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Models for forecasting Incidence of Thrips in Jabalpur District of Madhya Pradesh

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ABSTRACT:

This study was to describe the applicability of correlation, multiple regression procedure, ANOVA and t-test have been applied to raw data of incidence of average thrips' population on garlic crop. The data was collected from the Department of Entomology, J.N.K.V.V., Jabalpur (M.P.) in Kharif season 2011-12, 6 transplanting dates (1st November2012,15th November2012, 1st December2012,15th December2012, 1st January2012,15th January2012).The multiple regression procedure has been applied to study the pattern of seasonal fluctuations of garlic thrips through prediction models at different transplanting periods. Maximum temperature, vapor pressure, relative humidity, wind speed, evaporation and rainfall played an important role for governing the garlic thrips population at different of transplanting dates.

At On 1st November Trans planting date thrips population was significantly and positivelycorrelated with maximum temperature and evaporation while the other correlations were found to be non-significant.ANOVA was showing a combination of X_1(Maximum Temperature) and X_4(Rainfall) giving the value of R^2 as 75% towards the prediction of the thrips population.

Key Words: Garlic, Correlation coefficient, Regression coefficient

Introductions

Garlic is the second most important bulb crop grown throughout the plains of India for spices and condiments. Many factors affect the production and productivity of garlic, of which infestation of insect pests is the major one. According to Hill (1983),some authorities consider that Allium longicuspis Regael, which is endemic to CentralAsia, is the wild ancestor and spread in ancient times to Mediterranean region. It is known inEgypt inPredynastictimes, before3000BCandalso to ancient Greeksand Romans. It has long been grown in India and China. Garlic was carried to the Western hemisphere by the Spanish, Portuguese and French. Garlic was not liked by Romans due its strong odour.The production and productivity of garlic in India is very low compared to many other countries. Unawareness of farmers about improved varieties, climate, soil and agro-techniques, diseases and pests damaging the crops and their control measures as well as post-harvest management are though main reasons, inadequate market support is also responsible for limiting production and productivity indirectly.

Among the insects' pests the thrips *(thrips tabaci* family) "Thripidae" order "Thysanoptera" is one of the common and the most destructive pest of garlic. The species (*thrips tabaci*) was referred to with various scientific synonyms viz.; T. solanaceosorum(portschinskii); T.striatus(Gilette);T.allii(Sirrine Lowe)andT.flava obsoleta (Uzei). It was first recorded in North America in 1872; thereafter in the early 1900s it spread throughout the United States and Southern Canada (Capinera, 2001). In India, the thrips were recorded in for the first time by Dyadechko (1977).The thrips,T.tabacifound infestingmanyvegetables such asasparagus,bean, beet, cabbage, cantaloupe, carrot, cauliflower, celery, cowpea, etc.Thripsprefertofeedonnewlyemergedleavesinthecentreofthe necktherefore,the majority of thrips are foundatthe base of theyoungerleaves inthelowercentreof the neck on garlic. The principal form of damage caused by thrips resulted from the piercing of cells and the removal of cell contents by nymphs and adults. This leads to an irregular or blotchy whitening of the leaves, a condition sometimes termed "blast". High levels of feeding injury disrupt the hormonal balance of the plant, causing the leaves to curl and twist and the foliage to be stunted (Kendall and Biostad, 1990). Both nymphs and adults of the thrips were found between leaf sheaths and stems. In case of severe infestation, the bulb remains undersized and gets distorted (Butani and Verma, 1976). Thrips (*Thrips tabaci*) are perhaps the most important insect pests attacking garlic. They are most common during warm weather. They feed on leaf surfaces, causing them to whiten or silver. They are slender about 1/25" long and usually hide in angles of leaves.

Materials and Methods

The data were gathered from the Department of Entomology based on Garlic Thrips incidence during the year 2011-12 and weather collected from the Department of Agro-Meteorology of the same year. For conducting analysis of the incidence of thrips in Garlic crops 2 transplanting dates 1st November 2012, 15th November 2012, 1st December 2012, 15th December 2012, 1st January 2012 and 15th January 2012.

Methods

Correlation Analysis:

Correlation is a bivariate analysis that measures the strength of the association between two variables and the direction of the relationship. In terms of the strength of the relationship, the value of the correlation coefficient varies between +1 and -1. A value of ±1 indicates a perfect degree of association between the two variables. In statistics, we measure four types of correlations; Pearson correlation, Kendall rank correlation, Spearman correlation and the Point-Biserial correlation. In this analysis we used Pearson correlation.

Pearson Correlation: Pearson r correlation is used to measure the degree of relationship between the two variables. In this analysis, the dependent variable (Y) is taken as the average number of thrips per 5 plants and the independent variable (X) is taken as the weather parameters such as maximum temperature, minimum temperature, vapour pressure, relative humidity, wind speed etc. The following formula is used to calculate the Pearson r correlation:

$$r = \frac{\text{cov}XY}{\sigma x \sigma y} = \frac{N\Sigma xy - \Sigma x \Sigma y}{\sqrt{[N\Sigma x\,2 - \Sigma(x)2][N\Sigma y2 - \Sigma(y)2}}$$

where,

r = Pearson r correlation coefficient

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

N = number of observations corresponding to Meteorological standard week
Σx = sum of the average weather parameters data having x1 as max. temperature, x2 as min. temperature and so on according to the number of parameters.
Σy = sum of the average thrips population taken according to the transplanting date corresponding meteorological standard week.
Σxy = sum of the product of the above two variables.
Σx^2 = sum of squares of x variables.
Σy^2 = sum of squares of y variables.

Significance Test:

To test whether the association is merely apparent, and might have arisen by chance we use the t-test in the following calculation:

$$\mathbf{t = r\sqrt{n - 2 / 1 - r^2}}$$

where,

r = correlation coefficient and n = number of observations.

Regression Analysis

In statistical modeling, regression analysis is a set of statistical processes for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables (or 'predictors').

Models: Regression models involve the following parameters and variables:
• The unknown parameters, denoted as β, which may represent a scalar or a vector.
• The independent variable, X.
• The dependent variable, Y.
A regression model related Y to a function of X and β Y ~ f (X,β)

ultiple Linear Regression Models:

In this analysis we used multiple linear regression model followed by the least square method. In this model there are several independent variables as weather factors or functions of these variables.

$$Yi = \beta0 + \beta1xi + \beta2xi + \varepsilon i, i = 1,2,3\ldots\ldots.10$$

where, Yi= i^{th} observation of the average week mean population
β0and β1 = parameters of the model to be estimated
xi = independent weather factors.
The description of these weather parameters attributing incidence on Garlic thrips is given below:

X1 = Maximum Temperature (°C)
X2 = Minimum Temperature (°C)
X3 = Morning Vapour Pressure (mm)
X4 = Evening Vapour Pressure (mm)
X5 = Mor. Relative Humidity (%)
X6 = Eve. Relative Humidity (%)
X7 = Wind Speed km/hr
X8 = Sunshine hours
X9 = Rainfall (mm)
X10 = Evaporation (mm)

ISSN PRINT 2319 1775 Online 2320 7876
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Coefficient of Multiple Determinations (R^2):

R-squared is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determination, or the coefficient of multiple determination for multiple regression. It is the percentage of response variable that is explained by a linear model. Or:

R-squared = Explained variation/ Total variation.

R-squared is always between 0 and 100%.

• 0% indicates that the model explains none of the variability of the response data around its mean.

• 100% indicates that the model explains all the variability of the response data around its mean. In general, the higher the R-squared, the better the model fits your data.

Square Root Transformation:

Square Root Transformation is used for count data consisting of small whole numbers and the data, where the data ranges either between 0 to 30% or 70 to 100%.

Data obtained from counting the rare events like number of infected plants due to thrips where square root transformation can be used before taking up analysis of variance to draw a meaningful conclusion or inference. If most of the values in a data set are small (less than 10) coupled with presence of zero values. Instead of using $\sqrt{x}$ transformation it is better to use$\sqrt{x} + 0.5$. Then Analysis of Variance to be conducted with transformed data and the mean table should be made from the transformed data instead of taking the mean from the original data because of the facts stated earlier.

Analysis of Variance:

Analysis of variance (ANOVA) is a collection of statistical models and their associated estimation procedures (such as the "variation" among and between groups) used to analyze the difference among group means in a sample. This technique enables us to break down the variance of the measured variables into the portions caused by several factors, varied singly or in combination, and a portion caused by experimental error.

The assumptions of the analysis of variance are:

• Observations are random to any conditions.

• Means and variances of measured variables are additive.

• Experimental errors are independent.

• Variances of the experimental errors (eij) for all pairs (i, j) are equal with common valueσe 2.

• Distribution of experimental errors is normal.

Model:

There are three classes of models used in the analysis of variance. But in this analysis of Garlic thrips incidence, we used Fixed-effects models.

The Fixed-effects model (class I) of analysis of variance applies to situations in which the experimenter applies one or more treatments to the subjects of the experiment to see whether the response variable values change. This allows the experimenter to estimate the ranges of response variable values that the treatment would generate in the population as a whole.

In this analysis of variance, the two-way classified data will be employed to find out the effect of different plant protection approaches over the meteorological weeks, it can be shown by the mathematical fixed effect model given below:

$y_{ij} = \mu + \alpha_i + \beta_j + e_{ij} i = 1, 2 \ldots m$

where,

y_{ij} = effect of the j^{th} value of the meteorological data under i^{th} level of plant protection approach.

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μ = general mean effect.

α_i = effect of i^{th} level of plant protection approach or treatments (i = 1, 2…4).

β_j = effect of j^{th} level of the data of particular meteorological data (j = 1, 2….10).

e_{ij}= is the error which are supposed to be normally, independently and identically distributed with zero mean and σe 2.

Results and Discussion

The results emanated from the data considered under the purview of this investigation are presented as follows:The Table 1 was shows the degree of association between the increases in average Garlic thrips population due to different weather conditions. To test whether the association was merely apparent and might have arisen by chance, we performed t-test. The test gave significant values in some of the transplanting dates which was shown by '*'for significance at 5% level and '**'for significance at 5 % and 1% both. On 1st November Transplanting date thrips population was significantly and positively correlated with maximum temperature and Evaporation while the other correlations were found to be non-significant. the 15th November Transplanting date the thrips population was significantly and positively correlated with Evaporation and negatively correlated with morning relative humidity. On 1st December Transplanting date thrips population was significantly and positively correlated with maximum temperature and Evaporation and negatively correlated with morning relative humidity. Similarly, on the 15thof December Transplanting date evaporation is negatively correlated with the thrips population remaining others are non-significant. Similarly, at the 1st January Transplanting date Minimum temperature and morning vapor pressure are significantly and positively correlated with the thrips population, while evening relative humidity is negatively correlated, remaining others are nonsignificant. At 15th January Transplanting minimum temperature is significantly and positively correlated and negatively and morning relative humidity and wind speed significantly and negatively correlated with the thrips population remaining others non-significant. (Hole, U. B. and Salunkhe, G. N., 1997)

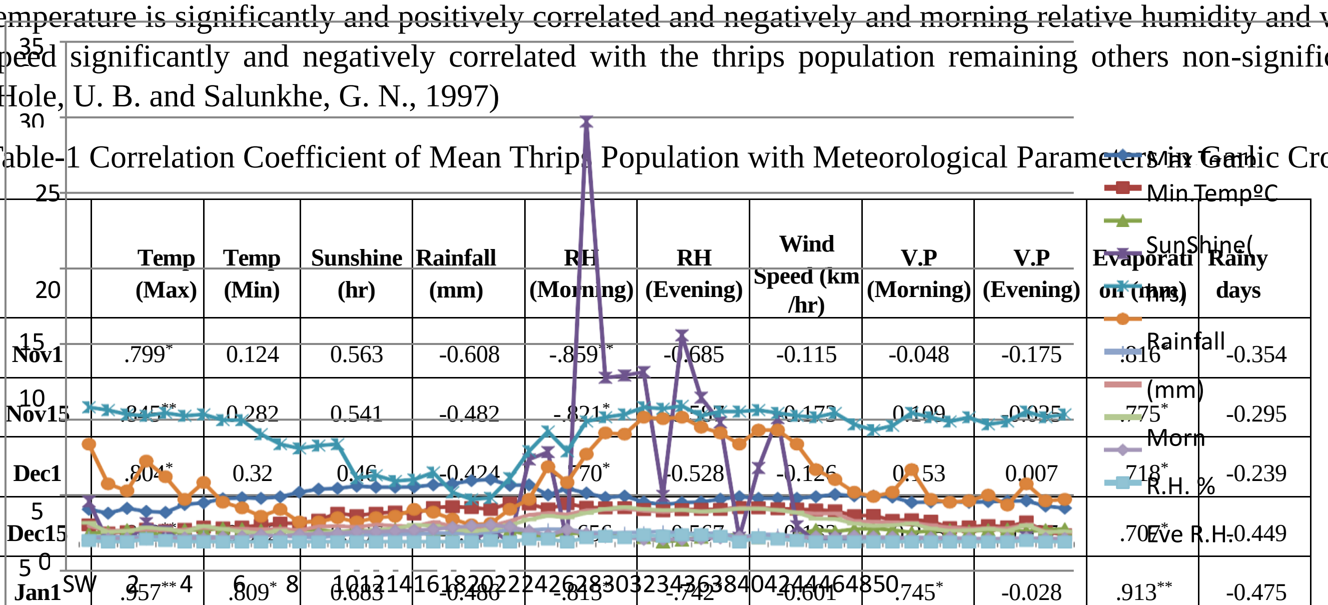

Table-1 Correlation Coefficient of Mean Thrips Population with Meteorological Parameters in Garlic Crop.

	Temp (Max)	Temp (Min)	Sunshine (hr)	Rainfall (mm)	RH (Morning)	RH (Evening)	Wind Speed (km /hr)	V.P (Morning)	V.P (Evening)	Evaporation (mm)	Rainy days
Nov1	.799*	0.124	0.563	-0.608	-.859**	-0.685	-0.115	-0.048	-0.175	.816*	-0.354
Nov15	.845**	0.282	0.541	-0.482	-.821*	[illegible]	-0.173	0.109	-0.035	.775*	-0.295
Dec1	.804*	0.32	0.46	-0.424	-.770*	-0.528	-0.126	0.153	0.007	.718*	-0.239
Dec15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.707*	-0.449
Jan1	.957**	.809*	0.683	-0.486	-.815*	-.742*	-0.601	.745*	-0.028	.913**	-0.475
Jan15	.870**	.725*	0.588	-0.382	-.798*	-0.657	-.773*	0.647	-0.031	.856**	-0.373

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

The graphshowsthechangingpatternofMeteorologicaldataduringtheGarliccropseasonoftheyear2011-12.

On**1st November Transplanting** date thrips population was significantly and positively correlated with maximum temperature and Evaporation while the other correlations were found to be non-significant.

On **15th November Transplanting** date thrips population was significantly and positivelycorrelatedwithEvaporationandnegativelycorrelatedwithmorningrelative humidity.

On **1st December Transplanting** date thrips population was significantly and positively correlated with maximum temperature and Evaporation and negatively correlated with morning relative humidity.

Similarly, at **15th December** Transplanting date evaporation is negatively correlated with the thrips population remaining others are non-significant.

Similarly, at the **1st January** Transplanting date Minimum temperature and morning vapor pressure are significantly and positively correlated with the thrips population, while evening relative humidity is negatively correlated, remaining others are non-significant.

At **15th January** Transplanting minimum temperature is significantly and positively correlated and negatively and morning relative humidity and wind speed significantly and negatively correlated with the thrips population remaining others non-significant.

TableNo.-2Correlationcoefficientsamongtheweathervariablesat1st NovemberTransplantingperiod.

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Y	1											
X1	.799*	1										
X2	0.124	0.448	1									
X3	0.563	.781*	-0.027	1								
X4	-0.608	-0.367	0.619	-0.626	1							
X5	-.859**	-0.666	0.090	-0.660	0.605	1						
X6	-0.685	-0.554	0.472	-.714*	.926**	0.702	1					
X7	-0.115	-0.253	-0.407	0.008	-0.397	0.220	-0.211	1				
X8	-0.048	0.347	.953**	-0.057	0.644	0.304	0.542	-0.307	1			
X9	-0.175	0.055	.881**	-0.370	.798*	0.381	.780*	-0.427	.892**	1		
X10	.816*	.796*	-0.138	.877**	-.756*	-.886**	-.883**	-0.040	-0.255	-0.517	1	
X11	-0.354	-0.522	0.237	-0.644	0.694	0.174	.748*	-0.288	0.138	0.478	-0.573	1

**.Correlationissignificantatthe0.01level(2-tailed).

*.Correlationissignificantatthe0.05level(2-tailed).

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Throughregressionanalysisleastsquaremethodtheregressioncoefficients $B=(X'X)^{-1}X'Y$ was obtained as follows:

TableNo.-3Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X1, X3, X6, X11)

Effect	Coefficients	Std.Error	t-value
Constant	-1.950	11.950	-0.163
X1	1.573	0.467	3.371
X3	-1.749	1.206	-1.450
X6	-0.376	0.131	-2.877
X11	3.745	2.177	1.720

Themeanpopulation(1st November)ofGarlicthripsperfiveplant Y_i considering variables i.e. X1, X3, X6, X11were obtained by the following regression equation:

$$\hat{Y}_i=-1.950+1.573X1-1.749X3-0.376X6+3.745X11$$

(0.467) (1.206) (0.131) (2.177)

TableNo.-4AnalysisofVarianceof the regressionmodelofmeanthrips population of Garlic crop on X1, X3, X6, X11

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	229.540	4	57.385	7.303	9.120	0.907
Residual	23.572	3	7.857			
Total	253.112	7				

Since,Fcal<Ftabthenullhypothesiswasacceptedandtherewasnosignificant difference among the variables. And R^2 i.e. coefficient of determination was 90%.Table- 4ANOVA was shows the weather variable combinations as X1 (Maximum Temperature), X3(Sunshine), X6(Evening Relative Humidity) and X11 (Rainy days) were taken into consideration for predicting the thrips population on the based on of zero-order correlation matrix .the value of the coefficient of determination (R^2) was found to be 90% showing the importance of Minimum Temperature, Sunshine and Evening Relative Humidity up to 90% towards the prediction of the thrips population.

TableNo.-5 Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X1, X6)

Effect	Coefficients	Std.Error	t-value
Constant	-8.938	15.045	-0.594
X1	1.002	0.467	2.144
X6	-0.152	0.124	-1.234

Theregressionequationwasobtainedasfollows:

$$\hat{Y}_i=-8.938+1.002X1-0.152X6 \ (0.124)$$

(0.467)

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

Table-6AnalysisofVarianceofthe regressionmodelofmeanthripspopulation of Garlic crop on X_1, X_6

Source	df	Sum of Squares	Mean Square	F-cal	F-tab	R Square
Regression	2	183.063	91.532	6.533	5.790	0.723
Residual	5	70.049	14.010			
Total	7	253.112				

Since,Fcal>Ftabthenullhypothesiswasrejectedandtherewassignificant differenceamongthevariables.AndR^2i.e.coefficientofdeterminationwas72%. Table-6 ANOVA was shows other, combinations which were remaineddue to not multicollinearity taken as X_1(Maximum Temperature) and X_6 (EveningRelativeHumidity)whichgavea 72%valueofR^2towardsthepredictionofthrips population.Therewasa Criticaldifferenceof9.619.

TableNo.-7 Regressioncoefficientsofthemodelofthrips populationwith meteorological parameters in Garlic crop (X1, X4)

Effect	Coefficients	Std.Error	t-value
Constant	-16.671	9.980	-1.670
X1	1.101	0.395	2.789
X4	-0.212	0.139	-1.524

Theregressionequationwasobtainedasfollows:

$$\hat{Y}i=-16.671+1.101X1–0.212X4$$
$$(0.395) \quad (0.139)$$

Table-8 AnalysisofVarianceofthe regressionmodelofmeanthripspopulation of Garlic crop

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	190.713	2	95.356	7.641	5.790	0.753
Residual	62.400	5	12.480			
Total	253.112	7				

on X1, X4

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

Since,Fcal>Ftabthenullhypothesiswasrejectedandtherewassignificant differenceamongthevariables.AndR^2i.e.coefficientofdeterminationwas75%. Table -8 ANOVA was showing a combination of X1(Maximum Temperature) and X4(Rainfall) had given the value of R^2 as 75% towards the prediction of thrips population.TherewasCriticaldifferenceof9.77.

TableNo.-9 Correlationcoefficientsamongtheweathervariablesat15^th^NovemberTransplantingperiod.

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Y	1											
X1	.845**	1										
X2	0.282	0.448	1									
X3	0.541	.781*	-0.027	1								
X4	-0.482	-0.367	0.619	-0.626	1							
X5	-.821*	-0.666	0.090	-0.660	0.605	1						
X6	-0.587	-0.554	0.472	-.714*	.926**	0.702	1					
X7	-0.173	-0.253	-0.407	0.008	-0.397	0.220	-0.211	1				
X8	0.109	0.347	.953**	-0.057	0.644	0.304	0.542	-0.307	1			
X9	-0.035	0.055	.881**	-0.370	.798*	0.381	.780*	-0.427	.892**	1		
X10	.775*	.796*	-0.138	.877**	-.756*	-.886**	-.883**	-0.040	-0.255	-0.517	1	
X11	-0.295	-0.522	0.237	-0.644	0.694	0.174	.748*	-0.288	0.138	0.478	-0.573	1

****.Correlationissignificantatthe0.01level(2-tailed).**

***.Correlationissignificantatthe0.05level(2-tailed).**

ThroughregressionanalysisleastsquaremethodtheregressioncoefficientsB= $(X'X)^{-1}X'Y$ was obtained as follows:

TableNo.-10 Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X2, X3, X4)

Effect	Coefficients	Std.Error	t-value
Constant	-12.041	7.842	-1.535
X2	3.124	1.000	3.125
X3	-0.787	1.093	-0.720
X4	-0.670	0.228	-2.942

Themeanpopulation(15th NOV)ofGarlicthripsperfiveplantYiconsidering variables i.e. X2, X3, X4were obtained by the following regression equation:

$\hat{Y}i$=-12.041+3.124X2-0.787X3-0.670X4

(1.000) (1.093) (0.228)

Table-11 AnalysisofVarianceofregressionmodelofmeanthripspopulation of Garlic crop on X2, X3, X4

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	155.454	3	51.818	5.483	6.590	0.804
Residual	37.806	4	9.451			
Total	193.260	7				

Since, Fcal< Ftabthe null hypothesis was accepted and there was no significant difference among the variables. And R^2i.e. coefficient of determination was 80%.Table-11 ANOVA was showing the weather variable combinations as X2 (Minimum Temperature), X3(Sunshine) and X4(Rainfall) were taken into consideration for predicting the thrips population on the basis of zero order correlation matrix the value of coefficient of determination (R^2) was found to be 80% showing the importance of Minimum temperature, Sunshine and Rainfall up to 80% towards prediction of thrips population.

TableNo.-12 Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X10, X11)

Model	Coefficients	Std.Error	t-value
Constant	-9.903	6.354	-1.559
X10	7.017	2.566	2.735
X11	1.548	2.294	0.675

Theregressionequationwasobtainedasfollows:

$\hat{Y}i$=-9.903+7.017X10+1.548X11

(2.566) (2.294)

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

TableNo.-13 AnalysisofVarianceofregressionmodelofmeanthrips population of Garlic crop on X10, X11

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	122.553	2	61.276	4.333	5.790	0.634
Residual	70.708	5	14.142			
Total	193.260	7				

Since, Fcal< Ftabthe null hypothesis was accepted and there were no significant difference among the variables. And R^2i.e. coefficient of determination was 63%. Table-13 ANOVA was showing another, combinations which was remained left due to not multicollinearity were taken as X10 (Evaporation) and X11(Rainy days) which gave 63% value of R^2towards the prediction of thrips population.

TableNo.-14 Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X2, X4)

Model	Coefficients	Std.Error	t-value
Constant	-14.874	6.449	-2.306
X2	2.700	0.768	3.516
X4	-0.542	0.136	-3.978

Theregressionequationwasobtainedasfollows:

$\hat{Y}i$=-14.874+2.700X2-0.542X4 (0.768)

(0.136)

TableNo.-15 AnalysisofVarianceofregressionmodelofmeanthrips population of garlic thrips on X2,X4

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	150.552	2	75.276	8.813	5.790	0.779
Residual	42.708	5	8.542			
Total	193.260	7				

Since,Fcal>Ftabthenullhypothesiswasrejectedandtherewassignificant difference amongthe 2

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

variables.AndR^2i.e.coefficientofdeterminationwas77%. Table -15 ANOVA was showing a combination of X2(Minimum Temperature) and X4(Rainfall) had given the value of R^2 as 77% towards the prediction of thrips population.There was Critical difference of 7.509

TableNo.16Correlationcoefficientsamongtheweathervariablesat1stDecemberTransplantingperiod.

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Y	1											
X1	.804*	1										
X2	0.320	0.448	1									
X3	0.460	.781*	-0.027	1								
X4	-0.424	-0.367	0.619	-0.626	1							
X5	-.770*	-0.666	0.090	-0.660	0.605	1						
X6	-0.528	-0.554	0.472	-.714*	.926**	0.702	1					
X7	-0.126	-0.253	-0.407	0.008	-0.397	0.220	-0.211	1				
X8	0.153	0.347	.953**	-0.057	0.644	0.304	0.542	-0.307	1			
X9	0.007	0.055	.881**	-0.370	.798*	0.381	.780*	-0.427	.892**	1		
X10	.718*	.796*	-0.138	.877**	-.756*	-.886**	-.883**	-0.040	-0.255	-0.517	1	
X11	-0.239	-0.522	0.237	-0.644	0.694	0.174	.748*	-0.288	0.138	0.478	-0.573	1

**.Correlationissignificantatthe0.01level(2-tailed).
*.Correlationissignificantatthe0.05level(2-tailed).

Through regression analysis least square method the regression coefficients $B = (X'X)^{-1}X'Y$ was obtained as follows:

TableNo.-17 Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X1, X2, X4)

Effect	Coefficients	Std.Error	t-value
Constant	-13.785	9.162	-1.505
X1	0.092	0.888	0.104
X2	2.072	2.089	0.992
X4	-0.397	0.356	-1.114

Theregressionequationwasobtainedasfollows:

$\hat{Y}i=-13.785+0.092X1-2.072X2–0.397X4$

(0.888) (2.089) (0.356)

TableNo.-18 AnalysisofVarianceofregressionmodelofmeanthrips population of Garlic crop on X1, X2, X4s

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

Regression	99.328	3	33.109	3.624	6.590	0.731
Residual	36.544	4	9.136			
Total	135.872	7				

Since, Fcal< Ftabthe null hypothesis was accepted and there was no significant difference among the variables. And R^2i.e. coefficient of determination was 73%. Table -18 ANOVA was showing the weather variable combinations as X1 (Maximum Temperature), X2(Minimum Temperature) and X4(Rainfall) were taken into consideration for predicting the thrips population on the basis of zero order correlation matrix the value of coefficient of determination (R^2) was found to be 73% showing the importance of Maximum temperature, Minimum Temperature and Rainfall up to 73% towards prediction of thrips population.

TableNo.-19 Regressioncoefficientsofthe modelofthripspopulationwith meteorological parameters in Garlic crop (X2, X3, X4)

Effect	Coefficients	Std.Error	t-value
Constant	-9.678	6.909	-1.401
X2	2.790	0.881	3.167
X3	-0.960	0.963	-0.997
X4	-0.586	0.201	-2.923

Theregressionequationwasobtainedasfollows:

$\hat{Y}i$=-9.678+2.790X2–0.960X3–0.586X4 (0.201)

(0.963) (0.201)

TableNo.-20 AnalysisofVarianceofregressionmodelofmeanthrips population of Garlic crop on X2, X3, X4

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	106.525	3	35.508	4.840	6.590	0.784
Residual	29.348	4	7.337			
Total	135.872	7				

Since, Fcal< Ftabthe null hypothesis was accepted and there was no significant difference among the variables. coefficient of determination was 78%. Table-20 ANOVA was showing another, combination which was remained left due to not multicollinearity were taken as X2 (Minimum Temperature), X3(Sunshine) and X4(Rainfall), which gave 78% value of R^2 towards the prediction of thrips population.

ISSN PRINT 2319 1775 Online 2320 7876
  UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

TableNo.-21

Correlationcoefficientsamongtheweathervariablesat15thDecemberTransplantingperiod.

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Y	1											
X1	.860**	1										
X2	0.332	0.448	1									
X3	0.507	.781*	-0.027	1								
X4	-0.463	-0.367	0.619	-0.626	1							
X5	-0.656	-0.666	0.090	-0.660	0.605	1						
X6	-0.567	-0.554	0.472	-.714*	.926**	0.702	1					
X7	-0.133	-0.253	-0.407	0.008	-0.397	0.220	-0.211	1				
X8	0.225	0.347	.953**	-0.057	0.644	0.304	0.542	-0.307	1			
X9	0.027	0.055	.881**	-0.370	.798*	0.381	.780*	-0.427	.892**	1		
X10	.707*	.796*	-0.138	.877**	-.756*	-.886**	-.883**	-0.040	-0.255	-0.517	1	
X11	-0.449	-0.522	0.237	-0.644	0.694	0.174	.748*	-0.288	0.138	0.478	-0.573	1

**.Correlationissignificantatthe0.01level(2-tailed).

Through regression analysis least square method the regression coefficients $B = (X'X)^{-1}X'Y$ was obtained as follows:

TableNo.-22 Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X2, X3, X4, X5)

Effect	Coefficients	Std.Error	t-value
Constant	85.921	26.907	3.193
X2	2.360	0.459	5.146
X3	-1.421	0.501	-2.839
X4	-0.428	0.110	-3.896
X5	-0.988	0.276	-3.583

Themeanpopulation(15thDEC)ofGarlicthripsperfiveplantYiconsidering variables i.e. X2, X3, X4,

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

X5were obtained by the following regression equation:

$\hat{Y}i$=85.921+2.360X2-1.421X3–0.428X4-0.988X5

(0.459) (0.501) (0.110) (0.459)

TableNo.-23 AnalysisofVarianceofregressionmodelofmeanthrips population of Garlic crop on X2, X3, X4, X5

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	130.313	4	32.578	17.581	9.120	0.959
Residual	5.559	3	1.853			
Total	135.872	7				

Since,Fcal>Ftabthenullhypothesiswasrejectedandtherewassignificant difference among the variables. And R^2i.e. coefficient of determination was 95%. Table-23 ANOVA was showing the weather variable combinations as X2(Minimum Temperature), X3(Sunshine), X4(Rainfall) and X5(Morning Relative Humidity) taken into consideration for predicting the thrips population on the basis of zero order correlation matrix the value of coefficient of determination (R^2) was found to be 95% showing the importance of Minimum temperature, Sunshine and Morning Relative Humidity up to 95% towards prediction of thrips population.TherewasCriticaldifferenceof3.061.

TableNo.-24 Regressioncoefficientsofthemodelofthrips populationwith meteorological parameters in Garlic crop (X8, X10, X11)

Effect	Coefficients	Std.Error	t-value
Constant	-21.953	12.321	-1.782
X8	1.374	1.108	1.240
X10	6.253	2.297	2.722
X11	1.518	2.006	0.757

Themeanpopulation(15^{th}DEC)ofGarlicthripsperfiveplantYiconsidering variables i.e. X8, X10, X11were obtained by the following regression equation.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

TableNo.-25 AnalysisofVarianceofthe regressionmodelofmeanthrips population of Garlic crop on X8, X10, X11

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	92.656	3	30.885	2.859	6.590	0.682
Residual	43.216	4	10.804			
Total	135.872	7				

Since, Fcal< Ftabthe null hypothesis was accepted and there was no significant difference among the variables. And R^2i.e. coefficient of determination was 68%.Table-25 ANOVA was shows another, combination which was remained left due to not multicollinearity were taken as X8 (Morning Vapour Pressure), X10 (Evaporation) and X11 (Rainy days), which gave 68% value of R^2 towards the prediction of thrips population.

TableNo.-26Correlationcoefficientsamongtheweathervariablesat1stJanuaryTransplantingperiod

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Y	1											
X1	.957**	1										
X2	.809*	.800*	1									
X3	0.683	.805*	0.435	1								
X4	-0.486	-0.544	-0.035	-0.670	1							
X5	-.815*	-.858**	-.772*	-0.640	0.119	1						
X6	-.742*	-.777*	-0.287	-.724*	.819*	0.569	1					
X7	-0.601	-0.571	-0.474	-0.312	-0.017	.780*	0.398	1				
X8	.745*	.730*	.912**	0.468	-0.181	-0.553	-0.213	-0.230	1			
X9	-0.028	0.001	0.491	-0.223	0.470	-0.035	0.577	0.039	0.583	1		
X10	.913**	.941**	0.623	.848**	-0.559	-.870**	-.862**	-0.622	0.513	-0.284	1	
X11	-0.475	-0.528	-0.022	-0.629	.998**	0.101	.819*	-0.017	-0.163	0.471	-0.538	1

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

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**.Correlationissignificantatthe0.01level(2-tailed).

*.Correlationissignificantatthe0.05level(2-tailed).

Through regression analysis least square method the regression coefficients B = $(X'X)^{-1}X'Y$ was obtained as follows:

TableNo.-27Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X6, X7, X10)

Effect	Coefficients	Std.Error	t-value
Constant	-12.103	17.051	-0.710
X6	0.055	0.142	0.391
X7	-0.162	2.342	-0.069
X10	5.566	2.624	2.121

Themeanpopulation(1st JAN)ofGarlicthripsperfiveplantYiconsidering variables i.e. X6, X7,X10were obtained by the following regression equation:

$\hat{Y}i$=-12.103+0.055X6–0.162X7+5.566X10

(0.142) (2.342) (2.624)

TableNo.-28AnalysisofVarianceofregressionmodelofmeanthrips population of Garlic crop on X6, X7, X10

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	78.103	3	26.034	7.035	6.590	0.841
Residual	14.803	4	3.701			
Total	92.905	7				

Since,Fcal>Ftabthenullhypothesiswasrejectedandtherewassignificantdifferenceamongthevariables.AndR^2i. e.coefficientofdeterminationwas74%. Table 4.2.7.2 ANOVA was showed the weather variable combinations as X6 (Evening Relative Humidity), X7(Wind speed) and X10(Evaporation) were taken into consideration for predicting the thrips population on the based on zero-order correlation matrix. The value of the coefficient of determination (R^2) was found to be 84% showing the importance of Evening Relative Humidity, Wind speed and Evaporation up to 84% towards the prediction of thrips population.Therewasa Criticaldifferenceof6.85.

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

TableNo.-29 Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X7, X10, X11)

Effect	Coefficients	Std.Error	t-value
Constant	-6.554	13.564	-0.483
X7	-0.509	2.645	-0.192
X10	4.659	1.942	2.399
X11	-0.030	1.396	-0.022

Themeanpopulation(1^{st}JAN)ofGarlicthripsperfiveplantYiconsidering variables i.e. X7, X10, X11were obtained by the following regression equation:

$\hat{Y}i$=-6.554-0.509X7+4.659X10–0.030X11

(2.645) (1.942) (1.396)

TableNo.-30 AnalysisofVarianceofthe regressionmodelofmean thrips population of Garlic crop on X7, X10, X11

Source	Sum of Squares	df	Mean Square	F-cal	F-tab	R Square
Regression	77.539	3	25.846	6.728	6.590	0.835
Residual	15.367	4	3.842			
Total	92.905	7				

Since,Fcal>Ftabthenullhypothesiswasrejectedandtherewassignificantdifferenceamongthevariables.AndRi.e .coefficientofdeterminationwas83%.Table-30 ANOVA was showed other, combinations which were remained left due to not multicollinearity were taken as X7(Wind Speed), X10(Evaporation) and X11(Rainy days) which gave 83% value of R^2 towards the prediction of thripspopulation.Therewasa Criticaldifferenceof4.448.

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ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

TableNo.-31 Correlationcoefficientsamongtheweathervariablesat15th JanuaryTransplantingperiod.

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Y	1											
X1	.870**	1										
X2	.725*	.800*	1									
X3	0.588	.805*	0.435	1								
X4	-0.382	-0.544	-0.035	-0.670	1							
X5	-.798*	-.858**	-.772*	-0.640	0.119	1						
X6	-0.657	-.777*	-0.287	-.724*	.819*	0.569	1					
X7	-.773*	-0.571	-0.474	-0.312	-0.017	.780*	0.398	1				
X8	0.647	.730*	.912**	0.468	-0.181	-0.553	-0.213	-0.230	1			
X9	-0.031	0.001	0.491	-0.223	0.470	-0.035	0.577	0.039	0.583	1		
X10	.856**	.941**	0.623	.848**	-0.559	-.870**	-.862**	-0.622	0.513	-0.284	1	
X11	-0.373	-0.528	-0.022	-0.629	.998**	0.101	.819*	-0.017	-0.163	0.471	-0.538	1

**.Correlationissignificantatthe0.01level(2-tailed).
*.Correlationissignificantatthe0.05level(2-tailed).

Through regression analysis least square method the regression coefficients B = $(X'X)^{-1}X'Y$ was obtained as follows:

TableNo.-32Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X3, X6, X8)

Effect	Coefficients	Std.Error	t-value
Constant	-7.788	9.624	-0.809
X3	-0.227	0.678	-0.335
X6	-0.150	0.093	-1.602
X8	1.937	1.043	1.858

Themeanpopulation(15th JAN)ofGarlicthripsperfiveplantYiconsidering variables i.e. X3, X6, X8 were obtained by the following regression equation:

$\hat{Y}i=-7.788–0227X3-0.150X6+1.937X8$

(0.678) (0.093) (1.043)

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

TableNo.-33AnalysisofVarianceofregressionmodelofmeanthrips population of Garlic crop on X3, X6, X8

Source	Sum of Squares	DF	Mean Square	F-cal	F-tab	R Square
Regression	31.426	3	10.475	3.249	6.59	0.709
Residual	12.898	4	3.225			
Total	44.325	7				

Since, Fcal< Ftabthe null hypothesis was accepted and there was no significant difference among the variables. And R^2i.e. coefficient of determination was 70%. Table-33 ANOVA was showing the weather variable combinations as X3 (Sunshine), X6(Evening Relative Humidity) and X8(Morning Vapour Pressure) were taken into consideration for predicting the thrips population on the basis of zero order correlation matrix.the value of coefficient of determination (R^2) was found to be 70% showing the importance of Sunshine, Evening Relative Humidity and Morning Vapour Pressure up to 70% towards prediction of thrips population.

Table-34 Regressioncoefficientsofthemodelofthripspopulationwith meteorological parameters in Garlic crop (X6, X8)

Effect	Coefficients	Std.Error	t-value
Constant	-9.006	8.079	-1.115
X6	-0.127	0.058	-2.173
X8	1.774	0.837	2.121

Themeanpopulation(15thJAN)ofGarlicthripsperfiveplantYiconsideringvariables i.e.X3,X6,X8wereobtainedbythefollowingregressionequation:

$\hat{Y}_i$=-9.006–0.127X6+1.774X8

(0.837)(0.058)

Table-35AnalysisofVarianceofregressionmodelofmeanthripspopulation of Garlic crop on X6, X8

Source	Sum of Squares	DF	Mean Square	F-cal	F-tab	R Square
Regression	31.065	2	15.533	5.857	5.79	0.701
Residual	13.259	5	2.652			
Total	44.325	7				

ISSN PRINT 2319 1775 Online 2320 7876
Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

Since,Fcal>Ftabthenullhypothesiswasrejectedandtherewasa significant difference among the variables. And R^2i.e. coefficient of determination was 70%. Table-35 ANOVA shows other, combinations which were remained left due to not multicollinearity were taken as X6(Evening Relative Humidity) and X8 (MorningVapourPressure),whichgavea 70% valueofR^2towardsthepredictionofthrips population.Therewasa Criticaldifferenceof4.183

Conclusion- The multiple regression procedure has been applied to study the pattern of seasonal fluctuations of garlic thrips through prediction models at different transplanting periods. Maximum temperature, vapor pressure, relative humidity, wind speed, evaporation and rainfall played an important role in governing the garlic thrips populationat different transplanting dates. On1st November Transplantingdate thrips population was significantly and positively correlated with maximum temperature and Evaporation while the other correlations were found to be non-significant. ANOVA was showing a combination of X1(Maximum Temperature) and X4(Rainfall) giving the value of R^2 as 75% towards the prediction of the thrips population.

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Reference-

Bagle, B. G. 1993. Seasonal incidence and control of thrips, *Scirtothrips* dorsalis Hood in Pomegranate. Indian J. Ent., 55 (2) : 148-153.

Borah, D. C. 1987. Bioecology of Polyphagotarsonemus latus Banks) (Acari: Tarsonemidae) and Scirtothrips dorsails Hood (Thysanoptera : Thripidae) infesting chilli and their natural enemies. Ph.D. Thesis submitted to UAS, Dharwad, 165-202.

Butani, D.K. and Verma, S. (1976) Pest of Vegetable and Their Control-3: Potato. Pesticides, 10, 46-51.

Chhatrol, D.P;Vyas, H.J. and Baraiya, K.P (2003). Influence of abiotic factors on the population buildup of thrips, (Thripstabaci Lindeman) in garlic. Indian J. Plant Prot, 31(2):98-100.

Deborah M. Kendall and Louis B. Bjostad 1990 Journal of Chemical Ecology. Volume 16, pages 981-991.

Hill DS. Tropical Crops and Their Pest Spectra. In: Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, London. 1983, 614.

Hole, U. B. and Salunkhe, G. N., 1997, Incidence of mites in relation to meteorological parameters on rose.

J. Maharashtra Agril. Unvi., 22 (2): 226-230.

Richards, L.A. (1968). Diagnosis and Improvement of Saline and Alkali Soil. U.S.D.A. Hand Book No. 60. Oxford and IBH Publishing Co., New Delhi.

ISSN PRINT 2319 1775 Online 2320 7876

 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

Snell, P.D. and Snell, G.T. (1949). Colorimetric method of analysis, 3rd Edn. Vol. II-D, Van Mostrand Co. Inc. New York.

Subbiah, B.V. and Asija, G.L. (1956). Rapid procedure for the estimation of available nitrogen in soil. Current Science 27:259-60.

Virmani, S.M.1994. The twenty first – Dr. R.V. Tamhane Memorial Lecture: UNCEED Agenda 21: The new challenge for sprite in research. *Journal of Indian Society of Soil Science*, 42: 516-523.