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Influence of weather parameters on the occurrence of major insect-pests in conventional rice ecosystem

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ABSTRACT

To assess the impact of weather parameters on rice pests, a field experiment was conducted in rice ecosystem during 2013-2014 at Agricultural Research Station, Gangavathi, Koppal district of Karnataka. The rice insect-pests infestation was monitored through light trap catches during 52 standard weeks of the study period and correlated with weather parameters. Results indicated high pest incidence during the months of October (Rabi, 2014). The favourable weather conditions for high incidence of rice leaf folder, leaf and plant hoppers were 38.80ºC mean temperature with a corresponding relative humidity that ranged between 85.30 to 92.80 per cent during the rabi season. The correlation studies made between BPH, WBPH and weather parameters revealed a positive relationship with morning relative humidity (r = 0.04 and r = 0.19) and evening relative humidity (r = 0.09 and r = 0.17), respectively. Whereas, high incidence of yellow stem borer (YSB) was observed in the second fortnight of April with a 37.43ºC and 52.71 per cent mean temperature and relative humidity, respectively. Maximum temperature had a positive effect on male (r= 0.31) and female (r= 0.24) moth of the yellow stem borer population.

Key words: *Meteorological factors, correlation analysis, rice insect pests*

INTRODUCTION

India is one of the world's largest producers of rice (*Oryza sativa* L.), accounting for 20 per cent of the world's production. Rice is India's important cereal crop and is the staple food of people of eastern and southern parts of the country which is cultivated over an area of 44.4 m ha with production of 104.32 m tonnes (Anonymous, 2014). The major reasons for low productivity of rice in India are the losses due to insect-pest, diseases and weeds. Pest alone is responsible for 10-15 per cent yield loss in India (Krishnaiah et al., 2013). The warm and humid environment is essential for rice cultivation, also conducive to the survival and proliferation of insects. More than 100 different species of insects are known as rice pests; out of which about 15 are major economic significance (Teng et al., 1993). These pests occur regularly and ravage the crop from the seedling stage to maturity and few acts as vectors of virus diseases also (Pradhan, 1971). Insects are likely to be affected by the dynamics in weather parameters since they are poikilothermic and these effects can be direct, through the influence of climatic factors on the insect's physiology and behaviouror indirectly mediated by host plants, competitors or natural enemies. The study of agricultural meteorology in relation to insects will be very useful to farmers in all areas, where major insect pests appear year after year and causing serious damage to crops.

The weather parameters are known to have a profound influence on the occurrence, growth and development and population build-up of insect pests in crop ecosystem and ultimately on the extent of damage to the crop and yield loss thereof. Information on the relationship of the prevalence and build-up of different insect pests and their natural enemies with the weather parameters is a prerequisite before formulating a location specific IPM module for management of these pests. For developing any pest management programme for specific agro-ecosystem information on abundance and distribution of pest in relation to weather parameters is a basic requirement (Patel and Shekh, 2006).

The measurement of insect population dynamics poses a practical challenge because of their mobility, variability among individuals and high mortality near the lower and upper threshold levels. It will aid in the development of powerful tools for analyzing eruptive insect population behaviour and response to changing climatic scenario. Hence, a study on the population build-up of insect pests and their natural enemies and their relationship with weather parameters is an essential component of pest management as it generates information which can be utilized to improve cultural, mechanical, behavioural and chemical methods of IPM. With this information, the time of crop sowing/planting can be adjusted so as to avoid the coincidence of the peak insect population with the most susceptible stage(s) of the crop. Keeping this in view the severity of damage by the yellow stem borer, leaf folder, leaf and plant hopper on rice grown in this the part of Gangavathi in Koppal district and the influence of weather factors on their growth, multiplication and distribution, investigations were taken up at the Agriculture Research Station, Gangavathi to study the seasonal influence of weather parameters on the incidence of major rice insect-pests.

MATERIALS AND METHODS

A field experiment was conducted during 2013-2014 at Agricultural Research Station, Gangavathi, Koppal district of Karnataka which is situated at 76°32' E longitude and 15°15' N latitude with an altitude of 419 metre above mean sea level. Trapping and counting of insect pests was done by using a Chinsurah type light trap fitted with 200-watt electric bulb. A wooden box containing bottle having plaster of paris and potassium cyanide is placed under the bulb. The insects that circle around the bulb drop in the wooden box which were collected and counted in the next morning. Thus, trap catches of yellow stem borer (YSB), rice leaf folder, green leafhopper and brown plant hoppers were recorded daily during the rice growing season from July to November in the years from 2013 to 2014 along with daily observations of meteorological variables, *viz.*, temperature (maximum and minimum), rainfall, relative humidity (morning and evening) and sunshine hour. These observations were compiled according to weeks and recorded after taking weekly averages. To predict the impact of weather parameters, correlation studies were used to know about the dynamics of insect pests in relation to time and meteorological variables. The calculated weekly averages of one year observations, including meteorological variables were tabulated for all the four insect pests. For prediction purpose mean trap catches were correlated with above mentioned meteorological variables.

Statistical analysis

Influence of weather parameters *viz.*, mean temperature (ºC), morning relative humidity (%) and total rainfall (mm), were correlated with the catches of yellow stem borer, leaf folder moths, leaf and plant hoppers population collected through light trap.

RESULTS AND DISCUSSION

The results of the correlation studies made between paddy insect pests and weather parameters are presented in the Table 1 and 2.

Yellow stem borer

It is evident from the observations that the maximum temperature had a significant and positive effect on Male (r= 0.31) and female (r= 0.24) moth of yellow stem borer population, whereas there was non-significant, negative effect on population with temperature (r = -0.10 and r = -0.18) and on average rainfall (r = -0.08 and r = -0.03). However, non-significant and positive effect with morning relative humidity (r = 0.04) and significant and positive relationship with evening relative humidity (r = 0.29) was noticed. While, the female moth showed non-significant negative correlation with morning relative humidity (r = -0.10) and evening relative humidity (r = - 0.19) (Table 2). Contrasting results were observed by Leo and Preetha (2013) wherein, Maximum temperature (r= 0.09) and morning relative humidity

Table 1. Monitoring of insect-pests of rice through light trap at ARS, Gangavathi during 2014

ISD weeks	Yellow stem borer moths		Leaf folder moths	Green leafhoppers		Brown plant hoppers	White backed plant hoppers	Temperature (°C)		Rainfall (mm)	Relative humidity (%)	
	Male	Female		N. virescens	N. nigropictus			Max.	Min.		Morn.	Even.
1	20.71	12.86	5.14	6.29	4.85	30.28	19.42	33.10	19.10	0.00	63.90	54.60
2	0.71	1.14	4.29	8.57	8.14	45.71	32.00	30.86	17.57	0.00	67.71	53.71
3	0.57	1.57	3.86	13.00	14.14	58.71	44.00	30.71	15.57	0.00	66.14	41.14
4	0.86	2.00	3.14	18.29	12.00	89.71	73.71	30.50	15.79	0.00	67.57	44.86
5	1.14	2.86	7.86	18.29	13.29	145.29	127.00	30.14	16.14	0.00	59.86	54.00
6	2.14	5.86	10.57	19.71	15.14	212.29	194.57	31.71	19.86	0.00	61.29	52.86
7	4.0	7.43	11.71	20.43	15.86	291.57	257.00	31.57	18.71	0.00	57.29	56.29
8	3.86	7.86	14.14	19.86	16.43	387.29	333.14	32.86	14.14	0.00	64.86	44.29
9	2.86	5.71	23.57	20.43	19.14	484.86	444.86	33.14	12.43	0.00	51.86	35.00
10	4.0	7.57	29.29	25.57	19.57	552.29	496.00	34.43	14.29	0.00	57.14	33.71
11	6.14	8.36	30.14	32.86	22.14	583.14	513.86	34.43	17.00	0.00	62.43	34.14
12	2.14	16.57	28.29	33.43	24.14	603.86	522.86	34.86	16.07	0.00	51.86	34.50
13	11.57	18.43	38.00	30.57	26.29	617.86	494.43	36.14	18.43	0.00	48.57	37.29
14	28.86	36.86	41.14	26.43	20.57	632.14	427.57	36.79	17.71	0.00	52.14	37.57
15	33	42.00	36.29	25.86	19.14	619.71	465.71	37.43	16.71	0.00	52.71	33.71
16	29.86	43.86	37.57	21.71	18.71	636.14	519.57	36.43	16.71	0.00	66.29	40.86
17	25.86	36.43	31.86	16.57	13.86	641.00	480.00	36.86	18.86	0.79	69.43	47.00
18	19.0	25.71	27.71	13.29	12.14	659.43	472.71	39.79	22.29	0.00	59.86	32.86
19	17.86	20.57	18.71	8.29	7.43	636.57	406.86	38.14	22.14	8.64	74.14	42.14
20	11.43	14.14	8.71	9.71	7.29	592.71	365.00	38.64	21.71	0.00	76.71	41.71
21	5.57	9.71	2.00	5.14	6.71	485.57	286.71	37.43	21.57	0.93	75.14	50.00
22	2.14	5.57	0.71	3.00	3.29	222.14	159.71	33.86	17.71	16.43	82.86	76.57
23	2.86	5.71	1.29	2.86	2.43	260.14	154.43	32.14	21.14	1.57	78.57	60.86
26	0.29	1.00	0.43	0.86	0.71	13.14	2.43	33.14	20.14	0.07	79.29	65.29
27	0.86	3.00	0.86	2.00	1.14	12.57	1.86	31.43	20.00	1.00	77.43	70.29
28	0.86	3.71	0.86	2.71	1.29	4.86	1.14	28.29	18.57	0.86	72.86	74.71
29	2.8	6.40	1.60	4.20	2.00	4.40	2.00	40.40	26.20	4.10	113	98.60
30	1.86	5.86	2.43	4.14	2.00	12.29	10.14	28.29	18.14	0.14	76.43	67.43
31	2.0	5.29	3.29	5.43	3.14	31.14	22.00	28.43	18.57	0.07	76.86	69.71
32	3.14	6.00	2.71	4.71	3.86	57.71	33.43	29.71	18.14	0.00	70.14	63.14
33	4.00	5.71	2.14	7.43	6.86	84.71	70.57	29.14	18.57	1.14	75.57	69.71
34	3.43	6.29	2.57	7.71	6.14	114.43	95.71	29.86	18.29	1.93	74.71	64.86
35	3.43	7.43	12.71	10.86	8.00	165.86	145.14	31.57	18.29	0.93	75.86	63.57
36	4.14	6.29	10.14	5.00	4.71	154.29	144.29	29.86	18.43	10.07	81.57	69.86
37	8.14	10.14	27.00	20.00	18.29	382.29	347.43	30.00	17.57	6.00	83.57	63.86
38	8.14	13.14	41.00	21.14	20.71	679.71	658.43	29.86	18.29	0.00	78.00	66.71
39	13.29	17.00	53.14	28.29	24.29	826.71	801.14	30.43	17.57	0.00	72.29	62.00
40	11.57	19.43	69.86	39.57	37.57	1225.25	1177.43	29.86	17.57	0.00	69.29	64.86

Continued.....

41	14.14	27.29	72.21	47.29	45.57	1669.71	1480.71	31.64	17.57	4.290	69.86	60.57
42	17.0	24.29	98.57	59.71	51.86	2310.57	2240.43	30.64	17.29	0.71	67.86	63.43
43	21.99	39.60	166.40	83.40	73.20	365.60	2880.00	38.80	23.90	14.70	92.80	85.30
44	21.00	33.29	114.43	62.43	56.43	2661.00	1637.14	30.64	15.86	0.00	69.43	61.00
45	21.86	32.57	113.71	51.29	45.71	2794.57	1660.86	29.14	15.00	0.00	77.00	55.29
46	22.42	38.57	124.57	35.86	27.57	2843.86	1654.57	28.36	12.93	0.29	72.79	50.00
47	23.0	34.29	87.86	21.14	18.00	2280.71	1477.71	29.50	15.14	0.00	68.43	51.00
48	2.86	31.00	78.00	14.57	11.14	2048.43	1117.14	29.86	15.14	0.00	75.71	50.00
49	21.0	27.14	62.14	10.00	6.86	1642.29	629.14	28.50	12.86	0.00	64.43	43.57
50	14.00	25.86	42.71	5.57	3.43	900.14	349.57	29.64	10.79	0.00	47.57	42.00
51	8.43	16.00	26.86	2.86	2.57	545.14	157.71	28.86	11.57	0.00	63.57	36.71
52	1.75	7.00	8.13	1.25	0.63	128.88	31.50	28.63	13.00	0.00	64.38	46.25

(0.13), had positive correlation with yellow stem borer infestation.

Light trap catches of yellow stem borer moth(both males and females) when correlated with major weather parameters revealed that only maximum temperature showed positive and significant influences. The main reason for this significant effect is because this pest prefers high temperature for multiplication hence, its incidence is more in the rabi/summer season (Fig. 1). The present findings are in confirmation with the report made by Rao and Padhi (1988) who reported significant correlation between pest infestations with maximum temperature. Nandihalli et al. (1990) reported the positive correlation with trap catches and the average maximum temperature and also average morning relative humidity.

Furthermore, the fluctuations in the infestation were recorded, which again reached a second peak during the first week of October (40^{th} SW) with 8.34 per cent white ears. The infestation of yellow stem borer was observed till 42^{nd} SW (3.45% white ear) similar pattern of seasonal incidence was reported by Adiroubane and Raja (2010), Kakde and Patel (2014), Kumar et al. (1995) and Mishra et al. (2012).

Rice leaffolder

Leaffolder population showed negative and non-significant correlation with maximum temperature (r= -0.03) and minimum temperature (r= - 0.21). Whereas, positive and non-significant correlation with average rainfall (r = 0.14), morning relative humidity (r = 0.13) and evening relative humidity (r = 0.11) (Table 2). These findings are in close agreement with the report of Bhaskar (1994), who reported non-significant negative correlation with maximum and minimum temperature, non-significant positive correlation with rainfall and relative humidity.

Green leafhopper

The results of the correlation studies between populations of green leafhopper (*N. virescens*) and weather factors revealed non-significant negative correlation with maximum temperature (r = -0.11), minimum temperature (r = -0.11), average rainfall *(r* = -0.03). While it showed non-significant positive correlation with morning relative humidity (r = 0.18) and evening relative humidity (r = 0.04). Whereas,

Table 2. Correlation between insect pests of rice monitored through light trap and weather parameters during 2014

Weather parameters	Yellow stem borer moth		Leaffolder moth	Green leafhoppers		Brown plant hoppers	White backed planthoppers
	Male	Female		*N. virescens*	*N. nigropictus*		
Maximum temperature (oC)	0.31*	0.24*	-0.03	-0.11	0.02	0.11	0.03
Minimum temperature (oC)	-0.10	-0.18	-0.21	-0.11	-0.25	0.07	-0.09
Rainfall (mm)	-0.08	-0.03	0.14	-0.03	-0.05	-0.14	-0.21
Morning relative humidity(%)	0.04	-0.10	0.13	0.18	-0.08	0.04	0.19*
Evening relative humidity (%)	0.29*	-0.19	0.11	0.04	-0.11	0.09	0.17

*Significant at p = 0.05

correlation between green leafhopper and weather factors revealed that non-significant positive correlation with maximum temperature (r= 0.02) and non-significant negative correlation with minimum temperature (r= -0.25), average rainfall (r= -0.05), morning relative humidity (r=-0.08) and evening relative humidity (r= -0.11) (Table 2). The main reason was humid climate which might have influenced the activity and multiplication of leafhoppers (Fig. 1). The present findings supported with the report of Shamim et al. (2009) who reported that with maximum temperature, minimum temperature and rainfall showed non-significant negative effect on the green leafhopper population.

Planthoppers

It was evident from the data (Table 2), the correlation studies made between BPH, WBPH and weather parameters revealed positive and non-significant relationship with maximum temperature (r = 0.11 and r = 0.03) and minimum temperature (r = 0.07 and r = -0.09) while, non-significant negative correlation was found with an average rainfall (r= -0.14 and r= -0.21) whereas, positive and significant relationship with morning relative humidity (r= 0.04 and r = 0.19) and evening relative humidity (r= 0.09 and r= 0.17), respectively. High humidity probably favours planthopper multiplication because planthoppers are highly adapted to the humid climate. The present findings are in agreement with the reports of Narayansamy et al. (1979) who reported a positive correlation with relative humidity. While Gupta (1981) reported a negative correlation between trap catches and rainfall. This may be due to variation in the weather parameters and their influences on the activity of pest population (Fig. 1).

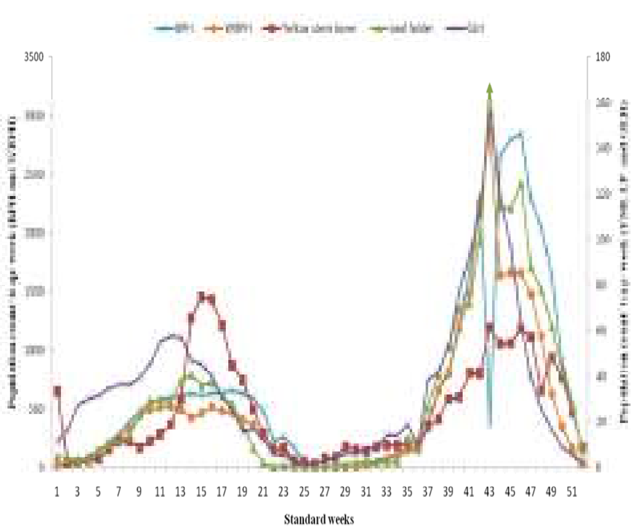

Fig. 1. Population dynamics of rice insect-pests through light trap catches

The incidence of pest during a season varies from region to region as influenced by many factors. Earlier workers reported the peak incidence of BPH from beginning to end of September (Varadharajan, 1979), first week of October (Behera et al., 2010), from last week of August upto third week of September (Firake et al., 2010) whereas, Prashant et al. (2012) observed the maximum number of BPH during November followed by December and October 2009. Two peaks of BPH were reported from China, the first peak appeared in July-August and the second peak appeared in September-October. The results of these earlier workers support the present findings.

CONCLUSION

Various weather parameters such as temperature, rainfall and humidity greatly influence the population dynamics of insect population under changing climatic scenario in different crop ecosystems and for developing any pest management programme for specific agro-ecosystem information on abundance and distribution of pest in relation to weather parameters is a basic requirement, hence the prediction and forewarning correlation studies described in this research paper may be used to predict the dynamics of the paddy pest population while taking management decisions. These considerations may help to reduce certain degree of loss caused by these rice insect pests.

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