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Research Article

Correlation of weather parameters with the incidence of Entomopathogenic fungi, *Zoophthora radicans* Brefeld (Batko) in Cuddalore District

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Abstract

Preliminary surveys were conducted in different spots of Cuddalore district to identify the hot spot of infection percentage of entomopathogenic fungi, *Zoophthora radicans* on rice leaf folder during 2011-2012 and 2012-2013. Confirmative studies during 2013-2014 reveals that maximum percentage of infection was noticed in Annamalainagar of Cuddalore district and selected as hot spot and it was compared with weather parameters during 2012-2013 and 2013-2014. Correlation and regression studies were conducted in 2012-2013 and 2013-2014 to correlate weather parameters of Annamalainagar with incidence of entomopathogenic fungi. Interaction of leaf folder infection percentage with weather parameters revealed that significant relationship was observed between minimum temperature and relative humidity, where as rainfall exhibited negative influence on the cadaver population. The wide spread occurrence of *Z. radicans* on the leaf folder larvae in regions like Cuddalore district reveals the adaptability and potentiality of the fungus under field conditions.

Keywords: Entomopathogenic fungi, *Zoophthora radicans*; leaf folder larvae .

Introduction

Rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) is one of the most important insect pests in Indian subcontinent (Gunathilagaraj and Gopalan, 1986). This pest has been reported to attain the major pest status in important paddy growing areas (Murugesan and Chelliah, 1987). Bhanu and Reddy (2008) reported that the leaf folder affected the crop adversely under favourable conditions causing 60% loss in India. The synthetic chemical pesticides have been the widely used approach to reduce the estimated 45% gross crop

loss due to pests and diseases that amounted to 290 billion rupees per annum. More and more quantities of synthetic pesticides are being used for agricultural intensification to feed on ever growing population. As the most of insecticides are banned, it becomes inevitable to find alternate, viable and effective biopesticides.

The bio pesticides play an important role in future pest management programme. But the over dependence on chemical pesticides and eventual

uninhibited use of them has necessitated for alternatives mainly for environmental concerns. Therefore, an ecofriendly alternative is the need of the hour. Biopesticides or biological pesticides based on pathogenic microorganisms specific to a target pest offer an ecologically sound and effective solution to pest problems. They pose less threat to the environment and to human health.

Philip Sridhar (1988) and Hariprasad (1999) reported that the peak population of leaf folder was recorded at higher RH. It was evident that a range of 85-95 per cent RH would be conducive in this coastal region for the rapid buildup of leaf folder population. With this background, present study was conducted to correlate the percentage of infection with the weather parameters.

Materials and Methods

Field surveys were taken in different places of Cuddalore district during November-February of 2011-2014. Diseased cadavers were gathered during early morning hours between 6.00 and 8.00 am. Fresh cadavers of different pathogenic forms with characteristics of the original specimen were gathered both from the rice fields and each specimen was kept in a clear, sterile plastic vial and tightly packed following usual precaution to avoid contamination. The preliminary surveys were conducted during 2011 - 2012 and 2012 - 2013 to identify hot spot of Cuddalore district. Confirmative surveys were also conducted during 2013 - 2014 to identify the hot spots and also to confirm the results of preliminary survey. Data on incidence percentage of entomopathogenic fungi were collected at fortnight intervals from hot spots between November- February of 2013 - 2014 and correlated with weather parameters. Cadavers thus collected were stored in sterile petriplate and glass vials with proper labeling. Weather parameters like maximum temperature, minimum temperature, relative humidity, rainfall from hot spot area of Cuddalore district were collected at fortnight intervals from meteorological stations, compared with percentage of infection. Correlation and regression analysis were done and results were tabulated. *Z. radicans* was isolated from cadavers

of *C. medinalis*. Fungi isolated were then subjected to pathogenicity, cultural characteristics, resting spore production and formulation.

Results and Discussion

Preliminary surveys were undertaken to collect naturally occurring entomopathogenic fungi on rice leaf folder from rice fields. Places like Annamalainagar, B. Mutlur, Sethiathoppu, Bhuvanagiri and Periyapattu were surveyed at fortnight intervals during samba season of 2011 - 2012 and 2012 - 2013. Survey showed that highest infection percentage was noticed during first fortnight of January (89.00%) 2012 (2011-2012) and second fortnight of December (92.00%) 2013 (2012-2013) in Annamalainagar. In 2011-2012, among the five places surveyed in the Cuddalore district, overall infection percentage of leaf folders were maximum at Annamalainagar (64.12%) followed by B. Mutlur (58.75%), Periyapattu (55.00%), Bhuvanagiri (54.50%) and Sethiathoppu (45.80%) respectively. In 2012 - 2013, among the five places surveyed in the Cuddalore district, overall infection percentage of leaf folder was maximum at Annamalainagar (65.25%) followed by B. mutlur (59.75%), Periyapattu (54.00%), Bhuvanagiri (52.87%) and Sethiathoppu (48.00%). So hot spot in cuddalore district was selected and confirmative survey was made during 2013 - 2014 and it confirmed the survey results of 2011 - 2012 and 2012 - 2013. Finally, Annamalainagar of Cuddalore district selected as hot spot. Incidence of entomopathogenic fungi on the rice leaf folder larvae in Annamalainagar were compared with weather parameters.

Multiple correlations between minimum temperature and infection percentage in Annamalainagar during 2012 - 2013 were highly significant (- 0.724) followed by RH (0.849) indicating that these factors exhibited definite and appreciable influence on the infection percentage. However, correlation with rainfall (- 0.597) and maximum temperature (-0.623) was not significant. In 2013 - 2014 minimum temperature (-0.926) and relative humidity (0.750) were significantly correlated with incidence of entomopathogenic on rice leaf folder. Whereas, rainfall (-0.688) and

maximum temperature (-0.630) were found to be non-significant. But, heavy rainfall in the first week of November may slow down the growth of fungus. Maximum temperature also had no influence on infection percentage.

With a view to bring out relationship among incidence of fungi on rice leaf folder and abiotic factors, multiple regressions were worked out. The fitted equation was for the year 2012-2013 was

$$Y= 65.25 + 0.681\ NS\ (x_1) - 21.42^*\ (x_2) + 12.642^*\ (x_3) - 0.462\ NS\ (x_4)$$

x_1=Maximum Temperature
x_2=Minimum Temperature
x_3=Relative Humidity
x_4= Rainfall

Among the different weather parameters during 2012-2013 minimum temperature (-21.42) and rainfall (-0.462) were negatively correlated and whereas, maximum temperature (0.681) and relative humidity (12.642) showed positive correlation with incidence of entomopathogenic fungi. In 2013-2014, negative correlation was evident with minimum temperature (-4.634) and rain fall (-11.626). Positive correlation was evident with maximum temperature (0.392) and relative humidity (27.934). In both the years rainfall exerted negative influence on incidence of entomopathogenic fungi. High relative humidity influenced the incidence of entomopathogenic fungi on rice leaf folder.

$$Y= - 63.62 + 0.392^*\ (x_1) - 4.634\ NS\ (x_2) + 27.934^*\ (x_3) - 11.626^*\ (x_4)$$

x_1= Maximum Temperature
x_2=Minimum Temperature
x_3=Relative Humidity
x_4= Rainfall

Even though various microbes have been reported to be responsible for suppressing the insect populations, the exploitation of such agents in field scale control of insects is limited (Padmanaban *et al.,*1990). Fungi in particular play an important role in causing mortality in insect pests of rice under natural field conditions (Lacey and Goettel, 1995). In India, National Bureau of Agriculturally Important Insects (NBAII) Bangalore is concentrating studies on entomofungal pathogens. The research on these aspects is developing in India. Narayanasamy (1991) and Ramamohan Rao (1989) have contributed significantly in this field.

With all these considerations, the present investigation was undertaken at various places in Cuddalore districts for the incidence of fungal pathogens on the rice leaf folder. It was revealed that the occurrence of *Zoophthora radicans* in all the places of collection. The detailed study on incidence of fungal infected leaf folder larvae indicated that maximum cadaver of 84% were recorded in second fortnight of December at Annamalainagar in 2011 and 92% in 2012 in the preliminary surveys. However, it was further confirmed in the hot spot studies where Annamalainagar recorded maximum (94%) leaf folder cadavers in the second fortnight of December in 2013.

Places surveyed under Cuddalore district were nearer to sea coast and relative humidity was very high in those places resulting in the increased fungal infection percentage. This clearly shows that minimum temperature and relative humidity influenced the multiplication of fungus. Lesser relative humidity was not ideal and encouraging for the fungus multiplication.

The highest number of cadavers (92%) was collected during the second fortnight of December 2012 when the maximum and minimum temperature was 28.0 and 20.5°C and the difference was 7.5°C whereas lowest number of 31% was noticed when the minimum and maximum temperatures were 30.4 and 21.0°C with a difference of 9.4°C. In confirmative field studies maximum percentage of fungal infected dead leaf folder larvae (94%) was recorded in second fortnight of December 2013 when the minimum and maximum temperatures were 27.1 and 19.6°C with a difference of 7.5°C.

Table – 1: Survey of Entomofungal pathogens of rice leaf folder larvae in Cuddalore District during samba season of 2011-2012.

S.No.	Month @fort night intervals	Fungal Infection Percentage				
		Cuddalore District				
		Annamalainagar	Bhuvanagiri	B.mutlur	Periyapattu	Sethiathoppuu
1	Nov I	29.00	25.00	27.00	27.00	23.00
2	Nov II	38.00	32.00	41.00	30.00	38.00
3	Dec I	63.50	58.00	60.00	49.00	64.00
4	Dec II	84.00	68.00	66.00	58.00	70.00
5	Jan 1	89.00	64.00	74.00	74.00	55.00
6	Jan II	85.00	78.00	81.00	80.00	42.00
7	Feb I	68.00	69.00	66.00	71.00	39.00
8	Feb II	57.00	42.00	55.00	51.00	36.00
	Average	**64.12**	**54.50**	**58.75**	**55.00**	**45.80**

Table – 2: Survey of Entomofungal pathogens of rice leaf folder larvae in Cuddalore District during samba season of 2012- 2013.

S.No.	Month @fort night intervals	Fungal Infection Percentage				
		Cuddalore District				
		Annamalainagar	Bhuvanagiri	B.mutlur	Periyapattu	Sethiathoppuu
1	Nov I	31.00	23.00	26.00	25.00	27.00
2	Nov II	35.00	31.00	35.00	29.00	41.00
3	Dec I	62.00	55.00	55.00	44.00	67.00
4	Dec II	92.00	61.00	74.00	64.00	69.00
5	Jan 1	91.00	72.00	86.00	68.00	64.00
6	Jan II	92.00	78.00	79.00	79.00	45.00
7	Feb I	71.00	64.00	69.00	74.00	38.00
8	Feb II	54.00	39.00	54.00	49.00	33.00
	Average	**65.25**	**52.87**	**59.75**	**54.00**	**48.00**

 I - Fortnight
 II - Fortnight

Table – 3: Percentage of rice leaf folder larvae infection in relation to weather parameters during 2012-2013 and 2013-2014.

S. No.	Period	Annamalainagar									
		2012-2013					2013-2014				
		Max. T (°C)	Min. T (°C)	R.H (%)	R.F (mm)	P.I (%)	Max. T (°C)	Min. T (°C)	R.H (%)	R.F (mm)	P.I (%)
1.	November I	30.4	21.0	79	302	31.00	29.6	21.0	80	360.70	27.00
2	November II	28.1	23.0	86	400	35.00	28.1	23.0	89	400.0	37.00
3	December I	27.9	22.5	88	406	62.00	27.3	21.5	88	210.4	61.00
4	December II	28.0	20.5	96	205	87.00	27.1	19.6	96	130.0	94.00
5	January I	27.3	20.0	94	036.6	90.00	26.8	20.8	93	046.6	89.00
6	January II	27.1	19.9	95	005.4	92.00	27.9	19.7	90	054.4	84.00
7	February I	29.8	20.0	86	000.0	71.00	28.9	21.0	84	000.0	69.00
8	February II	30.4	22.4	79	000.0	54.00	30.8	21.4	81	000.0	48.00

Table – 4: Over all correlation and regression between percentage of leaf folder infection and weather parameters in Annamalainagar during 2012-2013.

Particulars	Correlation coefficient (r)	Regression coefficient (b)	Constant (a)
Maximum temperature Vs P.I	-0.623 NS	-4.572 NS	21
Minimum temperature Vs P.I	-0.724*	-10.542*	17
Relative humidity Vs P.I	0.849*	3.874 NS	26
Rainfall Vs P.I	-0.597 NS	2.412 NS	12

*Significant at P=5%
NS=Not significant
P.I. =Percentage of infection

Table – 5: Multiple linear regression - interaction of leaf folder infection percentage with weather parameters Annamalainagar during 2012-2013.

	x_1=Max.temperaure	x_2=Min. temperature	x_3=Relative humidity	x_4=Rainfall
Y= 65.25	0.681 NS (x_1)	-21.42* (x_2)	12.642* (x_3)	- 0.462 NS (x_4)
Tb	-0.972	-1.493	2.972	1.424

R^2= 0.963

Table – 6: Over all correlation and regression between percentage of leaf folder infection and weather parameters in Annamalainagar during 2013-2014.

Particualrs	Correlation coefficient (r)	Regression coefficient (b)	Constant (a)
Maximum temperature Vs P.I	-0.630 NS	-3.784*	71
Minimum temperature Vs P.I	-0.926*	-1.243 NS	54
Relative humidity Vs P.I	0.750*	-0.364*	28
Rainfall Vs P.I	-0.688 NS	2.931 NS	98

*Significant at P=5%
NS=Not significant
P.I. =Percentage of infection

Table – 7: Multiple linear regression -interaction of leaf folder infection percentage with weather parameters in Annamalainagar during 2013-2014.

	x_1=Max. temperature	x_2=Min. temperature	x_3=Relative humidity	x_4=Rainfall
Y= 63.62	0.392* (x_1)	- 4.634 NS (x_2)	27.934*(x_3)	-11.626*(x_4)
Tb	-2.879	-3.773	3.934	-4.734

$R^{2=}$ 0.995

Wada (1979) has reported that leaf folder larvae developed rapidly within a temperature range of 17 to 30°C which is comparable with the present results. The present results also revealed that the higher percentage of humidity (96%) was favourable for increase in larval incidence and cadavers. These findings are in conformity with Waldbauer and Marciano (1979) who reported that 90 per cent RH was necessary for the development of *C. medinalis.* Philip Sridhar (1988) and Hariprasad (1999) reported that the peak population of leaf folder was recorded at higher RH. It was evident that a range of 85-95 per cent RH would be conducive in this coastal region for the rapid buildup of leaf folder population.

The results showed that rainfall received early in the season was contributing to the gradual build up of larval population in the subsequent months. Rainfall in the month of November was found to increase the incidence of larval population and also cadavers in the second fortnight of December.

Over all correlation and regression between weather factors and percentage of infection revealed significant relationship depending upon the interactions of biotic and abiotic factors. Correlation analysis clearly showed that both maximum temperature and higher rainfall had negative influence on the multiplication of larval population which is in agreement with the results reported by Upadhyay *et al.* (1975) and Hariprasad (1999).

Among the weather parameters studied in Annamalainagar, RH had the most significant positive relationship with the percentage of infection and Rainfall exerted negative influence on incidence of entomopathogenic fungi.

In the confirmative field studies, interaction of leaf folder infection percentage with weather parameters through multiple linear regression revealed that significant relationship was observed between minimum temperature and relative humidity, where as rainfall exhibited negative influence on the cadaver population. The wide spread occurrence of *Z. radicans* on the leaf folder larvae in regions like Cuddalore districts reveals the adaptability and potentiality of the fungus under field conditions.

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