

Original Research Article

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Estimating of Different Plant Protection Strategies and Transplanting Periods on Garlic Thrips Incidence in Jabalpur District: A Statistical Approach

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ABSTRACT

This study was to describe the applicability of Square Root Transformation, ANOVA techniques 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 November 2012, 15th November 2012, 1st December 2012, 15th December 2012, 1st January 2012, 15th January 2012). The aimed of this study was analyze the impact of different plant protection strategies and transplanting periods on Garlic thrips incidence using Statistical Approach. The statistical analysis was by treatment 2nd i.e. insecticide + fungicide is found to be better than that of all the treatments at all date of transplanting periods.

Introduction

Garlic (*Allium sativum* L.) is an important crop cultivated globally, particularly valued for its culinary and medicinal properties. India ranks among the top producers of garlic, and within the country, the Jabalpur district in Madhya Pradesh plays a significant role in its production.

However, the successful cultivation of garlic is often hindered by various pests, with garlic thrips (*Thrips tabaci*) being one of the most destructive. Thrips cause substantial economic losses by feeding on the sap of garlic plants, leading to reduced bulb size, delayed maturity, and overall yield decline. Effective management of thrips is thus crucial for maximizing garlic productivity. 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 with various scientific synonyms viz.; *T. solanaceosorum* (portschinskii); *T. striatus* (Gilette); *T. allii* (Sirrime Lowe) and *T. flava* obsoleta (Uzei). It was first recoded in North America in 1872; thereafter in early 1900s it spreaded throughout the United States and Southern Canada (Capinera, 2001).

In India, the thrips was recorded in for the first time by Dyadechko (1977). The thrips, *T. tabaci* found infesting many vegetables such as asparagus, bean, beet, cabbage, cantaloupe, carrot, cauliflower, celery, cowpea, etc.

Thrips prefer to feed on newly emerged leaves in the centre of neck therefore, majority of thrips are found at the base of the younger leaves in the lower centre of the neck on garlic. 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 Bjostad, 1990).

Both nymphs and adults of the thrips were found between leaf sheaths and stem. In case of severe infestation, the bulb remains undersized and gets distorted (Butani and Verma, 1976).

This study employs a statistical approach to rigorously evaluate and compare the incidence of garlic thrips under different experimental treatments. Statistical tools such as analysis of variance (ANOVA) will be used to test the hypotheses and draw meaningful conclusions, ensuring that the findings are backed by robust data.

To develop effective and sustainable thrips management strategies, it is essential to understand how different plant protection methods and transplanting periods impact thrips incidence. A thorough analysis of the interactions between these factors can help identify the most efficient methods for reducing thrips populations, minimizing crop damage, and ultimately increasing yield.

Materials and Methods

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

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 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 the several factors, varied singly or in combination, and a portion caused by experimental error.

There are three classes of models used in 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 situation 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 mathematical fixed effect model given below:

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

where,

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

μ = general mean effect.

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

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

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

Hypothesis

H_0 : there is no significant difference among the treatment means.

H_1 : there is significant difference among the treatment means.

Experimental Design

The design used for the two-way classification model is Randomized Complete Block Design (RCBD). The RCBD is the standard design for agricultural experiments where similar experimental units are grouped into blocks or replicates. The defining feature of the RCBD is that each block sees each treatment exactly once, generally more precise able. No restrictions on the number of treatments or replicates.

The data were analyzed as per the standard procedure for "Analysis of Variance" (ANOVA) as described by Gomez and Gomez (1984). The significance of treatment was tested by 'F' test (Variance ratio). Standard error of mean was computed in all cases. The difference in the treatment mean was tested by using Critical Difference (CD) at 5% level of probability.

Results and Discussion

Analysis of Variance of the Garlic Thrips Population Using Square Root Transformation

The second objective of the thesis was fulfilled by performing ANOVA techniques i.e. to study the impact of different plant protection strategies on thrips population of Garlic crop with the use of square root transmission.

For this we calculated the square root values of each treatment means as $\sqrt{x + 0.5}$ and proposed a two-way classification model under null hypothesis as H_0 : There was no significant difference among the treatment means, corresponding with RCBD. Due to less observation numbers, we excluded some of the transplanting dates due to low error degree of freedom.

At 1st October Transplanting

The average thrips population at Different transplanting date under different plant protection approaches calculated by square root transformation given as follows:

ANOVA table no. -2 shows that $F_{cal} < F_{tab}$ i.e. null hypothesis was accepted and there was no significant difference among the treatments for the occurrence of Garlic thrips.

ANOVA table no.-3 shows that $F_{cal} > F_{tab}$ i.e. null hypothesis was rejected and there was a significant difference among the treatments for the occurrence of Garlic thrips.

The Critical Difference (C.D.) between any two means were found to be $CD(0.05) = 0.462$ showing that the treatment T_3 (Control) differed significantly at 1% and 5% level of significance with other three treatments while the Fungicides and its mixture were found to be at par.

Comparison of Treatment Means with Critical Difference

The treatment means are arranged in decreasing order of their magnitude given below:

T_3	T_2	T_1
2.349	2.132	1.000
a	a	b

The same symbol subscripts indicate about non-significant difference while the other symbols, indicating the significant difference.

ANOVA table no.-4 shows that $F_{cal} > F_{tab}$ i.e. null hypothesis was rejected and there was a significant difference among the treatments for the occurrence of Garlic thrips.

The Critical Difference (C.D.) between any two means were found to be $CD(0.05) = 0.249$ showing that the treatment T_3 (Control) differed significantly at 1% and 5% level of significance with other three treatments while the Fungicides and its mixture were found to be at par.

Comparison of Treatment Means with Critical Difference

The treatment means are arranged in decreasing order of their magnitude given below:

T3	T2	T1
2.380	1.739	1.000
a	b	c

The same symbol subscripts indicate about non-significant difference while the other symbols, indicating the significant difference.

ANOVA table no.-5 shows that $F_{cal} > F_{tab}$ i.e. null hypothesis was rejected and there was a significant difference among the treatments for the occurrence of Garlic thrips.

The Critical Difference (C.D.) between any two means were found to be $CD(0.05) = 0.215$ showing that the treatment T3 (Control) differed significantly at 1% and 5% level of significance with other three treatments while the Fungicides and its mixture were found to be at par.

Comparison of Treatment Means with Critical Difference

The treatment means are arranged in decreasing order of their magnitude given below:

T3	T1	T2
1.481	1.000	1.000
a	b	b

The same symbol subscripts indicate about non-significant difference while the other symbols, indicating the significant difference.

ANOVA table no.-6 shows that $F_{cal} > F_{tab}$ i.e. null hypothesis was rejected and there was a significant difference among the treatments for the occurrence of Garlic thrips. The Critical Difference (C.D.) between any two means were found to be $CD(0.05) = 0.459$ showing that the treatment T3 (Control) differed significantly at 1% and 5% level of significance with other three treatments while the Fungicides and its mixture were found to be at par.

Comparison of Treatment Means with Critical Difference

The treatment means are arranged in decreasing order of their magnitude given below:

T3	T1	T2
1.53	1.00	1.00
A	b	b

The same symbol subscripts indicate about non-significant difference while the other symbols, indicating the significant difference.

ANOVA table no.-7 shows that $F_{cal} > F_{tab}$ i.e. null hypothesis was rejected and there was a significant difference among the treatments for the occurrence of Garlic thrips. The Critical Difference (C.D.) between any two means were found to be $CD(0.05) = 0.491$ showing that the treatment T3 (Control) differed significantly at 1% and 5% level of significance with other three treatments while the Fungicides and its mixture were found to be at par.

Comparison of Treatment Means with Critical Difference

The treatment means are arranged in decreasing order of their magnitude given below:

T3	T2	T1
1.81	1.191	1.00
5		0
a	b	b

The same symbol subscripts indicate about non-significant difference while the other symbols indicating the significant difference.

ANOVA table no.-8 shows that $F_{cal} > F_{tab}$ i.e. null hypothesis was rejected and there was a significant difference among the treatments for the occurrence of Garlic thrips. The Critical Difference (C.D.) between any two means were found to be $CD(0.05) = 0.612$ showing that the treatment T3 (Control) differed significantly at 1% and 5% level of significance with other three treatments while the Fungicides and its mixture were found to be at par.

Table.1 Skeleton of Analysis of Variance following RCBD

S. V.	D f	SS	MSS	Fcal	Ftab
Treatment	$(t - 1)$	SS t	$SS_t / (t - 1) = V_t$	V_t/V_e	F at 5% (t - 1) (n - 1)
Block	$(r - 1)$	SS r	$SS_r / (r - 1) = V_r$		
Error	$(t - 1) (r - 1)$	SS e	$SS_e / (t - 1) (r - 1) = V_e$		
Total	$(rt - 1)$				

where,

t = number of treatments

r = number of replications

V_t = treatment variance

V_r = replication variance

V_e = error variance

Table.2 Analysis for average Garlic Thrips population

Transplanting	Treatment-1 (Fungicide)	Treatment-2 (Insecticide + Fungicides)	Treatment-3 (No Spray)
At 1 st October	2.110	2.333	2.272
At 15 th October	1.000	2.132	2.349
At 1 st November	1.000	1.739	2.380
At 15 th November	1.000	1.000	1.481
At 1 st December	1.000	1.000	1.530
At 15 th December	1.000	1.000	1.530
At 1 st January	1.000	1.208	1.888
At 15 th January	1.000	1.000	1.628

Table.3 ANOVA for treatment means at 1st October Transplanting

Source of Variation	DF	Sum of Squares	Mean Squares	F-Cal	F-tab
Replication	7	2.198	0.314		
Treatment	2	0.212	0.106	0.927	3.74
Error	14	1.605	0.115		
Total	23	4.016			

Table.4 ANOVA for treatment means at 15th October Transplanting

Source of Variation	DF	Sum of Squares	Mean Squares	F-Cal	F-tab
Replication	7	0.517	0.073		
Treatment	2	8.396	4.198	23.044	3.74
Error	14	2.55	0.182		
Total	23	11.463			

Table.5 ANOVA for treatment means at 15th November Transplanting

Source of Variation	DF	Sum of Squares	Mean Squares	F-Cal	F-tab
Replication	7	0.276	0.039		
Treatment	2	1.233	0.616	15.614	3.74
Error	14	0.553	0.039		
Total	23	2.062			

Table.6 ANOVA for treatment means at 1st December Transplanting

Source of Variation	DF	Sum of Squares	Mean Squares	F-Cal	F-tab
Replication	6	0.913	0.152		
Treatment	2	1.309	0.655	4.3	3.89
Error	12	1.827	0.152		
Total	20	4.05			

Table.7 ANOVA for treatment means at 15th December Transplanting

Source of Variation	DF	Sum of Squares	Mean Squares	F-Cal	F-tab
Replication	4	0.266	0.066		
Treatment	2	1.818	0.909	8.287	4.46
Error	8	0.878	0.11		

Table.8 ANOVA for treatment means at 1st January Transplanting

Source of Variation	DF	Sum of Squares	Mean Squares	F-Cal	F-tab
Replication	4	0.189	0.047		
Treatment	2	2.159	1.079	6.316	4.46
Error	8	1.367	0.171		
Total	14	3.716			

Table.9 ANOVA for treatment means at 15th January Transplanting

Source of Variation	DF	Sum of Squares	Mean Squares	F-Cal	F-tab
Replication	3	0.187	0.062		
Treatment	2	1.051	0.525	8.427	5.14
Error	6	0.374	0.062		
Total	11	1.612			

Comparison of Treatment Means with Critical Difference

The treatment means are arranged in decreasing order of their magnitude given below:

T3	T2	T1
1.88	1.20	1.00
a	b	b

The same symbol subscripts indicate about non-significant difference while the other symbols, indicating the significant difference.

ANOVA table no.-9 shows that $F_{cal} > F_{tab}$ i.e. null hypothesis was rejected and there was a significant difference among the treatments for the occurrence of Garlic thrips. The Critical Difference (C.D.) between any two means were found to be $CD(0.05) = 0.44$ showing that the treatment T3 (Control) differed significantly at 1% and 5% level of significance with other three treatments while the Fungicides and its mixture were found to be at par.

Comparison of Treatment Means with Critical Difference

The treatment means are arranged in decreasing order of their magnitude given below:

T3	T2	T1
1.628	1.000	1.000
a	b	b

The same symbol subscripts indicate about non-significant difference while the other symbols, indicating the significant difference.

The aimed of this study was analyze the impact of different plant protection strategies and transplanting periods on Garlic thrips incidence using Statistical Approach. At 1st October Transplanting date ANOVA shows that $F_{cal} < F_{tab}$ i.e. null hypothesis was accepted and there was a significant no difference among the treatments for the occurrence of Garlic thrips. And At 15th October, 1st November, 15th November, 1st December, 15th December, 1st January, 15th January Transplanting date ANOVA shows that $F_{cal} > F_{tab}$ i.e. null hypothesis was rejected and there was a significant

difference among the treatments for the occurrence of Garlic thrips. The statistical analysis was by treatment 2nd i.e. insecticide + fungicide is found to be better than that of all the treatments at all date of transplanting periods.

Author Contributions

Navneet Raj Rathore: Investigation, formal analysis, writing—original draft. S. S. Gautam: Validation, methodology, writing—reviewing. Neelash Patel:— Formal analysis, writing—review and editing. Chandan Nagar: Investigation, writing—reviewing. Suchita Jain: Resources, investigation writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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