Original Research Article

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

ABSTRACT:

The seasonal occurrence of major insect pests of rice in Krishna Delta area of Krishna district of Andhra Pradesh was conducted during kharif 2023-24 in 30 farmers fields of 5 mandals (Kankipadu, Penamaluru, Vuyyuru, Thotlavalluru, Gannavaram). Weekly observations on pest population in parallel relation with abiotic factors revealed that initial incidence of yellow stem borer, *Scirpophaga incertulas* (Crambidae: Lepidoptera) as dead hearts (0.30 %) was noticed during SMW 30 and gradually increased reaching highest per cent of damage (5.57 % dead hearts) during SMW 38. The incidence of white ears (0.70 %) was first noticed after emergence of panicles during SMW 37 and reached the peak incidence (2.20 %) during SMW 42. The initial incidence (1.10 %) of rice leaf folder, *Cnaphalocrocis medinalis* (Crambidae: Lepidoptera) was noticed during SMW 30 and gradually increased causing highest per cent leaf damage during SMW 39 with 9.21 % leaf damage, when the crop is at boot leaf stage. The peak population of brown planthopper, *Nilaparvata lugens* and white backed plant hopper, *Sogatella furcifera* (Delphacidae: Hemiptera) was observed during SMW 39 (9.60 hoppers/hill) and SMW 38 (3.70 hoppers/hill) respectively, when the crop was in panicle initiation stage.

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 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_1) and riboflavin (Vitamin B_2) 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^{-1} 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). About 100 species of insects have been reported to attack on rice crop in India, out of which, yellow stem borer (YSB) (*Scirpophaga incerulas* 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).

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). The infestation of major insect pests of rice depends on the prevailing weather conditions in an area (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 L ha out of 22 L ha in AP). The data was collected at weekly intervals in 30 farmer fields from five mandals *viz.,* Kankipadu, Penamaluru, Vuyyuru, Thotlavalluru, Gannavaram of the study area. Random sampling was done in fixed plots to record the occurrence of various pests in rice ecosystem for the entire crop growth period i.e., from sowing till harvest. 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 SMWs, the observations were recorded from 30-45 SMWs of 2023 during the crop season.

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.

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

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.

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

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.

3. RESULTS AND DISCUSSION

Incidence of Yellow Stem Borer: Yellow stem borer caused damage to the tillers and panicles in vegetative and reproductive stages of the crop, respectively which were represented as percent dead hearts and percent white ears. The incidence of YSB started in tillering stage and continued till harvest.

Per cent Dead Hearts during: The dead hearts caused due to YSB incidence presented in (Table 1) 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 (5.57 %) during SMW 38 (17 Sep - 23 Sep 2023). 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 2) 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 3). 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 1). 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 2) 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 3). 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 data on leaf folder incidence presented in (Table 1) 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 38 (17 Sep - 23 Sep 2023) and SMW 39 (24 Sep - 30 Sep 2023) causing 8.58 % and 9.21 % leaf damage respectively. 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 2) 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 3). 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 38 (17 Sep - 23 Sep 2023) and SMW 39 (24 Sep - 30 Sep 2023) and with 9.20 and 9.60 hoppers/hill respectively (Table 1). 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 2) 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 3). 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 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 1). 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 2) 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 (5.57 %) 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.

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.

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.

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.

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 Dupta, 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*, Gunee). *International Journal of Conservation Science*. 8(6): 763-766.

Sreelatha, E., Sai Prasoona, 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.

Table 1. Incidence of insect pests of rice during *kharif* 2022-2023

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 2. 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 (^{0}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 3. 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^2
Yellow stem borer (Dead hearts)	Y = -17.265 - 0.271 X1 + 0.460 X2 - 0.004 X3 + 0.285 X4 - 0.036 X5	0.715
Yellow stem borer (White ears)	Y = -16.040 + 0.282 X1 - 0.092 X2 + 0.148 X3 - 0.055 X4 + 0.033 X5	0.539
Leaf folder	Y = -50.593 + 0.747 X1 - 0.643 X2 + 0.369 X3 + 0.244 X4 - 0.031 X5	0.475
Brown planthopper	Y = -53.209 + 0.332 X1 - 0.219 X2 + 0.301 X3 + 0.430 - 0.054 X5	0.608
White backed planthopper	Y = -19.630 + 0.348 X1 - 0.244 X2 + 0.089 X3 - 0.127 X4 - 0.012 X5	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).