value of 0.539, which indicates that the weather parameters could cause 53.9 % variation in occurrence of white ears (Table 4). The findings related to correlation of per cent white ears with abiotic factors were in line with the findings of Appalanaidu *et al.*, (2021) and Morshed *et al.*, (2023) who reported non-significant positive correlation with maximum temperature and non-significant negative correlation with minimum

temperature and evening relative humidity. Ashrith *et al.*, (2017), Sulagitti *et al.*, (2017), Varsha *et al.*, (2022) and Amandeep *et al.*, (2022) who reported non-significant positive correlation with morning relative humidity and non-significant negative correlation with rainfall also support the present findings.

**Incidence of Leaf Folder:** The mean data on leaf folder incidence presented in (Table 2) revealed that, the initial incidence (1.10%) was noticed during SMW 30 (23 Jul - 29 Jul 2023) and gradually increased causing highest per cent leaf damage during SMW 39 (24 Sep - 30 Sep 2023) causing 9.21% leaf damage (Table 2), during which maximum and minimum temperature ranged from 33.43<sup>0</sup>C and 22.00<sup>0</sup>C, morning and evening relative humidity ranged from 88.29% and 66.43% and rainfall 38.20mm (Table 5). The present findings are in accordance with the findings of Kakde and Patel (2015), Netam and Gupta (2015), Gajjar *et al.*, (2017), Thokchom *et al.*, (2018), Rautaray *et al.*, (2020), Das (2020), Seni *et al.*, (2022) and Das *et al.*, (2023) who reported peak infestation of leaf folder during SMW 39.

The correlation results of leaf folder damage with abiotic factors (Table 3) revealed non-significant positive correlation with maximum temperature (0.054), morning relative humidity (0.482), evening relative humidity (0.355) and rainfall (0.003) unlike minimum temperature (-0.331), which showed non-significant negative correlation. The incidence of leaf folder and abiotic factors were subjected to MLR analysis and the results revealed coefficient of determination ( $R^2$ ) value of 0.475, which indicates that the weather parameters could cause 47.5 % variation in leaf folder incidence (Table 4). The above findings with respect to abiotic factors and leaf folder infestation were in line with the reports of Varsha *et al.*, (2022) who stated that maximum temperature, morning relative humidity, evening relative humidity and rainfall showed non-significant positive correlation. Studies conducted by Ashrith *et al.*, (2017), Bumireddy *et al.*, (2018) and Rautaray *et al.*, (2020) reported that correlation of leaf folder incidence with minimum temperature showed non-significant negative correlation.

**Incidence of brown planthopper:** The initial incidence of BPH was noticed at early tillering stage of the crop during SMW 31 (30 Jul - 05 Aug 2023) with 0.20 hoppers/hill and gradually increased where the highest number of hoppers/hill were observed during SMW 39 (24 Sep - 30 Sep 2023) with 9.60 hoppers/hill (Table 2), during which maximum and minimum temperature ranged from 33.43<sup>0</sup>C and 22.00<sup>0</sup>C, morning and evening relative humidity ranged from 88.29% and 66.43% and rainfall 38.20mm (Table 5). Studies carried out by Tetarwal *et al.*, (2016), Das (2020), Mohanta

*et al.*, (2020), Yadav *et al.*, (2023) also reported peak incidence of BPH during SMW 39 which confirms the above findings of the present study.

The results of correlation between BPH and abiotic factors (Table 3) revealed negative non-significant correlation with maximum temperature (0.422), minimum temperature (0.450) and rainfall (0.123), while showed positive non-significant correlation with morning relative humidity (0.184), evening relative humidity (0.323). The incidence of BPH and abiotic factors were subjected to MLR analysis and the results revealed coefficient of determination ( $R^2$ ) value of 0.549, which indicates that the weather parameters could cause 60.8 % variation in leaf folder incidence (Table 4). Verma *et al.*, (2021) and Kumar *et al.*, (2023) had also almost similar findings, that morning relative humidity, evening relative humidity showed positive non-significant correlation and rainfall showed positive non-significant correlation. On the other hand, study conducted by Kumar *et al.*, (2020) that showed negative non-significant correlation with maximum temperature and minimum temperature is in agreement with the present study.

**Incidence of white backed planthopper:** The initial incidence of WBPH started in early tillering stage of the crop during SMW 32 (06 Aug - 12 Aug 2023) with 0.40 hoppers/hill and gradually increased where the highest number of hoppers/hill were observed during SMW 38 (17 Sep - 23 Sep 2023) with 3.70 hoppers/hill (Table 2), during which maximum and minimum temperature ranged from 34.00<sup>0</sup>C and 23.90<sup>0</sup>C, morning and evening relative humidity ranged from 91.43% and 74.00% and rainfall 71.5mm (Table 5). The above finding was similar to the findings of Krishnaiah *et al.*, (2007) at Maruteru, Andhra Pradesh, who reported maximum incidence of WBPH at panicle initiation stage. The results of correlation between WBPH and abiotic factors (Table 3) revealed non-significant positive correlation with maximum temperature (0.089) and evening relative humidity (0.455), while showed non-significant negative correlation minimum temperature (-0.358), rainfall (-0.009) and significant positive correlation with morning relative humidity (0.507\*).

#### 4. CONCLUSION

The research revealed that, the initial occurrence of YSB (0.30%) was observed during SMW 30 and gradually increased reaching highest per cent of damage (5.56%) during SMW 38 and during reproductive stage of the crop white ear head was maximum during SMW 42. The initial occurrence of leaf folder was observed during SMW 30 and

gradually increased causing highest per cent leaf damage during SMW 39 with 9.21% leaf damage. The initial incidence of brown planthopper (*Nilaparvata lugens*) was observed at early tillering stage of the crop during SMW 31 with 0.20 hoppers/hill and gradually increased where the highest number of hoppers/hill were observed during SMW 39 with 9.60 hoppers/hill. The results are benefitting to promote Economic Threshold Level (ETL) among farmers as a result of which unnecessary and irrational usage of pesticides can be reduced.

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### **6. REFERENCES**

- Amandeep, G.S., Verma, P.K., Varma, A and Chaudhary, R. 2022. A study on seasonal incidence of rice stem borer and rice leaf folder in relation to weather factors in basmati rice. *The Pharma Innovation Journal*. 11(7): 3227-3231.
- Anil Kumar, S.T., Sudhakar, S.K., Moulya, M.R., Srinivas, K and RS, M. 2020. Seasonal incidence of major insect pests of rice (*Oryza sativa* L.) and its correlation with weather parameters. 8(6): 1717-1720
- Appalanaidu, N., Kumar, D.A., Dhurua, S and Suresh, M. 2021. Studies on incidence of major lepidopteran pests in rice and its correlation with weather parameters. *The Andhra Agricultural Journal*. 68(2):195-199.
- Ashrith, K.N., Sreenivas, A.G., Guruprasad, G.S., Patil, N.B., Hanchinal, S.G and Chavan, I. 2017. Influence of weather parameters on the occurrence of major

insect-pests in conventional rice ecosystem. *ORYZA-An International Journal on Rice*. 54(3): 324-329.

Bhumireddy, S., Simon, S and Nagar, S. 2018. Seasonal incidence of rice leaf folder, *Cnaphalocrocis medinalis* (Guen) in Allahabad region. *Journal of Pharmacognosy and Phytochemistry*. 7(4): 2528-2530.

Chaudhari, P. R., Tamrakar, N., Singh, L., Tandon, A., and Sharma, D. (2018). Rice nutritional and medicinal properties. *Journal of Pharmacognosy and Phytochemistry*. 7(2): 150-156.

Das, R., 2020. Insect pests associated with rice crop (*Oryza sativa*) at Cachar district of Assam. *International Journal of Current Microbiology and Applied Sciences*. 9(9): 2157-2163.

Devi, R.S and Varma, N.R.G. 2022. Seasonal incidence and effect of weather parameters on yellow stem borer, *Scirpophaga incertulas* (Walker) in rice. *The Pharma Innovation Journal*. 11(4): 1889-1895.

Directorate of Economics and Statistics. Government of Andhra Pradesh. 2023. Agricultural statistics at a glance. *District-wise area, production and yield of principal crops for the year 2021-22 & 2022-23 in Andhra Pradesh*. 40.

Dhaliwal, G.S and Singh, J. 1996. Extent of damage and pattern of emergence from over- wintering larvae of rice stem borer in Punjab. *Indian Journal of Ecology*. 23: 104-108.

Gajjar, S.N., Patel M.B and Shukla, A. 2017. Study on population builds up of rice leaf folder *Cnaphalocrocis medinalis* (Guenee) in relation to weather parameters. *International Journal of Advanced Research*. 5(3): 2215-2218.

Jasrotia, P., Khippal, A., Yadav, J., Kashyap P.L., Kumar, S and Singh, G.P. 2019. Effect of weather variables on the incidence of yellow stem borer (*Scirpophaga incertulas* W.) and leaf folder (*Cnaphalocrocis medinalis* G.) in rice. *Journal of Cereal Research*. 11(3): 247-251.

Justin, C and Preetha, G. 2013. Seasonal incidence of rice yellow stem borer, *Scirpophaga incertulas* (Walker) in Tamil Nadu. *Indian Journal of Entomology*. 75(2): 109-112.

Kakde, A.M and Patel, K.G. 2015. Seasonal incidence of rice leaf folder in relation to SRI and conventional methods of planting and its correlation with weather parameters. *Plant Archives*. 15(1): 121-126.

- Krishnaiah, N.V., Rama Prasad, A.S., Raghavendra Rao, C., Pasalu, I.C., Zaheruddeen, S.M., Varma, N.R.G., Jhansi, V.L., Lakshminarayanamma, V and Lingaiah, T. 2007. Population dynamics of rice Whitebacked planthopper, *Sogatella furcifera* and natural enemies of planthoppers in Godavari Delta of Andhra Pradesh State. *Indian Journal of Plant Protection*. 35(2): 238-242.
- Kumar, A., Kumar, P., Chandra, U., Patel, P.K., Omar, V., Pathak, R and Rajak, R.K. 2023. Abundance of Major Insect Pests in Rice and Their Relation to Weather Parameters. *International Journal of Environment and Climate Change*. 13(8): 752-1760.
- Kumar, P., Singh, R. and Pandey, S.K. 1996. Population dynamics of rice leaf folder, *Cnaphalocrocis medinalis* Guen., in relation to stage of the crop, weather factors and predatory spiders. *Journal of Entomological Research*. 20(3): 205-210.
- Mohanta, K., Raju, S.V.S and Giri, G.S. 2020. Influence of environmental factors on seasonal incidence of sucking pests of rice Pankaj. *Journal of Pharmacognosy and Phytochemistry*. 9(3): 822-825.
- Morshed, M.N., Al Mamun, M.A., Nihad, S.A.I., Rahman, M.M., Sultana, N and Rahman, M.M. 2023. Effect of weather variables on seasonal abundance of rice insects in southeast coastal region of Bangladesh. *Journal of Agriculture and Food Research*. 11:100-513.
- Netam, C.S and Dupla, A.K. 2015. Seasonal incidence of rice leaf folder *Cnaphalocrocis medinalis* (Guen.) in agro climatic condition of Bastar Plateau Zone. *Annals of Plant and Soil Research*. 17(1): 24-28.
- Nikhil, H.K., Jalgaonkar, V.N., Wade, P.S., Naik, K.V., Thantharate, S.H and Kinjale, R.S. 2021. Seasonal incidence of yellow stem borer, *Scirpophaga incertulas* Walker infesting rice and its correlation with weather parameters. *Journal of Entomology and Zoology Studies*. 9(1): 263-266.
- Paramasiva, I., Vineetha, U., Sreelakshmi, C and Rajasekhar, P. 2021. Seasonal incidence and light trap catches of yellow stem borer, *Scirpophaga incertulas* (Walker) in relation to meteorological factors. *The Pharma Innovation Journal*. 10(12): 1831-1834.
- Patel, S and Singh, C.P. 2017. Seasonal incidence of rice stem borer, *Scirpophaga incertulas* (Walker) on different varieties of rice in relation to weather parameters. *Journal of Entomology and Zoology Studies*. 5(3): 80-83.
- Patil, S.D., Kusalkar, D.V., Patil, H.M and Bhoite, K.D. 2020. Seasonal incidence of insect pests on rice and impact of various abiotic factors on their incidence. *Journal of Pharmacognosy and Phytochemistry*. 9(2): 1869-1872.

- Rautaray, B.K., Bhattacharya, S and Dash, S.R. 2020. Effect of weather parameters on the seasonal incidence of rice leaf folder (*Cnaphalocrosis medinalis*, Guenee). *International Journal of Conservation Science*. 8(6): 763-766.
- Sreelatha, E., Sai Prasoon, U., Shailaja, B and Jesu Rajan, S. 2022. Study on seasonal incidence of insect pests in rice (*Oryza sativa* L.) ecological engineering field. *Biological Forum– An International Journal*. 14(2a): 44-49.
- Sulagitti, A., Raghuraman, M., Reddy, M.S. and Sathua, S.K., 2018. Impact of abiotic factors on population fluctuation of major insect pests of rice under Varanasi conditions. *Journal of Experimental Zoology India*. 21(2): 709-712.
- Tetarwal, A.S., Ram, L., Singh, R and Jat, M.K. 2016. Effect of biotic and abiotic factors on the population of brown planthopper, *Nilaparvata lugens* (Stal) in relation to two varieties and planting dates. *ORYZA-An International Journal on Rice*. 53(1): 81-90.
- Thokchom, J., Ray D.C and Singh K.I. 2018. Seasonal incidence of rice leaf folder (*Cnaphalocrosis medinalis* Guenee) and its correlation with environmental factors on rainfed rice crop in Manipur. *International Journal of Current Advanced Research*. 7(4). 12202-12205.
- Varsha, V.J.H., Rao, C.S., Chiranjeevi, C.H., Rao, V.S and Varma, P.K. 2022. Seasonal incidence of major insect pests of rice in Krishna Western Delta region of Guntur district. *The Journal of Research ANGRAU*. 50(4): 20-26.
- Verma, P.K., Singh, H., Singh, B., Singh, R.P and Varma, V. 2021. Population dynamics of brown plant hopper, *Nilaparvata lugens* (Stal.) in basmati rice and its correlation with abiotic factors in western plain zone of Uttar Pradesh. *The Pharma Innovation Journal*. 10(11): 35-38.
- Yadav, P.K., Singh, S.K., Verma, R.K and Singh, S.P. 2023. Impact of Abiotic Factors on the Incidence of Insect Pests in Rice. *International Journal of Environment and Climate Change*. 13(5): 413-421.
- Chaturvedi, Kushal, Sanjay Vaishampayan, Naveen Kumar, Ankit Rai, Akanksha, and Sitaram Seervi. 2024. "Taxonomic Distribution of Major Insect Pest of Rabi Season at Jhansi (U.P.) Using Solar Powered Light Traps". *Journal of Advances in Biology & Biotechnology* 27 (5):684-89. <https://doi.org/10.9734/jabb/2024/v27i5829>.
- Lou YG, Zhang GR, Zhang WQ, Hu Y, Zhang J. Biological control of rice insect pests in China. *Biological Control*. 2013 Oct 1;67(1):8-20.

**Table 1. Details of the farmers selected during *kharif* 2023-2024 in Krishna Delta of Andhra Pradesh**

S. No.	Mandal	Village	Name of the Farmer	GPS Coordinates of the Field
1	Kankipadu	Kankipadu	Srinivasa Rao T	16.44N, 80.77E
2			Arun Kumar T	16.43N, 80.77E
3		Edupugallu	Srinivasa Rao V	16.44N, 80.76E
4			Rama Krishna T	16.45N, 80.77E
5		Kolavennu	Ramesh P	16.45N, 80.77E
6			Sai Babu N	16.44N, 80.76E
7	Penamaluru	Tadigadapa	Azez Sk	16.45N, 80.70E
8			Yasin Sk	16.45N, 80.69E
9		Pedapulipaka	Venkat Ramayya B	16.45N, 80.70E
10			Srinivas Reddy V	16.45N, 80.71E
11		Yanamalakuduru	Ragavayya N	16.45N, 80.70E
12			Imran Md	16.45N, 80.71E
13	Vuyyuru	Gandigunta	Yugendra Prasad N	16.37N, 80.99E
14			Kishore D	16.37N, 80.84E
15		Pedaogirala	Sathish N	16.37N, 80.82E
16			Somasekhar N	16.37N, 80.84E
17		Chinaogirala	Bhupal Reddy R	16.37N, 80.84E
18			Murali P	16.37N, 80.84E

19	Thotlavalluru	Thotlavalluru	Venkat Reddy B	16.35N, 80.79E
20			Prabakhar Reddy B	16.35N, 80.79E
21		Boddapadu	Venkatappa Reddy B	16.36N, 80.77E
22			Koti Reddy k	16.36N, 80.76E
23		Chalivendrapalem	Sagar P	16.34N, 80.79E
24			Shiva Reddy R	16.34N, 80.79E
25	Gannavaram	Mustabada	Karimulla Sk	16.52N, 80.76E
26			Kalil Rahman Sk	16.53N, 80.77E
27		Kesarapalli	Sambasiva Rao K	16.51N, 80.77E
28			Raja Ramesh U	16.50N, 80.74E
29		Purushothapatnam	Chakradhar Rao M	16.52N, 80.76E
30			Madhina saheb Sk	16.52N, 80.76E

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**Table 2. Incidence of insect pests of rice during *kharif* 2022-2023 (Mean of all 30 farmer fields)**

Standard meteorological week (SMW)	Duration	Yellow stem borer		Leaf folder (% leaf damage)	Brown planthopper (hoppers/hill)	White backed planthopper (hoppers/hill)
		% Dead hearts	% White Ears			
SMW30	23 Jul - 29 Jul 2023	0.30	0.00	1.10	0.00	0.00
SMW31	30 Jul - 05 Aug 2023	0.70	0.00	1.31	0.20	0.00
SMW32	06 Aug - 12 Aug 2023	1.00	0.00	2.50	0.70	0.40
SMW33	13 Aug - 19 Aug 2023	2.15	0.00	2.20	2.45	0.90
SMW34	20 Aug - 26 Aug 2023	3.20	0.00	3.15	3.80	1.20
SMW35	27 Aug - 02 Sep 2023	3.93	0.00	3.94	5.40	1.50
SMW36	03 Sep - 09 Sep 2023	4.70	0.00	7.16	8.95	1.96
SMW37	10 Sep - 16 Sep 2023	4.30	0.70	8.02	7.45	2.35
SMW38	17 Sep - 23 Sep 2023	5.56	1.10	8.58	9.20	3.70
SMW39	24 Sep - 30 Sep 2023	0.50	1.23	9.21	9.60	3.15
SMW40	01 Oct - 07 Oct 2023	0.35	0.90	7.02	4.50	1.33
SMW41	08 Oct - 14 Oct 2023	0.00	1.80	4.60	1.80	0.96
SMW42	15 Oct - 21 Oct 2023	0.00	2.20	2.26	1.33	0.80
SMW43	22 Oct - 28 Oct 2023	0.00	0.50	1.24	0.00	0.00
SMW44	29 Oct - 04 Nov 2023	0.00	0.33	1.00	0.00	0.00
SMW45	05 Nov - 11 Nov 2023	0.00	0.00	0.36	0.00	0.00

**Table 3. Correlation between incidence of insect pests of rice and weather parameters during *kharif* 2023-24 in in Krishna Delata area of Krishna district of Andhra Pradesh**

Insect pest	Correlation coefficient (r)				
	Temperature ( $^{\circ}$ C)		Relative humidity (%)		Rainfall (mm)
	Maximum	Minimum	Morning	Evening	
Yellow stem borer (Dead hearts)	-0.084	0.264	0.227	0.449	-0.100
Yellow stem borer (White ears)	0.325	-0.253	0.329	-0.150	-0.122
Leaf folder	0.054	-0.331	0.482	0.355	0.003
Brown planthopper	-0.020	-0.179	0.490	0.484	-0.018
White backed planthopper	0.089	-0.358	0.507*	0.455	-0.009

\*\* Correlation is significant at 0.01 level (2-tailed)

\* Correlation is significant at 0.05 level (2-tailed)

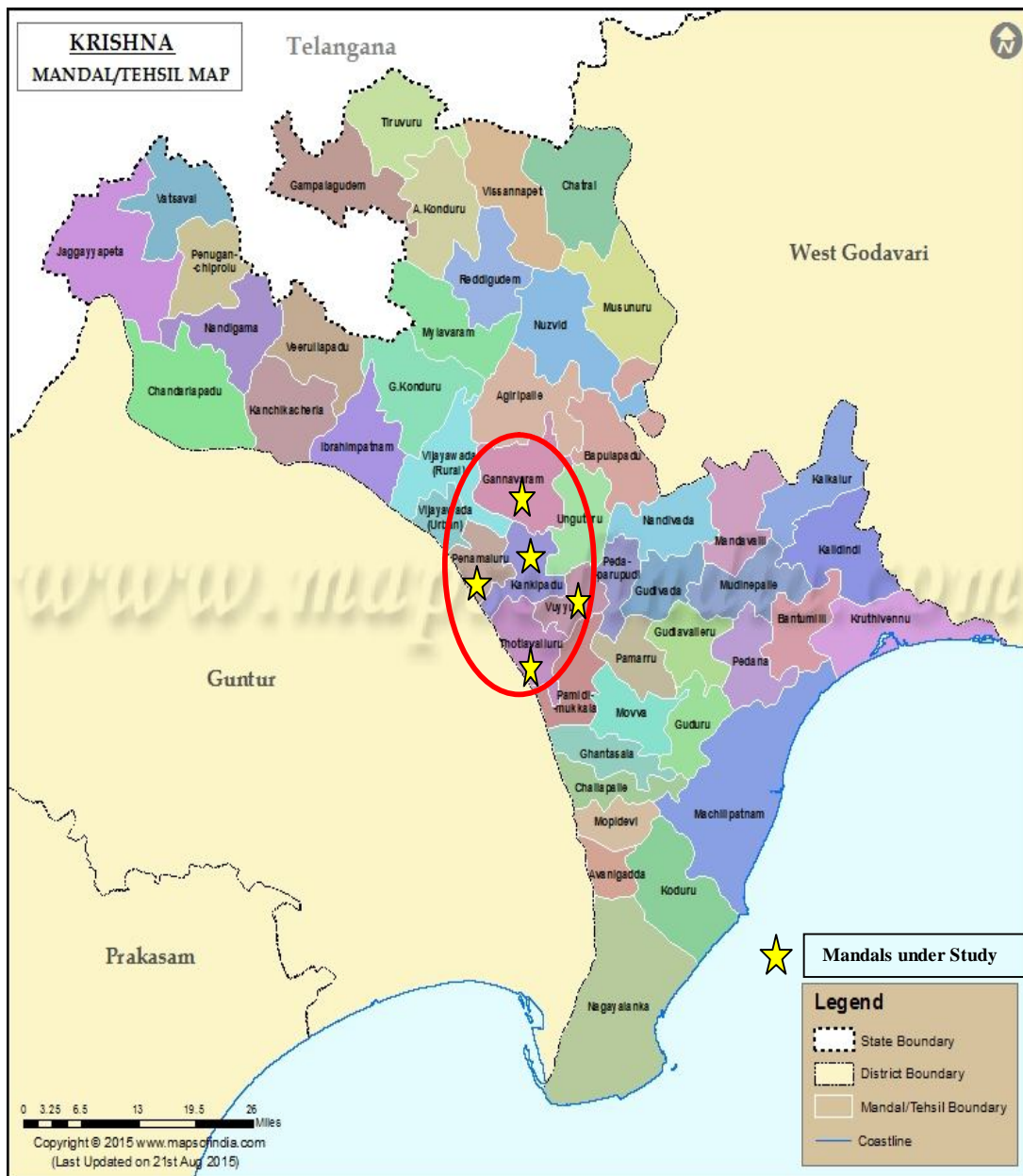
**Table 4. Regression equations for insect pest complex of rice with weather parameters during *kharif* 2023-24 in Krishna Delata area of Krishna district of Andhra Pradesh**

Insect pests	Regression equation	R <sup>2</sup>
Yellow stem borer (Dead hearts)	$Y = -17.265 - 0.271 X_1 + 0.460 X_2 - 0.004 X_3 + 0.285 X_4 - 0.036 X_5$	0.715
Yellow stem borer (White ears)	$Y = -16.040 + 0.282 X_1 - 0.092 X_2 + 0.148 X_3 - 0.055 X_4 + 0.033 X_5$	0.539
Leaf folder	$Y = -50.593 + 0.747 X_1 - 0.643 X_2 + 0.369 X_3 + 0.244 X_4 - 0.031 X_5$	0.475
Brown planthopper	$Y = -53.209 + 0.332 X_1 - 0.219 X_2 + 0.301 X_3 + 0.430 - 0.054 X_5$	0.608
White backed planthopper	$Y = -19.630 + 0.348 X_1 - 0.244 X_2 + 0.089 X_3 - 0.127 X_4 - 0.012 X_5$	0.678

Note:  $X_1$  = Maximum temperature (Mean),  $X_2$  = Minimum temperature (Mean),  $X_3$  = Morning relative humidity (Mean),  $X_4$  = Evening relative humidity (Mean),  $X_5$  = Rainfall (Mean).

**Table 5. Weather data during *kharif* 2023-24 (Source: ARS, Vuyyuru)**

SMW	Date	Maximum Temp. (°C)	Minimum Temp. (°C)	Morning RH (%)	Evening RH (%)	Rainfall (mm)
27	July 02 - Jul 08	33.57	25.57	85.85	60.14	24.00
28	July 09 - Jul 15	32.71	25.42	86.00	65.14	24.9
29	July 16 - Jul 22	30.87	25.57	87.28	74.85	67.4
30	July 23 - Jul 29	30.14	25.00	91.00	78.57	216.5
31	July 30 - Aug 05	34.00	26.70	78.14	59.00	2.0
32	Aug 06 - Aug 12	34.28	26.42	81.85	56.28	4.20
33	Aug 13 - Aug 19	34.00	26.28	83.14	58.42	4.00
34	Aug 20 - Aug 26	34.28	25.85	87.14	67.71	2.20
35	Aug 27 - Sep 02	35.57	26.42	83.42	60.14	0.3
36	Sep 03 - Sep 09	32.42	26.28	89.14	68.71	35.5
37	Sep 10 - Sep 16	32.00	25.86	89.14	68.29	18.00
38	Sep 17 - Sep 23	34.00	23.29	91.43	74.00	71.5
39	Sep 24 - Sep 30	33.43	22.00	88.29	66.43	38.2
40	Oct 01 - Oct 07	34.57	26.29	86.29	52.71	10.9
41	Oct 08 - Oct 14	35.00	26.14	88.86	60.57	13.4
42	Oct 15 - Oct 21	34.71	25.57	86.86	54.86	4.6
43	Oct 22 - Oct 28	34.00	24.14	80.00	50.71	0
44	Oct 29 - Nov 04	33.14	24.43	86.57	58.86	28.1
45	Nov 05 - Nov 11	32.71	24.00	88.14	60.57	27.9
46	Nov 12 - Nov 18	32.71	23.57	83.14	51.57	0.1
47	Nov 19 - Nov 25	32.42	23.85	80.14	61.85	34.8
48	Nov 26 - Dec 02	33.00	22.57	82.28	60.00	0



**Fig 1. Mandals selected for the study in Krishna district of Andhra Pradesh**