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Impact of insects (YSB, BPH, RLF) in rice crop yield in Raipur district of Chhattisgarh

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Abstract
Rice (*Oryza sativa*) is one the major food crop of India. Rice yield losses due to moderate to severe pest infestations in an attempt has been made to measure the population dynamics and weather parameter influencing the occurrence of YSB, BPH and RLF. Weather conditions parameters *viz,* maximum temperature, minimum temperature, rainfall, relative humidity (RH-1 and RH-2) remain the major weather elements defining the insect pest occurrence. Theoretical discrete distribution *viz,* Negative binomial distribution, Polya-Aeppli distribution, Generalized Poisson distribution be situated best fitted for all insect count data. Out of all-weather parameters under study, the correlation between YSB and rainfall was found negatively significant. We can finish that as the rainfall escalations the population of YSB decreases. The temperature, minimum and maximum, does not show such type of importance for the presence of YSB. Similar conclusion approximately rainfall and BPH can also draw as the correlation between these two variables was found negative maximum times. All the weather parameter plays significant role in case of YSB. Negative Binomial Distribution has been best fitted for YSB. The value of goodness of fittest in case of Negative Binomial distribution for YSB was found (18.04), BPH (8.02), RLF (5.89), in case of Polya-Aeppli distribution the value of Chi-square be situated YSB, BPH, RLF separately, (6.57, 0.52, 1.90), in case of Generalized Poisson Distribution value of chi-square test of goodness of fit for YSB, BPH, RLF separately (3.56, 18.54, 6.57). The correlation coefficient of all-weather parameter shows the positive relationship in case of YSB, and BPH, RLF.Weather parameter *viz.*, maximum temperature, minimum temperature, rainfall, morning relative humidity, evening relative humidity are the major weather elements determining the insect Pests occurrence. Insect *viz*., (Yellow stem borer, Brown plant borer, Rice leaf folder). Yellow stem borer is major insect pest always causing damage to the rice crop resulting in considerable yield losses.

Keywords: Negative binomial distribution, polya-aeppli distribution, generalized poisson distribution, yellow stem borer (YSB), brown plant hopper (BPH), rice leaf folder (RLF), population dynamic, correlation coefficient

1. Introduction
Rice (*Oryza sativa*) is the most important crop in India. It also Contribute significantly to the gross domestic product (GDP). India is the second largest country of rice producing after China. Insect pest continues to be a constant problem for rice production between many others, in all the rice cultivated area. Rice is prone to more than 100 invasive species of insect during its crop growth period which markedly reduce the productivity. The key insect pest affecting the yield are *Scirpophoga incertulas*, yellow stem borer (YSB; *Nilaparvata lugens*) brown plant hopper (BPH); *Cnaphalocrocis medinalis,* rice leaf folder (RLF). Weather parameters *viz*., Temperature, rainfall, relative humidity, sunshine hours and wind speed are the major weather element determining the insect pests' occurrence. Keeping in view of the emergence of insects' probability distribution for the clustering pattern of different insects on rice crops has been studied. The second objective of the study was to find the relationship of the insect emergence with the weather parameters,

Raipur situated in eastern central part of Chhattisgarh at latitude of 22°33 North to 21°14 and 82°6 to 81°38 East latitude.it occupies the south eastern part of the upper Mahanadi River Valley and the bordering hills in the south and the east. The district is located on the Chhattisgarh plain.

When we take crop of rice then the weather condition is almost optimum during crop growth maximum temperature of range from 26.1 °C to 40.8 °C whereas minimum temperature ranged from 8.1 °C to 25.8 °C. Morning relative humidity varied from 47 to 91 and evening relative humidity varied from 12 to 84 percent. The average rainfall was 28.53 mm, whereas average maximum temperature, minimum temperature, morning relative humidity and evening relative humidity were 33.02 °C, 22.15 °C, 80.85% and 46.77%, respectively.

2. Materials and Methods
The experiment conducted at the research farm of Indira Gandhi Krishi Vishwavidyalaya Raipur (CG). The insect catch was recorded from the year 2006 to 2019. The maximum insect adult population was observed through light trap daily observation at growing stages of rice crop. The experimental field was free from insecticide sprays.

1) Correlation coefficient
Correlation coefficient (r) between each insect with different weather parameters were computed as

$$r = \frac{\sum_{i=1}^{n}(X_i-\bar{X})(Y_i-\bar{Y})}{[(\sum(X_i-\bar{X})^2)(\sum(Y_i-\bar{Y})^2)]^{½}}$$

where X is insect catch and Y is weather parameter.

2) Probability distribution
(a) Polya-Aeppli Distribution
This Distribution is one of the important contagious distributions and is useful for situation where events (which are to be counted) occur in clusters and the number of clusters follows a Poisson distribution with expectation θ and the number of individual (aphids) per cluster follows a geometric distribution with parameter q.
A random variable X is said to follow Polya-Aeppli distribution with parameters θ and p if its p.m.f. is given by

$$p(x;\theta,p) = \begin{cases} e^{-\theta} \; when \; x = 0 \\ e^{-\theta}p^x \sum x_j = \frac{(x-1)}{(j-1)} \frac{[\theta(1-p)/p]^j}{j!} \; x = 1, 2, ... \end{cases}$$

$$0 < p < 1; \; \theta > 0$$

Where θ and p are the shape parameters.

$$\text{Mean} = \frac{\theta}{1-p}$$

$$\text{Variance} = \frac{\theta(1+p)}{(1-p)^2}$$

(b) Negative Binomial distribution
A random variable X is said to follow negative binomial distribution with parameters r and p if its p.m.f. is given by;

$$P(X = x) = \binom{x+r+1}{r-1} p^r q^x; x = 0,1,2, ... ; \; 0 < p < 1$$

$$\text{Mean} = \frac{r(1-p)}{p}$$

$$\text{Variance} = \frac{r(1-p)}{p^2}$$

(c) Generalized Poisson distribution
This is also one of the important contagious distributions and is useful for the situation where Polya-Aeppli distribution is applied. This distribution with two parameters λ_1 and λ_2; was obtained as a limiting case of the generalized negative binomial distribution (Jain and Consul 1971) [11].

The variance of the distribution is greater than equal to or smaller than the mean according as λ_2 is positive, zero or negative. This distribution is more suitable to unimodal or reverse J-shaped distribution. For completeness this distribution is defined by.

$$P_k = P[X = k] = \lambda_1(\lambda_1 + k\,\lambda_2)^{k-1} e^{-(\lambda_1+k\,\lambda_2)}, k = 0,1,2, ... ; \; \lambda_1 > 0, |\,\lambda_2\,| < 1$$

= 0, otherwise

3) Test for goodness of fit
A very important and very useful test for testing the significance of the adjustment b/w theory and experiment was given by Prof. Karl Pearson and is known as 'χ^2 test of goodness of fit'.
If O_i (i=1,2…….,n) is a set of observed frequency and E_i (i=1,2…,n) is the corresponding set of expected frequency. Then χ^2 test of goodness of fit is given by

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i-E_i)^2}{E_i}$$

The open access R software was used for the analysis and fitting of the distribution.

3. Results and Discussion
1) Relationship between weather parameters and insect (YSB, BPH and RLF) of rice
(a) Correlation coefficient for YSB
Correlation coefficient of YSB with weather parameters are presented in Table 1. Critical observation on Table 1 revealed that as the rainfall increases the presence of YSB decreases. It can be seen from the table that the correlation between YSB and rainfall was negative in maximum years. Sometimes it was negatively significant also. The temperature, minimum and maximum, does not show such type of importance for the presence of YSB, because the correlation between YSB and temperature (minimum or maximum) was observed negative and positive both. Morning relative humidity (RH-1) showed positive relationship with the YSB presence though was non-significant maximum times. Same case was observed for the evening relative humidity (RH-2).

(b) Correlation coefficient for BPH
Correlation coefficient of BPH with weather parameters are presented in Table 2. Table 2 revealed that as the rainfall increases the presence of BPH decreases. It can be seen from the table that the correlation between BPH and rainfall was negative in maximum years. Sometimes it was negatively significant also. Other weather parameters (Minimum temperature, maximum temperature and RH-1) does not show such type of importance for the presence of BHP, because the correlation between BHP and these weather parameters were observed negative and positive both. Evening relative humidity (RH-2) showed negative relationship with the BHP presence maximum times. In some years it was found negatively significant.

Table 1: Correlation coefficient of YSB with weather

Year	Max. Temp.	Min. Temp.	Rainfall	RH-1	RH-2
2006	0.2622	-0.0736	-0.1047	0.3674	-0.1219
2008	-0.3112	-0.5392*	-0.1860	0.0947	-0.3276
2009	-0.3912	-0.4907	-0.2673	0.5457*	0.1899
2010	-0.2123	-0.0005	0.2498	0.4059*	0.2172
2011	0.0266	0.1314	-0.0676	0.1149	0.0964
2012	-0.0733	-0.0788	-0.1424	0.1156	-0.0036
2013	0.0408	-0.3140	-0.1424	-0.2083	-0.3805
2014	-0.0132	-0.1231	-0.0936	-0.0623	-0.1419
2015	-0.1320	0.0310	0.3454	0.3387	0.1970
2016	0.5113	0.6884*	-0.7156**	0.4532*	0.0126
2017	0.1166	0.2588	0.1417	0.0018	0.1723
2018	0.2327	0.0466	-0.3589*	-0.2371	-0.2673
2019	0.5610*	0.2601	-0.3040*	-0.6850**	-0.5280*

**Significant at 1% level of significance
* Significant at 5% Level of significance

Table 2: Correlation coefficient for BPH

Year	Max. Temp	Min. Temp	Rainfall	RH-1	RH-2
2010	-0.1844	-0.7768	-0.1748	0.2289	-0.6091*
2012	0.4805*	0.5216*	-0.0456	-0.5553*	-0.3802*
2013	-0.0060	-0.0935	-0.1970	-0.0044	-0.1265
2014	0.0236	0.0013	-0.1455	0.0012	-0.1084
2015	-0.0492	-0.0793	-0.0783	0.1210	-0.0578
2016	0.1581	0.1585	-0.1571	-0.2444	-0.1030
2017	-0.4369	-0.4939*	0.0799	0.4771*	0.5020
2018	-0.2161	-0.4809*	-0.2640	0.1940	-0.1843
2019	0.1835	0.0108	-0.1786	-0.2338	-0.2338

**Significant at 1% level of significance
* Significant at 5% Level of significance

(c) Correlation coefficient for RLF

Correlation coefficient of RLF with weather parameters are presented in Table 3. The correlation between weather factors and Rice Leaf folder population indicated that the maximum temperature, minimum temperature, rainfall and sunshine hours have a significant negative relationship while morning relative humidity and evening relative humidity exhibited a positive relationship.

Table 3: Correlation coefficient for RLF

Year	Max. Temp	Min. Temp	Rainfall	RH-1	RH-2
2008	0.3928	-0.2321	-0.4226*	-0.3545	-0.4195*
2009	-0.8319	-0.8264*	-0.3367	0.3543	-0.5512
2010	0.2704	-0.1368	-0.1563	-0.2662	-0.3494
2011	-0.1040	-0.3306	-0.3480*	-0.3470	-0.3784
2012	-0.1735	0.1096	-0.0220	0.3063	0.2970
2013	0.0084	-0.2367	-0.4122	-0.2526	-0.3525
2014	-0.2017	-0.1922	-0.1146	0.2857	0.0972
2015	0.0211	0.0160	-0.0991	0.2382	-0.0129
2016	-0.1121	-0.0251	0.0112	0.0011	-0.1406
2017	0.0614	0.0702	0.1966	0.3390	0.1873
2018	-0.0877	0.4681*	0.0337	0.4454	0.4033*
2019	0.2030	0.2896	-0.0812	0.4362	0.2053

**Significant at 1% level of significance
* Significant at 5% Level of significance

2) Fitting of probability distributions of insect (YSB, BPH and RLF) of rice population

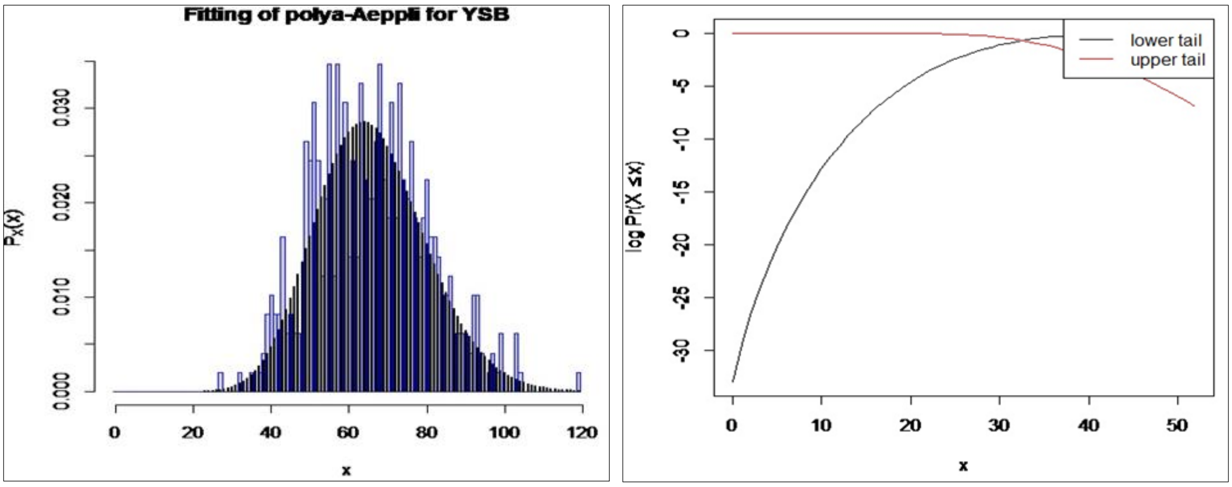
(a) Polya-Aeppli Distribution

Parameters of Polya-Aeppli Distribution and goodness of fit test values for all the three insects are presented on Table 4.

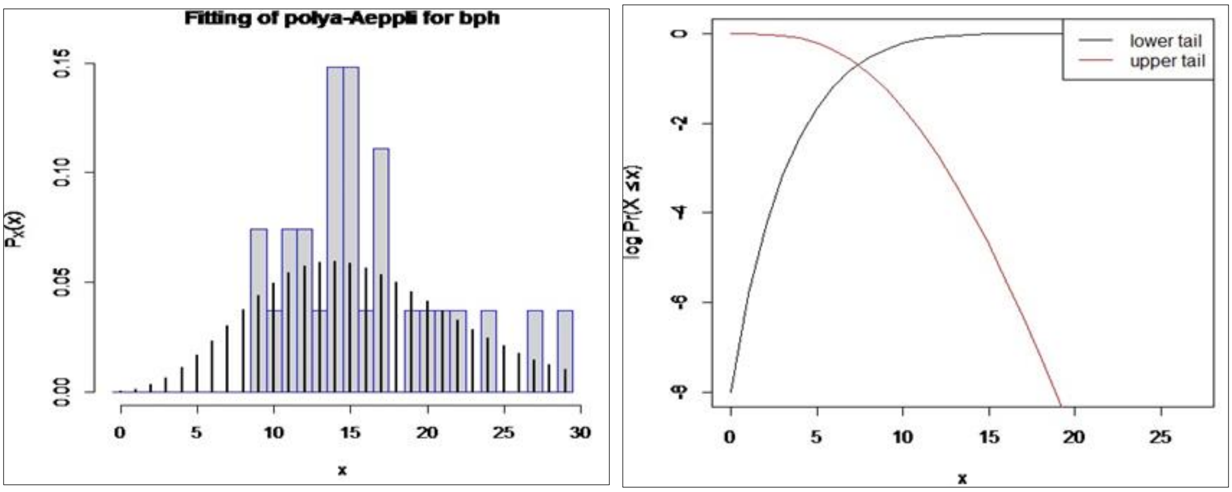
- **Polya-Aeppli Distribution for YSB:** The values of mean, λ_1 and λ_2 for the insect YSB were found to be 34, 33 and 0.74, respectively. The test of goodness of fit (χ^2) for this distribution for the insect YSB was found to be 6.57. The values of χ^2 did not approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 1(i) exhibits the visual displayed of Polya-Aeppli distribution for YSB.
- **Polya-Aeppli Distribution for BPH:** The values of mean, λ_1 and λ_2 for the insect BPH were found to be 76, 18 and 0.46, respectively. The test of goodness of fit (χ^2) for this distribution for the insect BPH was found to be 0.57. The values of χ^2 did not approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 1 (ii) exhibits the visual displayed of Polya-Aeppli distribution for BPH.
- **Polya-Aeppli Distribution for RLF:** The values of mean, λ_1 and λ_2 for the insect RLF were found to be 89, 23 and 0.50, respectively. The test of goodness of fit (χ^2) for this distribution for the insect RLF was found to be 1.90. The values of χ^2 did not approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 1(iii) exhibits the visual displayed of Polya-Aeppli distribution for RLF.

Table 4: Parameter estimation and goodness of fit for Polya-Aeppli Distribution

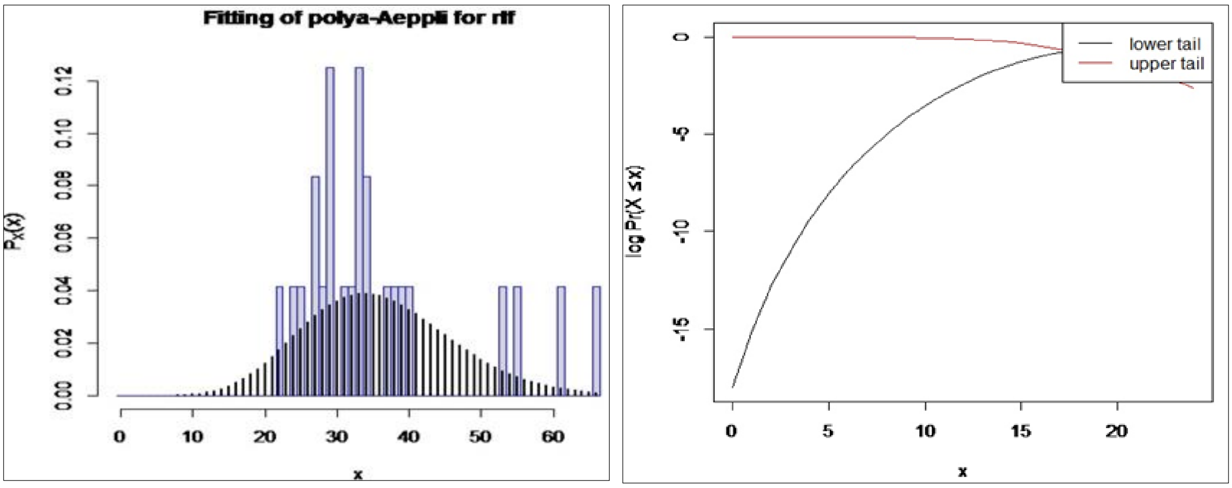
Insect	Mean	λ_1	λ_2	Chi-square
YSB	34	33	0.74	6.57
BPH	76	18	0.46	0.52
RLF	89	23	0.50	1.90



(i) Polya-Aeppli Distribution for YSB



(ii) Polya-Aeppli Distribution for BPH



(iii) Polya-Aeppli Distribution for RLF

Fig 1: Polya-Aeppli distribution for (i) YSB (ii) BPH (iii) RLF

(b) Negative binomial distribution (NBD)

Parameters of Negative binomial distribution and goodness of fit test values for all the three insects are presented on Table 5.

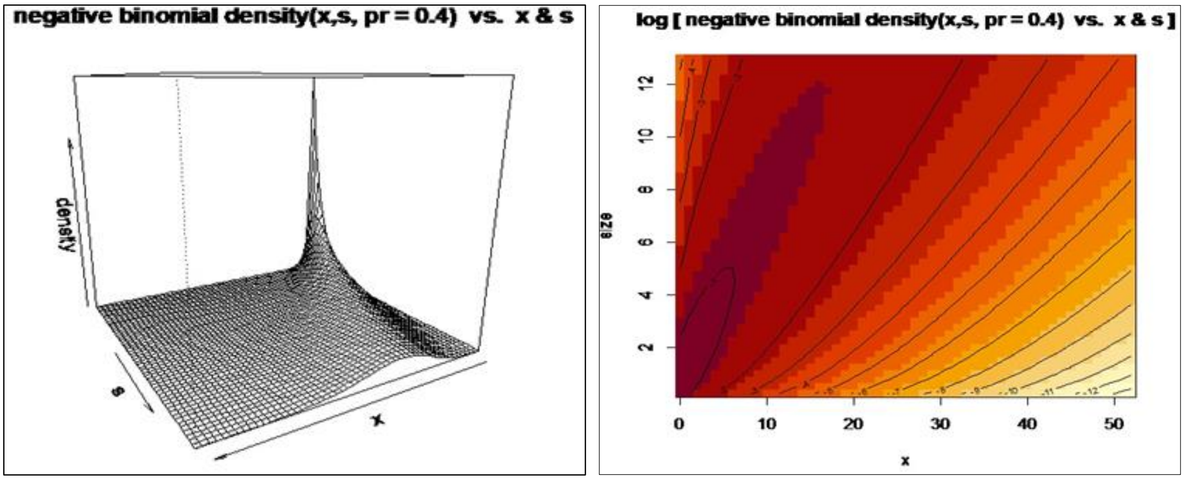
- **Negative binomial distribution for YSB:** The values of mean, r and p for the insect YSB were found to be 17, 2 and 0.12, respectively. The test of goodness of fit (χ^2) for this distribution for the insect YSB was found to be 18.54. The values of χ^2 did not approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 2 (i) exhibits the visual displayed of Negative binomial distribution for YSB.
- **Negative binomial distribution for BPH:** The values of mean, r and p for the insect BPH were found to be 19, 2 and 0.11, respectively. The test of goodness of fit (χ^2) for

this distribution for the insect BPH was found to be 8.02. The values of χ^2 did not approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 2 (ii) exhibits the visual displayed of Negative binomial distribution for BPH.

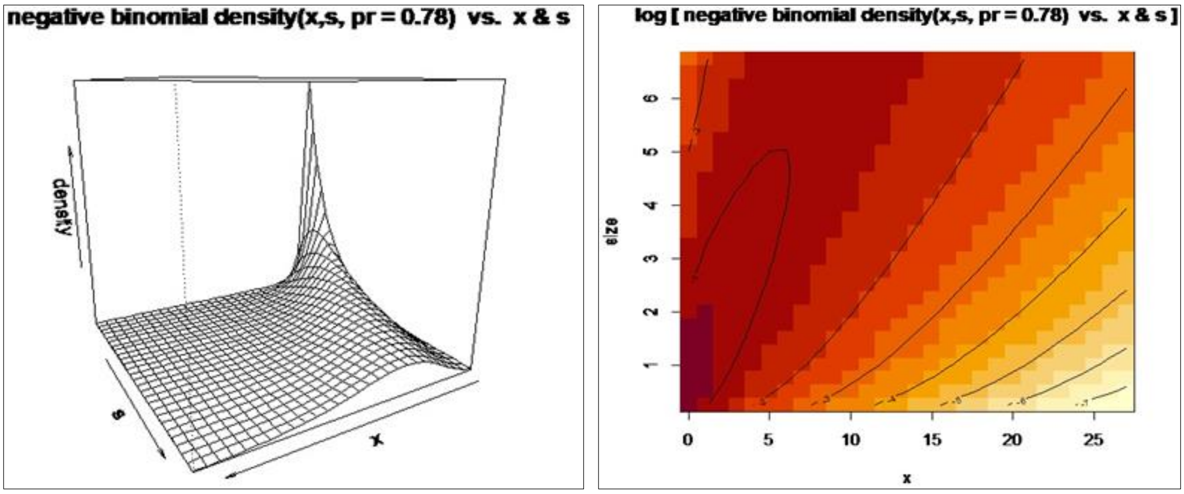
- **Negative binomial distribution for RLF:** The values of mean, r and p for the insect RLF were found to be 23, 2 and 0.29, respectively. The test of goodness of fit (χ^2) for this distribution for the insect RLF was found to be 5.89. The values of χ^2 didn't approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 2(iii) exhibits the visual displayed of Negative binomial distribution for RLF.

Table 5: Parameter estimation and goodness of fit for Negative binomial distribution

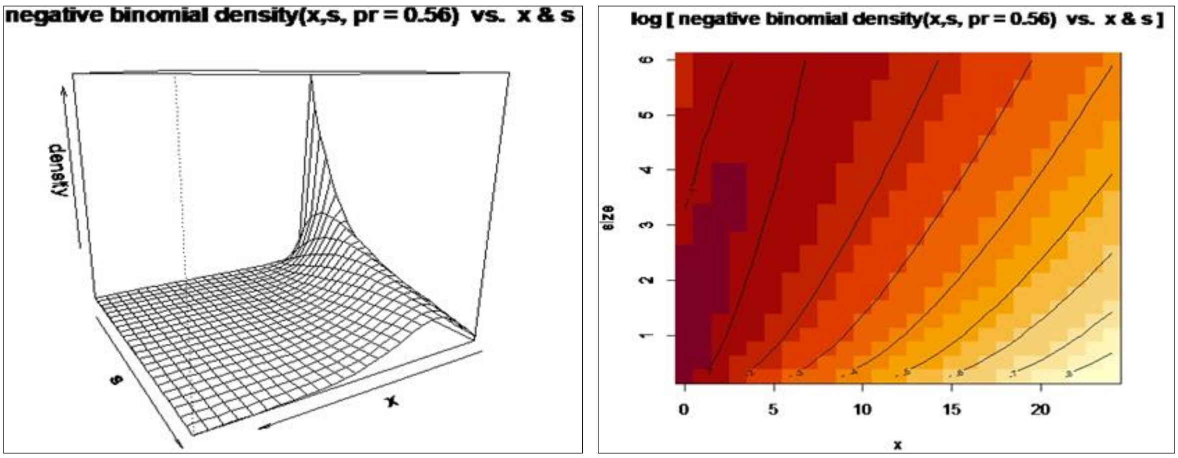
Insect	Mean	r	p	Chi-square
YSB	17	2	0.12	18.54
BPH	19	2	0.11	8.02
RLF	23	2	0.29	5.89



(i) Negative binomial Distribution for YSB



(ii) Negative binomial Distribution for BPH



(iii) Negative binomial Distribution for RLF

Fig 2: Negative binomial Distribution for (i) YSB (ii) BPH (iii) RLF

(c) Generalized Poisson distribution (GBD)

Parameters of Generalized Poisson distribution and goodness of fit test values for all the three insects are presented on Table 6.

- **Generalized Poisson distribution for YSB:** The values of mean, λ_1 and λ_2 for the insect YSB were found to be 56, 39.1 and 0.99, respectively. The test of goodness of fit (χ^2) for this distribution for the insect YSB was found to be 3.56. The values of χ^2 did not approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 3(i) exhibits the visual displayed of Generalized Poisson distribution for YSB.
- **Generalized Poisson distribution for BPH:** The values of mean, λ_1 and λ_2 for the insect BPH were found to be 98, 11.21 and 0.56, respectively. The test of goodness of fit (χ^2) for this distribution for the insect BPH was found to be 18.54. The values of χ^2 did not approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 3 (ii) exhibits the visual displayed of Generalized Poisson distribution for BPH.
- **Generalized Poisson distribution for RLF:** The values of mean, λ_1 and λ_2 for the insect RLF were found to be 18, 18.90 and 0.34, respectively. The test of goodness of fit (χ^2) for this distribution for the insect RLF was found to be 6.57. The values of χ^2 did not approach significance at 5% level and corresponding degree of freedom resulting that the fit was good. Figure 3 (iii) exhibits the visual displayed of Generalized Poisson distribution for RLF.

Table 6: Parameter estimation and goodness of fit for Generalized Poisson distribution

Insect	Mean	λ_1	λ_2	Chi-square
YSB	56	39.10	0.99	3.56
BPH	98	11.21	0.56	18.54
RLF	18	18.90	0.34	6.57

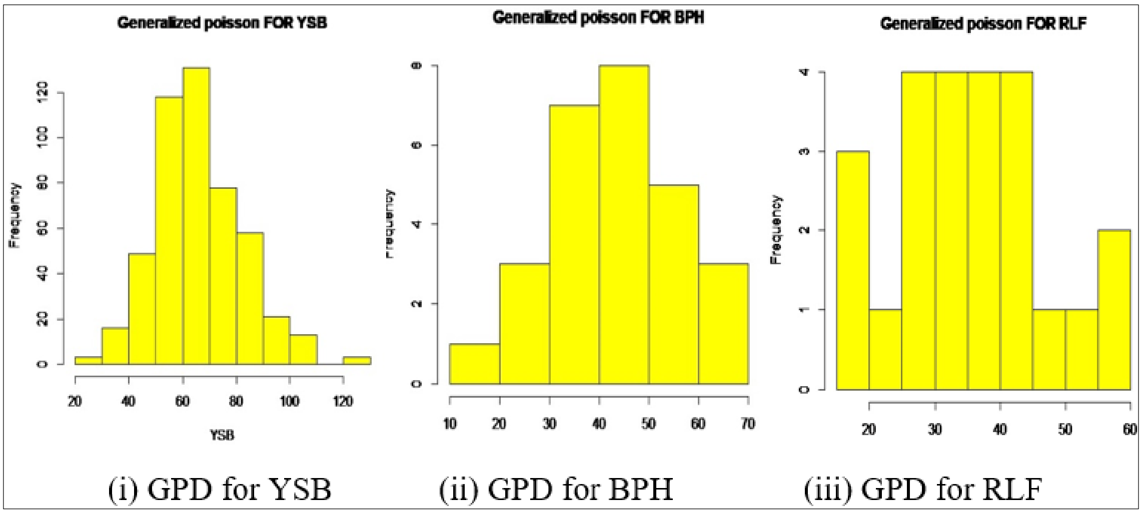


Fig 3: Generalized Poisson distribution for (i) YSB (ii) BPH (iii) RLF

4. Conclusion

Out of all-weather parameters under study, the correlation between YSB and rainfall was found negatively significant. We can conclude that as the rainfall increases the population of YSB decreases. The temperature, minimum and maximum, does not show such type of importance for the presence of YSB. Similar conclusion about rainfall and BPH can also be drawn as the correlation between these two variables was found negative maximum times.

5. References

1. Dhruv RS, Soni VK. Influence of ambient weather on population fluctuation of rice insect pests through light trap catches. Journal of Entomology and Zoology studies. 2020;8(2):1346-1349.
2. Nag S, Chaudhary JL, Shori SR, Netam J, Sinha HK. Influence of weather parameters on populations dynamics of yellow stem borer (YSB) in rice crop at Raipur. Journal of Pharmacognosy and Phytochemistry. 2018;SP4:37-44.
3. Sahoo SK, Saha A, Jha S. Influence of weather parameters on the population dynamics of insect-pests of mango in West Bengal. Journal of Agrometeorology. 2016;18(1):71-75.
4. Longkumer IY, Singh KI, Singh A. Efficacy of eco-friendly insecticides against yellow stem borer under kharif rice-crop-ecosystem of Manipur valley. The Pharma Innovation journal. 2017;6(11):19-21.
5. Islam MS, Das S, Islam KS, Rahman A. Evaluation of different insecticides and botanical extracts against yellow stem borer, *Scirpophaga incertulas* in rice field. Int. J Biosciences. 2013;3(10):117-125.
6. Jeer M, Choudhary VK, Dixit A. Effect of pre-mix combination of Acephate and Imidacloprid on insect pests of rice and their natural enemies. J of Ent and Zoo. Studies. 2017;5(3):1272-1278.
7. Khuhro GA. Effect of methods and time of threshing on grain losses and milling recovery of IR-6 variety of rice. Pak. J of Agri., Agri. Eng. and Vet Sci. 1988;4(1-2).
8. Kiritani K. Pest management in rice. Ann. Rev. Entomol. 1979;24:279-312.
9. Litsinger JA, Bandong JP, Canapi BL, Dela Cruz CG, Pantua PC, Alviola AL, *et al*. Evaluation of action thresholds for chronic rice insect pests in the Philippines. I. Less frequently occurring pests and overall assessment. Int. J Pest Manage. 2005;51:45-61.
10. Pandey S, Choubey MN. Management of yellow stem borer, *Scirpophaga incertulas* in rice Agricultural. Sci. Digest. 2012;32(1):7-12.
11. Jain GC, Consul PC. A generalized negative binomial distribution. SIAM Journal on Applied Mathematics. 1971 Dec;21(4):501-13.