



STATISTICAL ANALYSIS AND FORECASTING OF GROUNDNUT LEAFHOPPER BASED ON CLIMATE FACTORS IN CHITTOOR DISTRICT OF ANDHRA PRADESH

V. AMARVADH, B. RAVINDRA REDDY*, P. SUMATHI, G. MOHAN NAIDU AND I. BHAVANI DEVI

Department of Statistics and Mathematics, S.V. Agricultural College, ANGRAU, Tirupati – 517 502,
Chittoor Dt., Andhra Pradesh

Date of Receipt: 11-07-2017

ABSTRACT

Date of Acceptance: 24-10-2017

This paper presents the groundnut leafhopper incidence and the influence of climatic factors in groundnut growing areas of Chittoor district of Andhra Pradesh. The data analysis on leafhopper incidence and its correlation with the climate factors in standard weeks of groundnut growing seasons from 2007 to 2016 revealed that the rainfall distribution varied greatly within groundnut growing seasons over years. The average minimum temperatures ranged from 12.8°C – 32.5°C, average maximum temperatures ranged from 25.7°C – 41.9°C, morning relative humidity ranged from 36.8 – 95% and evening relative humidity ranged from 21.5 – 91.5%. The results revealed that the days with RH > 78 per cent, temperature ranging from 13°C – 42°C and rainfall ranging from 0.00 to 297 mm are most critical factors for incidence of leafhopper. Correlation coefficients were computed to ascertain the pattern of relationship between leafhopper and climate factors over years (2007-2016). The results revealed that there was a positive relationship between the leafhopper incidence and rainfall, evening relative humidity and sunshine hours. The MLR models for within year and between years found to be useful in the prediction of leafhopper incidence. The logistic models were found to be useful in the prediction of probabilities for occurrence and non-occurrence of leafhopper incidence of groundnut. The markov chain models revealed that there was significant change in occurrence of leafhopper in consecutive days.

KEYWORDS: Leafhopper, climate factors, logistic regression, MLR models, Markov chain models.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an annual legume crop belonging to the family Fabaceae and is commonly known as peanut. It forms the world's largest source of edible oil and ranks 13th among the food crops and 4th among the most important oilseed crops of the world. The major groundnut growing countries in the world are India, China, Nigeria and Myanmar, which occupies an area of 25.41 M ha, producing 41.20 MT with an average productivity of 1620 kg ha⁻¹ (USDA, 2013-14). In India, groundnut occupies an area of 5.51 M ha producing 9.714 MT with an average productivity of 1764 kg ha⁻¹ (www.indiastat.com, 2013-14). Gujarat and Andhra Pradesh are the major groundnut growing states in India. In Andhra Pradesh, the crop is grown in an area of 1.386 M ha producing 1.236 MT with an average productivity of 949 kg ha⁻¹ (Anonymous, 2014).

Groundnut oil is considered as staple and nutritive food as it contains just the right proportion of Oleic and Linoleic acids (Mathur and Khan, 1997). More than 100

species of insect and mites are known to attack groundnut (Nandagopal, 1992). Among the various insect pests attacking this crop, jassid commonly known as leafhopper, causes extensive damage. Leafhoppers are the major pest of importance on groundnut crop specially when raised under summer conditions (David and Ramamurthy, 2011). Leafhoppers suck the sap from the leaves (prefers first three terminal leaves) and petioles producing 'V' shaped yellowing at the tip, known as hopper burn (Khan and Hussain, 1965). The present work was carried out by keeping in mind the importance pest forecasting and role of correlations between incidence of insect pest species and weather parameters. The information on correlation between insect pest incidence and weather parameters will be of great help in formulating better Integrated Pest Management (IPM) practices that are area specific.

MATERIAL AND METHODS

The secondary data pertaining to leafhopper incidence was collected from the Regional agricultural research station (RARS), Tirupati along with weather data

*Corresponding author, E-mail: balamrr72@gmail.com

from Meteorological observatory available at RARS, Tirupati. The data was collected from the period ranging from 2007 to 2016. The data was analysed by using the various statistical techniques *viz.*, Simple statistics, Correlation, Multiple Linear Regression (MLR), Logistic Regression and Markov chain models with the help of SAS 9.3 software (SAS, 2016).

RESULTS AND DISCUSSION

The data analysed based on average climatic factors from 2007 to 2016 from groundnut growing seasons revealed that the average rainfall distribution varied greatly within groundnut growing seasons over years (0.0mm to 296.4mm). The average minimum temperatures ranged from 12.8°C to 32.5°C; maximum temperature ranged from 25.7°C to 41.9°C; morning relative humidity ranged from 36.8 to 95% and evening relative humidity ranged from 21.5 to 91.5%.

The data analysed on leafhopper incidence during the year 2012, revealed that the morning relative humidity and sunshine hours showed significant negative association, maximum temperature, minimum temperature and rainfall exhibited significant positive association and evening relative humidity and wind velocity exhibited non-significant positive association with the leafhopper incidence. The multiple linear regression model revealed that the influence of weather variables on leafhopper incidence was to the extent of 52 per cent ($R^2 = 0.52$).

During the year 2013, the results showed that the wind velocity exhibited significant negative association, maximum temperature and sunshine hours exhibited non-significant negative association, evening relative humidity and rainfall exhibited significant positive association and minimum temperature and morning relative humidity exhibited non-significant positive association with leafhopper incidence. The multiple linear regression model revealed that the influence of weather variables on leafhopper incidence was to the extent of 25 per cent ($R^2 = 0.25$).

During the year 2014, the results revealed that the maximum temperature, sunshine hours and wind velocity showed significant negative association, minimum temperature exhibited non-significant negative association, morning relative humidity, evening relative humidity and rainfall exhibited significant positive association with leafhopper incidence. The multiple linear

Table 1. Descriptive statistics for leafhopper during the years 2007 to 2016

Simple Statistics				
Variable	Mean	Std Dev	Minimum	Maximum
Leafhopper	36.44	25.71	10.14	168.57
Max_Tem	33.24	3.14	25.70	41.90
Min_Tem	22.51	3.49	12.80	32.50
MRH	77.62	10.30	36.80	95.00
ERH	48.75	12.46	21.50	91.50
RF	23.26	40.92	0.00	296.40
SSH	5.49	2.26	0.30	13.60
WV	6.28	2.70	1.99	19.30

regression model revealed that the influence of weather variables on leafhopper was to the extent of 60 per cent ($R^2 = 0.60$).

During the year 2015, the results revealed that the sunshine hours showed significant negative association, maximum temperature and wind velocity showed non-significant negative association, evening relative humidity exhibited significant positive association and minimum temperature, morning relative humidity and rainfall exhibited non-significant positive association. The multiple linear regression model revealed that the influence of weather variables on leafhopper was to the extent of 26 per cent ($R^2 = 0.26$).

During the year 2016, the analysis revealed that the morning, evening relative humidity, and sunshine hours showed non-significant negative association, maximum temperature, minimum temperature, rainfall and wind velocity showed non-significant positive association with leafhopper incidence. The multiple linear regression model revealed that the influence of weather variables on leafhopper was to the extent of 24 per cent ($R^2 = 0.24$).

Overall from the year 2007-16, the data analysis revealed that the minimum temperature and morning relative humidity showed non-significant negative association, wind velocity showed significant negative association and maximum temperature exhibited non-significant positive association and evening relative humidity rainfall and sunshine hours exhibited significant positive association with leafhopper incidence. The multiple linear regression model revealed that the influence of weather variables on leafhopper to the extent of 64 per cent ($R^2 = 0.54$).

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Table 2. Correlation coefficients of different climate factors with leafhopper population

Pearson Correlation Coefficients Prob > r under H0: Rho=0							
Year	Max_Tem	Min_Tem	MRH	ERH	RF	SSH	WV
2012	0.27759 (0.0529)	0.59837 (0.0001)	-0.52841 (0.0005)	0.19610 (0.2252)	0.41618 (0.0076)	-0.49717 (0.0011)	0.17105 (0.2913)
2013	-0.16063 (0.2976)	0.11859 (0.4433)	0.25210 (0.0988)	0.36754 (0.0141)	0.22035 (0.0150)	-0.15742 (0.3075)	-0.2692 (0.0772)
2014	-0.32856 (0.0174)	-0.10539 (0.4571)	0.31824 (0.0215)	0.64950 (0.0001)	0.29577 (0.0333)	-0.31158 (0.0245)	-0.3735 (0.0064)
2015	-0.13162 (0.3523)	0.17444 (0.5999)	0.19241 (0.5147)	0.40543 (0.0029)	0.20080 (0.1535)	-0.27128 (0.0517)	-0.1171 (0.4080)
2016	0.11657 (0.9072)	0.15119 (0.2847)	-0.15759 (0.2645)	-0.1574 (0.6861)	0.10673 (0.4514)	-0.23379 (0.0953)	0.11432 (0.9197)
2007-16	0.16124 (0.2246)	-0.17274 (0.1490)	-0.21470 (0.7709)	0.22053 (0.0001)	0.32796 (0.0109)	0.23521 (0.0071)	-0.3306 (0.0001)

The values in parenthesis are probabilities.

The highlighted values are significant probabilities with respect 5 % / 1 % LOS

Table 3. Multiple regression functions for the prediction of leafhopper population

Year	Pest	Equation	R ²
2012	Leafhopper	-119.53 + (17.47) X ₁ + (0.15)X ₂ + (-5.34) X ₃ + (4.56) X ₄ + (0.30) X ₅ + (6.87) X ₆ + (-1.05) X ₇ + (-12.46) X ₈	0.52
2013	Leafhopper	193.25 + (-8.23) X ₁ + (12.54) X ₂ + (-1.80) X ₃ + (3.87) X ₄ + (-1.07) X ₅ + (38.61) X ₆ + (4.61) X ₇ + (-15.18) X ₈	0.25
2014	Leafhopper	-218.78 + (1.49) X ₁ + (4.29) X ₂ + (0.17) X ₃ + (2.49) X ₄ + (0.45) X ₅ + (-5.44) X ₆ + (3.58) X ₇ + (-4.65) X ₈	0.60
2015	Leafhopper	-26.98 + (0.66) X ₁ + (0.57) X ₂ + (-0.22) X ₃ + (0.91) X ₄ + (-0.15) X ₅ + (4.43) X ₆ + (0.24) X ₇ + (-0.58) X ₈	0.26
2016	Leafhopper	154.09 + (-2.33) X ₁ + (0.78) X ₂ + (-0.18) X ₃ + (-0.77) X ₄ + (0.08) X ₅ + (-0.36) X ₆ + (-1.41) X ₇ + (-0.34) X ₈	0.24
2007-16	Leafhopper	461.13 + (-8.98) X ₁ + (9.89) X ₂ + (-2.93) X ₃ + (1.39) X ₄ + (-0.27) X ₅ + (7.02) X ₆ + (-3.19) X ₇ + (-16.50) X ₈	0.54

Table 4. Logistic regression function of climate factors with leafhopper

Pest	MSW	Equation	R ²
Leafhopper	46	-1056.6 + (25.38) X ₁ + (3.71) X ₂ + (3.66) X ₃ + (-2.04) X ₄ + (0.52) X ₅ + (-1.47) X ₆ + (10.47) X ₇	0.56
Leafhopper	47	110.8 + (-2.06) X ₁ + (4.01) X ₂ + (0.04) X ₃ + (-1.43) X ₄ + (-0.04) X ₅ + (-6.97) X ₆ + (0.24) X ₇	0.61
Leafhopper	48	254.6 + (-4.89) X ₁ + (4.05) X ₂ + (0.54) X ₃ + (-1.78) X ₄ + (0.09) X ₅ + (-2.72) X ₆ + (-3.22) X ₇	0.50
Leafhopper	49	-526.3 + (15.05) X ₁ + (5.80) X ₂ + (-0.28) X ₃ + (1.41) X ₄ + (-0.12) X ₅ + (-1.71) X ₆ + (-12.84) X ₇	0.65

Table 5. Table representing the frequencies of transitions for leafhopper from 2007-16

	Period I (2007-11)		Period II (2012-16)	
	0	1	0	1
0	26	6	6	4
1	7	105	3	132

Table 6. T.P.M'S of leafhopper in different periods

	Period I (2007-11)		Period II (2012-16)	
	0	1	0	1
0	0.8125	0.1875	0.6129	0.4122
1	0.0625	0.9375	0.0294	0.9706

The fitted logistic regression models were found to be useful in predicting the occurrence/ non-occurrence of leafhopper incidence of various standard weeks. The results based on Markov chain model revealed that, the limiting behaviour of the TPMs was obtained for leafhopper for two different periods, the period II (2012-16) limiting behaviour of occurrence of pest for two consecutive days is very high (0.9315) than period I (2007-11) (0.75).

Table 7. Higher order transition probabilities of leafhopper for the year 2007-16

	Period I (2007-11)		Period II (2012-16)	
	0	1	0	1
P =	0.8125	0.1875	0.6129	0.4122
	0.0625	0.9375	0.0294	0.9706
P ⁽²⁾ =	0.6718	0.3281	0.3717	0.6282
	0.1093	0.8906	0.0461	0.9538
P ⁽⁴⁾ =	0.4873	0.5126	0.1672	0.8327
	0.1708	0.8291	0.0612	0.9387
R ⁽⁸⁾ =	0.3250	0.6749	0.0789	0.9210
	0.2249	0.7750	0.0676	0.9323
R ⁽¹⁶⁾ =	0.2575	0.7424	0.0685	0.9314
	0.2474	0.7525	0.0684	0.9315
R ⁽¹⁶⁾ =	0.25	0.75	0.0684	0.9315
	0.25	0.75	0.0684	0.9315

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LITERATURE CITED

- Anonymous, 2014. <http://www.indiastat.com.default.aspx>.
- David, B and Ramamurthy, V.V. 2011. *Elements of Economic Entomology*. Namrutha Publications, pp.385.
- USDA, 2013-14. <https://fsu.usda.gov>. 2013-14.
- Khan, M.K and Hussain, M. 1965. Role of coccinellid and syrphid predators in biological control of aphid. *Indian Oilseed Journal*. 9: 67-70.
- Mathur, R.S and Khan, M.A. 1997. Groundnut is poor men nut. *Indian Farmers Digest*. 30 (5): 29-30.
- Nandagopal, V. 1992. Studies on integrated pest management in Groundnut in Saurashtra, *Ph.D. Thesis*, Saurashtra University, Rajkot, Gujarat (INDIA).
- SAS 2016. <http://www.sas.com>