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Influence of Weather Parameters on the Occurrence of Major Insect Pests and Diseases of Paddy

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ABSTRACT

A bulk plot of 200 sq m. and a light trap was maintained to study the influence of weather parameters on the occurrence of major insect pests and diseases of Paddy in *kharif*, 2014. During the crop season, leaf folder and leaf blast was observed in field and brown planthopper, green leafhopper and adults of leaf folder were appeared in light trap catches. No significant correlation was observed between weather factors studied with brown planthopper catches and leaf folder infestation. However, green leafhopper catches showed a non-significant and negative correlation with maximum temperature (r = -0.337) and rainfall (r = -0.189) and significant positive correlation with morning (r = 0.478) and evening relative humidity (r = 0.465). Whereas, the leaf folder adult catches in light trap showed a non- significant negative correlation with maximum temperature (r = -0.354), minimum temperature (r = -0.186), rainfall (r = -0.254) and significant positive correlation with morning relative humidity (r = 0.486). Leaf blast incidence showed a significant negative correlation with maximum (r = - 0.560) and minimum temperature (r = -0.631) but, significantly positive correlation (r = 0.672) with morning relative humidity.

Key words: *Diseases, Paddy, Occurrence, Pests, Weather parameters.*

Rice (*Oryza sativa* L.) is the staple food of 65% of the total population of India. It constitutes about 52% of the total food grain production and 55% of total cereal production. India is the largest rice growing country, though China is the largest producer of rice. Out of 722.22 M t production of rice in the world, Asian countries shared 90% (653.83 M t) of world's rice production. While, India contributes 157.90 M t annual production with 22% share of world's production and 24% of Asian countries, contribution of rice production (FAO, 2011). In India, paddy is grown in 44.06 M ha constituting 34.4% of the total cultivable area. About 70% of our farmers are cultivating paddy and the production is about 105.31 M t and the productivity, being 2178 t ha^{-1}. In Andhra Pradesh, it occupied an area of 4.51 M ha with a production of 13.03 M t and productivity of 2891 kg ha^{-1} during 2013-14. (Directorate of Economics and Statistics, 2013-14). Among various constraints of rice production, the insect pests and diseases are of prime importance and are the major limiting factors in getting higher grain yield. The hot and humid environment wherein rice is grown is highly conducive for proliferation of insect pests resulting in serious outbreak. Weather factors regulate insect pest populations under field circumstances (Hyslops, 1941). Under Indian conditions, though paddy is attracted by a wide range of insect pests as compared to any other crop, scanty information is available on the incidence and population build-up of rice pests under varying agro-climatic conditions (Sharma *et al*., 2004). Therefore the present investigation was taken to study the influence of weather parameters on the occurrence of major pests and diseases of Paddy.

MATERIAL AND METHODS

Most popular and widespread variety of rice BPT 5204 (*Samba mashuri*) was raised without any insecticidal application in College Farm of Agricultural College, Bapatla during *kharif*, 2014 with an area of 200 sq m. All the field operations were carried out following standard agronomic practices. The field data on various insect pests and natural enemies in the plot were recorded randomly on 50 hills per plot at three day intervals. Data was recorded when the pest and natural enemies activity was high (early hours at 6.00 AM). A light trap with 200 Watt bulb was installed on the field bund. The data on various pests was collected daily and simultaneously, the weather data prevailed was recorded. However, the data pertaining to blast and sheath blight incidence was collected randomly from 20 sampling units each of one sq. m area in standard weeks for seasonal incidence.

Assessment of leaf folder infestation:

The data thus collected with reference to rice leaf folder damage was converted into per cent leaf damage by adopting the following formula:

$$\text{Leaf folder per cent infestation} = \frac{\text{Number of damaged leaves per hill}}{\text{Total number of leaves per hill}} \times 100$$

Assessment of leaf blast: The data obtained with regard to blast incidence (score) following the SES (Standard Evaluation Scale) (IRRI, 1996) following 0-9 scale was converted into per cent disease index by using the formula:

$$\text{Per cent disease index} = \frac{\text{Sum of all disease rating}}{\text{Total number of rating} \times \text{maximum disease grade}} \times 100$$

RESULTS AND DISCUSSION

Correlation of Weather Factors with Leaf folder Incidence:

The initial incidence of leaf folder infestation started during 39th standard week with 12.95 per cent leaf folder infestation, after which the infestation decreased upto 42nd standard week and then increased gradually upto 48th standard week with 18.31 per cent leaf folder infestation per 50 hills. Later, the infestation declined and reached to minimum during 49rd standard week with 8.10 per cent infestation per 50 hills. (Table: 1). The correlation analysis between weather factors and leaf folder incidence revealed that, there was a no significant correlation between leaf folder infestation and maximum temperature (r = -0.088), minimum temperature (r = -0.009), rainfall (r = 0.296), morning relative humidity (r = 0.232) and evening relative humidity (r = 0.400). (Table 2). The data on leaf folder infestation and weather factors were subjected to multiple linear regression analysis and the following equation was obtained (Table: 3).

$$Y= -0.3295 + 0.1814\ X_1 -0.3609\ X_2 +0.0874\ X_3 + 0.7662\ X_4+0.3045\ X_5$$

Thus, it was observed that the coefficient of determination (R^2) for leaf folder infestation was 0.2008 which indicated that the abiotic factors were able to cause the variation in leaf folder infestation to the extent of 20.08 per cent only. These observations are similar to the results of Ahmed *et al.* (2010) who reported that mean maximum and minimum temperatures had no influence on leaf folder infestation.

Correlation of Weather Factors with Blast Severity:

The leaf blast incidence was started during 43rd standard week with 1.55 per cent severity, and gradually increased and reached a peak during 48th standard week with 14.66 per cent per 50 hills. Later, the incidence has declined gradually and reached

Paddy blast scoring scale used in the experiment.

SCALE	PARTICULARS/ SYMPTOMS
0	No lesions
1	Small brown specks of pinhead size
2	Larger brown specks
3	Small, roundish to slightly elongated, necrotic grey spots, about 1-2 mm in diameter, with brown margin
4	Typical blast lesions elliptical, 1-2 cm long, usually confined to the area of the two main veins infecting less than 2% of the leaf area
5	Typical blast lesions infecting less than 10% of the leaf area
6	Typical blast lesions infecting 11-25% of the leaf area
7	Typical blast lesions infecting 26-50% of the leaf area
8	Typical blast lesions infecting 51-75% of the leaf area and many leaves dead
9	All leaves dead

(IRRI, 2006)

Table 1. Damage by leaf folder and incidence of blast during *kharif,* 2014.

S. No.	Standard Week	Leaf folder damage (%)	Blast disease severity (%)	Temp. Max. (^{0}C)	Temp. Min. (^{0}C)	Rain-fall (mm)	RH Mor. (%)	RH Eve. (%)
1	37 (10-16th Sep)	0.00	0.00	35.70	24.98	4.24	76.00	73.00
2	38 (17-23rd Sep)	0.00	0.00	32.05	24.02	12.08	84.57	78.28
3	39 (24-30th Sep)	12.95	0.00	33.78	25.72	0.00	80.57	74.14
4	40 (01-07th Oct)	10.89	0.00	33.27	24.76	3.00	82.42	73.00
5	41 (08 -14th Oct)	5.89	0.00	34.18	25.70	1.40	82.57	73.43
6	42 (15-21st Oct)	8.39	0.00	36.82	24.44	1.20	72.42	66.57
7	43 (22-28th Oct)	10.56	1.55	32.00	22.78	19.60	83.14	75.29
8	44 (29-4th Nov)	10.34	5.77	30.55	21.61	141.20	85.85	75.29
9	45 (05-11th Nov)	14.74	8.88	30.28	20.81	0.00	83.85	68.57
10	46 (12-18th Nov)	15.47	8.22	30.51	22.01	34.50	84.71	73.57
11	47 (19-25th Nov)	17.34	13.55	30.74	20.30	76.00	91.14	80.29
12	48 (26- 2nd Dec)	18.31	14.66	30.41	17.65	0.00	88.57	75.57
13	49 (03-09th Dec)	8.10	12.66	30.27	17.91	0.00	87.14	64.86
14	50 (10-16th Dec)	0.00	6.22	30.58	18.20	0.00	87.05	67.40
15	51 (16-23rd Dec)	0.00	2.55	29.34	20.97	0.00	85.28	68.59
16	52 (24-30th Dec)	0.00	0.00	29.31	16.30	0.20	86.12	65.37

Table 2. Correlation between rice leaf folder infestation with abiotic and biotic factors during *kharif* – 2014.

Variable	CorrelationCo-efficient (r)
X_1- Maximum temperature (^{0}C)	-0.088
X_2-Minimum temperature (^{0}C)	-0.009
X_3-Morning relative humidity (%)	0.232
X_4- Evening relative humidity (%)	0.400
X_5- Rain fall (mm)	0.296

r_{tab} (14,0.05)=0.497 r_{tab} (14,0.01)=0.62

Table 3. Multiple linear regressions – interaction of rice leaf folder infestation with abiotic factors during *kharif* - 2014.

Variable	Regression Coefficient (r)	Standard error (B)	t-value
X_1- Maximum temperature (^{0}C)	0.398	2.196	0.1814
X_2-Minimum temperature (^{0}C)	-0.477	1.322	-0.3609
X_3-Morning relative humidity (%)	0.106	1.220	0.0874
X_4- Evening relative humidity (%)	0.583	0.761	0.7662
X_5- Rain fall (mm)	0.017	0.058	0.3045

Intercept (a) = -0.453 F (cal) = 5.025

Percentage of variation attribute to the regression (R^2) = 20.08 %

* Significance at 5 %

Table 4. Correlation between rice leaf blast with abiotic factors during *kharif* – 2014.

Variable	CorrelationCo-efficient (r)
X_1- Maximum temperature (^{0}C)	-0.560*
X_2-Minimum temperature (^{0}C)	-0.631**
X_3-Morning relative humidity (%)	0.672**
X_4- Evening relative humidity (%)	0.100
X_5- Rain fall (mm)	0.255

r_{tab} (14,0.05)=0.497 r_{tab} (14,0.01)=0.62

Table 5. Multiple linear regressions – interaction of rice leaf blast infestation with abiotic factors during *kharif,* 2014.

Variable	Regression Coefficient (r)	Standard error (B)	t-value
X_1- Maximum temperature (^{0}C)	1.058	1.310	0.807
X_2-Minimum temperature (^{0}C)	-1.192	0.788	-1.511
X_3-Morning relative humidity (%)	0.625	0.035	0.858
X_4- Evening relative humidity (%)	0.176	0.727	0.389
X_5- Rain fall (mm)	0.014	0.454	0.404

Intercept (a) = -0.685 F (cal) = 2.702

Percentage of variation attribute to the regression (R^2) = 57.47 %

* Significance at 5 % level

minimum during 51st standard week with 2.55 per cent per 50 hills (Table 1).

The correlation analysis between weather factors and leaf blast severity revealed that, there was a significant and negative correlation with maximum temperature (r = - 0.560) and minimum temperature (r = -0.631) whereas, a significant and positive correlation was observed with morning relative humidity (r = 0.672) (Table 4). The data on leaf blast severity and weather factors were subjected to multiple linear regression (MLR) analysis and the following equation was obtained (Table 5)

$$Y= -0.8355+ 0.807 X_1 -1.511 X_2 + 0.858 X_3 +0.389 X_4+ 0.404 X_5$$

Thus it was observed that the coefficient of determination (R^2) for leaf blast was 0.5747 which indicated that the abiotic factors were able to cause the variation in leaf blast incidence to the extent of 57.47 per cent. There was no significant influence of individual weather parameter in development of disease. These results are in conformity with the findings of Kapoor *et al.* (2004) and Paatro and Madhuri (2014) who reported that mean relative humidity and rainfall will have positive impact on development of blast disease.

Natural enemies: Among the natural enemies, spiders, dragonflies and damselflies have dominated the ecosystem. The number of spiders ranged from 1.00 to 21.00 per 50 hills whereas, damselflies ranged from 5.00 to 16.00 per 20 hills . However, the population of dragonfly was less compared to both spiders and damsel flies and ranged from 1.00 to 18.00 per 20 hills (Table 6).

Correlation of Weather Factors with Light trap Catches:

Brown planthopper:

In light trap, the BPH catches started appearing from 25th October (15.00), gradually increased and attained peak during 9th November (5400) and then decreased gradually upto 24th

Table 6 Incidence of BPH, GLH and Leaf folder during *kharif* 2014 (light trap) and natural enemies (field).

Day of Obser-vation	Light Trap catches			Natural enemies			Temp. Max. (^0C)	Temp. Min. (^0C)	Rain fall (mm)	RH (Mor) (%)	RH (Eve) (%)
	Brown plant hopper	Green leaf hopper	Leaf folder	Spider	Dragon fly	Dam-sel fly					
16-Oct	0.00	0.00	0.00	0.00	1.00	5.00	41.97	25.47	6.37	81.67	79.33
19-Oct	0.00	0.00	0.00	4.00	3.00	6.00	32.77	23.57	0.13	85.00	74.67
22-Oct	0.00	0.00	0.00	2.00	3.00	6.00	32.90	23.80	0.03	80.33	71.00
25-Oct	15.00	0.00	0.00	0.00	2.00	7.00	32.93	22.93	7.43	83.33	74.33
28-Oct	91.33	0.00	0.00	3.00	2.00	5.00	29.37	21.87	39.63	90.33	78.00
31-Oct	390.67	11.33	0.00	4.00	5.00	5.00	31.17	21.23	0.00	83.67	66.00
03-Nov	846.67	31.67	0.00	15.00	6.00	16.00	30.80	21.77	56.22	82.67	71.00
06-Nov	2473.33	25.33	1.33	13.00	4.00	10.00	30.93	19.37	0.00	82.67	70.00
09-Nov	**5400.00**	64.00	0.00	10.00	8.00	9.00	31.30	19.90	0.00	83.67	72.67
12-Nov	3000.00	581.00	3.00	21.00	14.00	12.00	29.70	22.30	11.50	91.67	79.33
15-Nov	880.00	**2328.67**	1.00	16.00	8.00	8.00	29.37	22.37	6.40	90.67	84.00
18-Nov	526.67	1097.67	6.67	14.00	18.00	8.00	31.40	21.40	18.93	91.00	76.00
21-Nov	409.33	949.00	3.33	12.00	6.00	5.00	31.23	23.73	0.00	88.33	77.67
24-Nov	156.33	886.00	6.00	15.00	4.00	5.00	30.60	20.17	0.00	90.00	76.67
27-Nov	307.67	224.67	0.00	11.00	4.00	12.00	30.10	18.83	0.00	87.33	64.67
30-Nov	1392.33	301.33	2.00	11.00	16.00	10.00	29.97	18.13	0.00	87.33	66.67
3-Dec	**2145.00**	404.00	1.00	18.00	4.00	15.00	31.00	16.80	38.10	86.67	63.33
6-Dec	855.00	458.00	5.00	8.00	5.00	12.00	30.57	17.63	0.00	88.67	67.00
9-Dec	1197.67	1211.23	6.67	18.00	8.00	12.00	30.47	19.27	0.00	86.67	71.50
12-Dec	1928.00	4400.00	**20.00**	21.00	15.00	8.00	28.67	21.03	0.67	90.67	83.00
15-Dec	1087.33	**4731.33**	10.67	20.00	3.00	14.00	29.63	20.87	0.00	87.67	76.33
18-Dec	906.00	615.33	6.67	11.00	3.00	6.00	30.93	19.67	0.00	88.33	74.67
21-Dec	381.33	20.33	5.00	4.00	2.00	0.00	29.17	16.23	0.00	83.67	53.33

November (156.33) and again the population increased gradually and attained 2^{nd} peak during 3^{rd} December (2145) and gradually decreased towards the end of the season. (Table 6).

The correlation analysis between weather factors and brown planthopper population revealed that, there was no significant correlation existing between brown planthopper population catches and maximum temperature (r = -0.240), minimum temperature (r = -0.297), rainfall (r = 0.028), morning relative humidity (r = 0.053) and evening relative humidity (r = 0.029) (Table 7). These results were in conformity with Krishnaiah *et al.* (2006) who reported that there was no correlation existing between maximum temperature, rainfall, morning and evening relative humidity with the light trap catches of brown planthopper. The data on brown planthopper population and weather factors were subjected to multiple linear regression (MLR) analysis and the following equation was obtained (Table 8)

$$Y= 2.050-0.624 X1 -2.727^* X_2 -2.074 X_3 +2.682^* X_4 + 0.057 X_5$$

Thus, it was observed that the coefficient of determination (R^2) for brown planthopper catches was 0.367 which indicates that the abiotic factors were able to cause variation in brown planthopper population upto to the extent of 36.72 per cent. It was also observed from the MLR equation that among the abiotic factors studied, the partial regression coefficient (b) of brown planthopper was significant and negatively correlated (-2.727) with minimum temperature and significant and positively correlated with evening relative humidity (2.682). Therefore, it was evident that for every one per cent decrease in minimum temperature or increase in evening relative humidity will lead to increase of 2.7 per cent of brown planthoppers.

Table 7. Correlation between brown planthopper population with abiotic and biotic factors during *kharif* – 2014.

Variable	CorrelationCo-efficient (r)
X_1- Maximum temperature (^{0}C)	-0.240
X_2-Minimum temperature (^{0}C)	-0.297
X_3-Morning relative humidity (%)	0.053
X_4- Evening relative humidity (%)	0.029
X_5- Rain fall (mm)	-0.028

r_{tab} (14,0.05)=0.413 r_{tab} (14,0.01)=0.523

Table 8. Multiple linear regressions – interaction of brown plant hopper with abiotic factors during *kharif* - 2014.

Variable	Regression Coefficient (r)	Standard error (B)	t-value
X_1- Maximum temperature (^{0}C)	-0.833	0.133	-0.624
X_2-Minimum temperature (^{0}C)	-0.591	0.216	-2.727*
X_3-Morning relative humidity (%)	-0.258	0.124	-2.074
X_4- Evening relative humidity (%)	0.206	0.076	2.682*
X_5- Rain fall (mm)	0.909	0.015	0.057

Intercept (a) = 23.313 F (cal) = 1.973

Percentage of variation attribute to the regression (R^2) = 36.72 %

* Significance at 5 % level

Green leafhopper:

In light trap, the green leafhoppers catches started appearing from 31st October (11.33), gradually increased and attained peak during 15th November (2328.67) and then the population decreased gradually upto 27th November (224.67). The catches increased gradually and attained 2nd peak during 15th December (4731.33) and thereafter decreased towards the end of the season. (Table 5)

The correlation analysis between weather factors and green leafhopper population revealed that, there was a significant and positive correlation with morning (r = 0.478) and evening relative humidity (r = 0.465) whereas, the correlation was non-significant with maximum temperature (r = -0.337) and rainfall (r = -0.189) at 5% (Table 9). The data on green leafhopper population and weather factors were subjected to multiple linear regression analysis and the following equation was obtained. (Table 10)

$$Y= 0.2676 -1.227 X_1 -1.201 X_2 -0.402 X_3 +2.291^* X_4 -1.125 X_5$$

Thus, it was observed that the coefficient of determination (R^2) for green leaf hopper was 0.4823 which indicated that the abiotic factors were able to cause the variation in green leafhopper catches upto to the extent of 48.23 per cent (Table 10). It was also observed from the MLR equation that among the abiotic factors studied; the partial regression coefficient (b) of green leafhopper was significant and positive with evening relative humidity. Therefore, it was evident that for every one per cent increase in evening relative humidity lead to increase of 2.29 per cent of green leafhoppers catches. These results are in corroboration with Singh *et al.* (2007) who reported that a positive correlation exists between insect population and weather *i.e.,* fall in the minimum temperature and rise in evening relative humidity.

Table 9. Correlation between rice green leafhopper population with abiotic and biotic factors during *kharif* – 2014.

Variable	CorrelationCo-efficient (r)
X_1- Maximum temperature (^{0}C)	-0.337
X_2-Minimum temperature (^{0}C)	-0.025
X_3-Morning relative humidity (%)	0.478*
X_4- Evening relative humidity (%)	0.465*
X_5- Rain fall (mm)	-0.189

r_{tab} (14,0.05)=0.413 r_{tab} (14,0.01)=0.523

Table 10. Multiple linear regressions – interaction of rice rice green leafhopper population with abiotic factors during *kharif* - 2014.

Variable	Regression Coefficient (r)	Standard error (B)	t-value
X_1- Maximum temperature (^{0}C)	-0.154	0.125	-1.227
X_2-Minimum temperature (^{0}C)	-0.245	0.204	-1.201
X_3-Morning relative humidity (%)	-0.047	0.117	-0.402
X_4- Evening relative humidity (%)	0.165	0.072	2.291*
X_5- Rain fall (mm)	-0.016	0.014	-1.125

Intercept (a) = 2.8645 F (cal) = 3.167
Percentage of variation attribute to the regression (R^2) = 48.23%
* Significance at 5 % level

Leaf folder adult population:

In light trap catches the leaf folder adults started appearing from 6th November (1.33) and gradually increased towards the end of crop season and attained peak at 12th December (20) and decreased towards the end of crop season. (Table 1)

The correlation analysis between weather factors and leaf folder adult population revealed that there was a non-significant and negative correlation with maximum temperature (r = -0.354), minimum temperature (r = -0.186), rainfall (r = -0.254) and non-significant positive correlation with evening relative humidity (r = 0.268). Significant and positive correlation was observed with morning relative humidity (r = 0.486) (Table 11). The data on leaf folder adult population and weather factors were subjected to Multiple linear regression analysis and the following equation was obtained (Table 12)

$$Y= -0.091-0.475 X_1 -1.545 X_2 +0.139 X_3 +1.722 X_4 -1.362 X_5$$

Thus, it was observed that the coefficient of determination (R^2) for green leaf hopper was 0.4280 which indicated that the abiotic factors were able to cause the variation in leaf folder adult population upto an extent of 42.80 per cent. There was no significant influence of individual weather parameters on leaf folder adult population. These results were in agreement with Khan and Ramamurthy (2004) who reported that maximum temperature, minimum temperature had negative impact on adult numbers, while, the morning relative humidity had positive impact. Chakraborty and Chandradeb (2011) also reported that maximum humidity imparts positive impact on leaf folder numbers.

From the aforesaid studies, it is clear that almost all the insect pests of rice appeared in the month of October due to prevalence of maximum temperatures during the early season of crop growth period and low relative humidity prevalence during August and September months. The activities of

Table 11.Correlation between rice leaf folder adult population with abiotic and biotic factors during *kharif* – 2014.

Variable	CorrelationCo-efficient (r)
X_1- Maximum temperature (^{0}C)	-0.354
X_2-Minimum temperature (^{0}C)	-0.186
X_3-Morning relative humidity (%)	0.486*
X_4- Evening relative humidity (%)	0.268
X_5- Rain fall (mm)	-0.254

r_{tab} (14,0.05)=0.413 r_{tab} (14,0.01)=0.523

Table 8. Multiple linear regressions – interaction of brown plant hopper with abiotic factors during *kharif* - 2014.

Variable	Regression Coefficient (r)	Standard error (B)	t-value
X_1- Maximum temperature (^{0}C)	-0.002	0.047	-0.475
X_2-Minimum temperature (^{0}C)	-0.119	0.077	-1.545
X_3-Morning relative humidity (%)	-0.061	0.044	0.139
X_4- Evening relative humidity (%)	0.047	0.027	1.722
X_5- Rain fall (mm)	-0.007	0.005	-1.362

Intercept (a) = -3.710 F (cal) = 2.544

Percentage of variation attribute to the regression (R^2) = 42.80%

* Significance at 5 % level

pests started with rise in relative humidity and fall in maximum temperature during November and decreased gradually during December month. The correlation, with weather factors, brown planthopper catches and leaf folder infestation under field conditions was non-significant. The green leaf hopper catches in light trap were maximum during 2nd fortnight of November to 2nd fortnight of December. A significant and positive correlation existed between green leafhopper trap catches and relative humidity (both morning and evening) and the correlation was non-significant with other weather parameters. The leaf folder adult catches were peak during 1st fortnight of December which had a non- significant correlation with maximum temperature, minimum temperature and rainfall whereas a significant and positive correlation with morning relative humidity. Leaf blast severity attained peak during 48th standard week (November 26th -2nd December) and had a significant and negative correlation with maximum and minimum temperature whereas, the correlation was significant and positive with morning relative humidity.

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