

## Infestation and growth index on *Zea mays* by *Sitophilus zeamais* affected by temperature and humidity; created in *in-vitro* conditions

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### Abstract

The research compares the data of effects of humidity and temperature on infestation rates and growth rates of *Sitophilus zeamais* on *Zea mays* of 5 different districts of India based on creating *in-vitro* conditions similar to the district of Karimnagar (Telangana), Ghaziabad (U.P.), Karnal (Haryana), Kapurthala (Punjab) and Bhilwara (Rajasthan). This re-analyzes quantitative description and information needed for predicting the infestation and growth rates in different environments. T1- Karimnagar (Telangana)- High temperature with high humidity showed the highest infestation and growth index amongst the others. However when the temperature was increased a gradual increase in the growth and infestation was seen. T4- Bhilwara (Rajasthan) High temperature with low humidity showed lowest infestation and lowest growth index amongst all the treatments. Hence, it is evident that if the stored grains are kept in dry and cold storage conditions there are less chances of the thriving of the pest. T5-. Kapurthala (Punjab) Average temperature with average humidity showed higher growth index and infestation than T4 only at 20-40% of humidity. However T5 was still showing less growth index and infestation than T1 in both the conditions which means other factors may affect the same.

Predicting population rise pattern and developmental trends along with infestation and growth index trends is important for accurately timing insect sampling programs, their behavior with respect to the environment and control tactics.

**Keywords:** *Sitophilus zeamais*, humidity, temperature, growth index, infestation, *Zea mays*

### Introduction

*Sitophilus zeamais* is a loathsome pest of the stored grains. This pest destroys approximately 45%-60% of the stored grain. Knowing the infestation and growth patterns & trends helps in avoiding its growth. Temperature and humidity adversely affects growth index and infestation. However according to Aslam *et al.* the life span of *Sitophilus* is highly influenced by the temperature. There was a significant growth in the higher temperatures in comparison to low temperatures. Along with temperature, humidity also influences its growth. The growth was maximum when the R.H. was 60%. However it was observed that among 50%, 60% and 65% of relative humidity, 65% was most favorable.

### Material and method

#### Collection of plant

On the basis of availability of *Zea mays* were collected from different parts of India i.e. Karimnagar (Telangana), Ghaziabad (U.P.), Karnal (Haryana), Kapurthala (Punjab) and Bhilwara (Rajasthan) for rearing the pest *Sitophilus zeamais*.

**Study area:** The study was conducted in the zoology department of A.N.D.N.N.M. Mahavidhyalaya, Kanpur, Uttar Pradesh which is under the C.S.J.M. University of Kanpur.

#### Assessment of physical characters

The grains were sundried and then were stored in air tight jars to avoid moldiness. Completely intact and un-infested grains were used for the experimental procedure.

#### Grain moisture content and its removal

Silva [10] method was used for checking the moisture in the maize grain. 50grams of grain was placed on previously

weighed crucibles. It was then heat dried between 95-105°F in hot air oven until the grain weight was absolutely constant.

Moisture content = Initial weight – Final dried weight

#### Grain weight

Infestation was studied for the grain weight. So, 50 grams of fresh grains were taken for weighing. The measures of the weight was noted down. The process was repeated every 10 days for 2 months.

#### Removal of hidden infestation

The infestation of algae, fungi, other organisms and insects were eliminated by heat sterilization of the grain from 25-30°C for 20-30 min.

**Collection of insect:** Eggs of *Sitophilus zeamais* were collected from Chandra Shekhar Azad University Kanpur U.P. that infested variety *Baby Azad* of *Zea mays* which was then used as inoculum to induce the growth of the pest in different stored maize grains.

**Rearing of pest:** Eggs of *Sitophilus zeamais* were collected from the *Zea mays* var. *Baby Azad* and then used as inoculum in different varieties of *Zea mays* collected from Karimnagar (Telangana), Ghaziabad (U.P.), Karnal (Haryana), Kapurthala (Punjab) and Bhilwara (Rajasthan) for rearing the pest *Sitophilus zeamais*. for further experiment and observation. Rearing was done on *Zea mays* collected from Karimnagar (Telangana), Ghaziabad (U.P.), Karnal (Haryana), Kapurthala (Punjab) and Bhilwara (Rajasthan). Ample amount of food and air supply was provided in an *in-vitro* conditions, that's why the pest was kept in glass jars with 50grams of grain and the top of the jar

was covered with muslin cloth; hence creating a similar environment with a controlled temperature of 32°C with relative humidity of 60% that was set up for neonate larvae that were kept individually. Soon larvae turned into adults. Adults were kept in separate jar in pairs for mating and spawning. The jars were covered with muslin cloth for proper aeration. Periodical examination at an interval of a week was done during whole experiment.

**Districts of different topographical areas of India**

Treatments were grouped as T1- Karimnagar (Telangana)- High temperature with high humidity, T2- Ghaziabad (U.P.) Moderate temperature with average humidity, T3- Karnal (Haryana) Average temperature with above average humidity, T4- Bhilwara (Rajasthan) High temperature with very low humidity and T5- Kapurthala (Punjab) Average temperature with average humidity.

**Procedure of treatment:** In *in-vitro* conditions the steady temperature and humid conditions was created. As soon as first symptoms of infestation were observed, the readings were noted down. Readings were noted after an interval of every 10 days for about 3 times to see their infestation & growth index of *Sitophilus zeamais*.

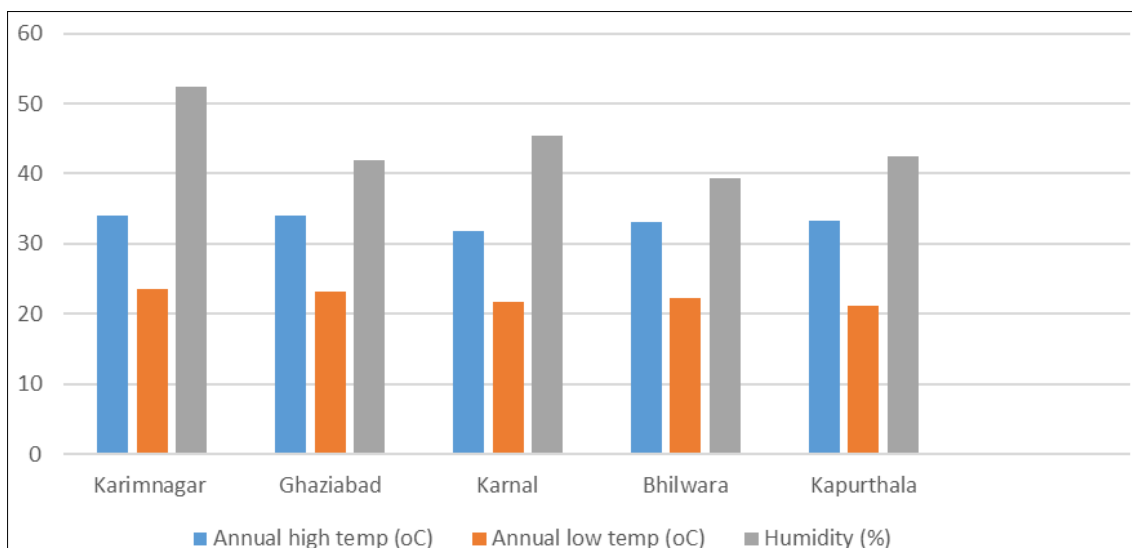
**Observation tables**

**Table 1:** Temperature in different districts (topographic areas) of India

S. No.	District	State	Annual high temp (°C)	Annual low temp (°C)	Warmest month (°C)	Coldest month (°C)
1.	Karimnagar	Telangana	33.93	23.62	May (42.81)	Dec (17.72)
2.	Ghaziabad	Uttar Pradesh	34.1	23.09	May (43.78)	Jan (11.03)
3.	Karnal	Haryana	31.88	21.73	Jun (42.8)	Jan (9.98)
4.	Bhilwara	Rajasthan	33.06	22.32	May (41.68)	Jan (12.16)
5.	Kapurthala	Punjab	33.32	21.14	Jun (43.71)	Jan (8.36)
6.	Control		-	-	-	-

**Table 2:** Humidity in different districts (topographic areas) of India

S. No.	District	State	Wettest month (mm)	Driest month (mm)	Humidity (%)
1.	Karimnagar	Telangana	Aug (309.52)	Feb (6.65)	52.49
2.	Ghaziabad	Uttar Pradesh	Jul (252.45)	Nov (3.71)	41.84
3.	Karnal	Haryana	Aug (67.97)	Oct (0.41)	45.47
4.	Bhilwara	Rajasthan	Aug (438.47)	Dec (0.42)	39.31
5.	Kapurthala	Punjab	Aug (213.55)	Oct (0.3)	42.51
6.	Control		-	-	-



**Chart 1:** Temperature (°C) and Humidity percent in different districts (topographic areas) of India

**a. Data collection:** After an interval of every 10 days the experimental values were taken from the setup that was arranged. C.R.D. Design was used for the laboratory experiment.

**b. Statistical analysis:** Abbott’s formula was used and then analysis was done using the ANOVA method, for the correction of the experimental data:

$$F\text{-Value} = \frac{\text{Variance of 1}^{\text{st}} \text{ data set}}{\text{Variance of 2}^{\text{nd}} \text{ data set}}$$

**c. Calculation of weight loss:** These losses can ne estimated by=

$$\frac{\text{Total yield of maize (q ha-1)} - \text{Yield of healthy maize (q ha-1)}}{\text{Total yield of maize (q ha-1)}}$$

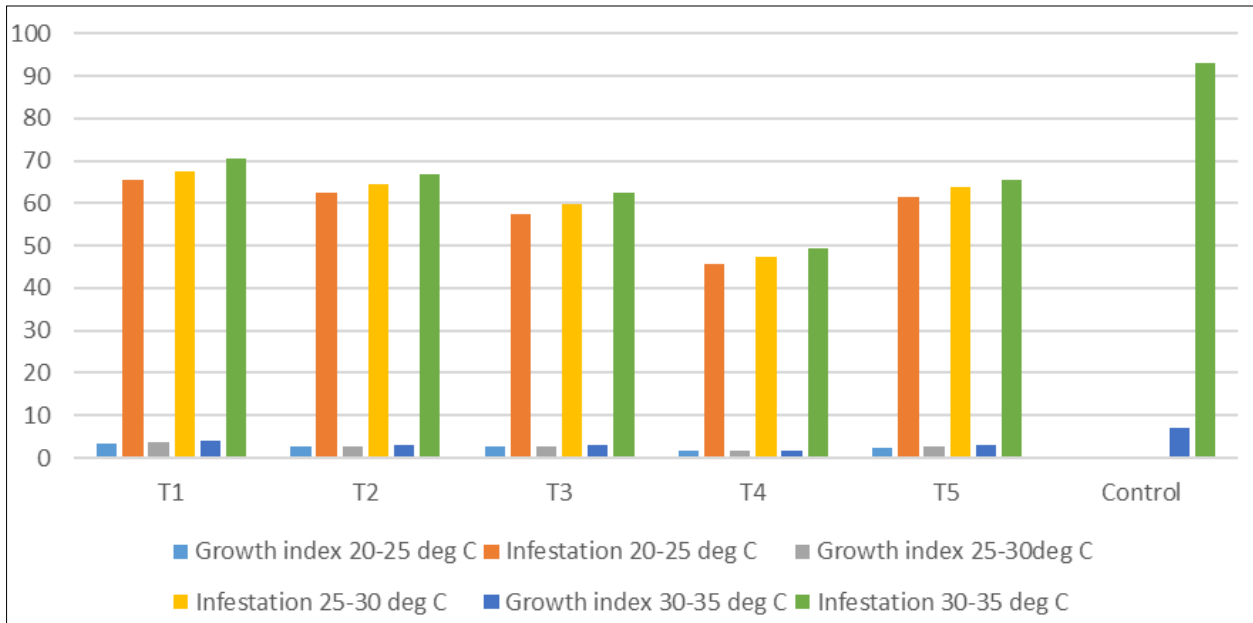
**d. Growth indices calculation:** Dividing the % of adult emerged from the mean no. of days for the adult formation (sum of larval and pupal period)

Adult formation= Larval period + Pupal period

Growth indices = % of adults emerged / mean no. of days for adult formation

**Table 3:** Growth index and infestation at 20-40 % of humidity with different temperature

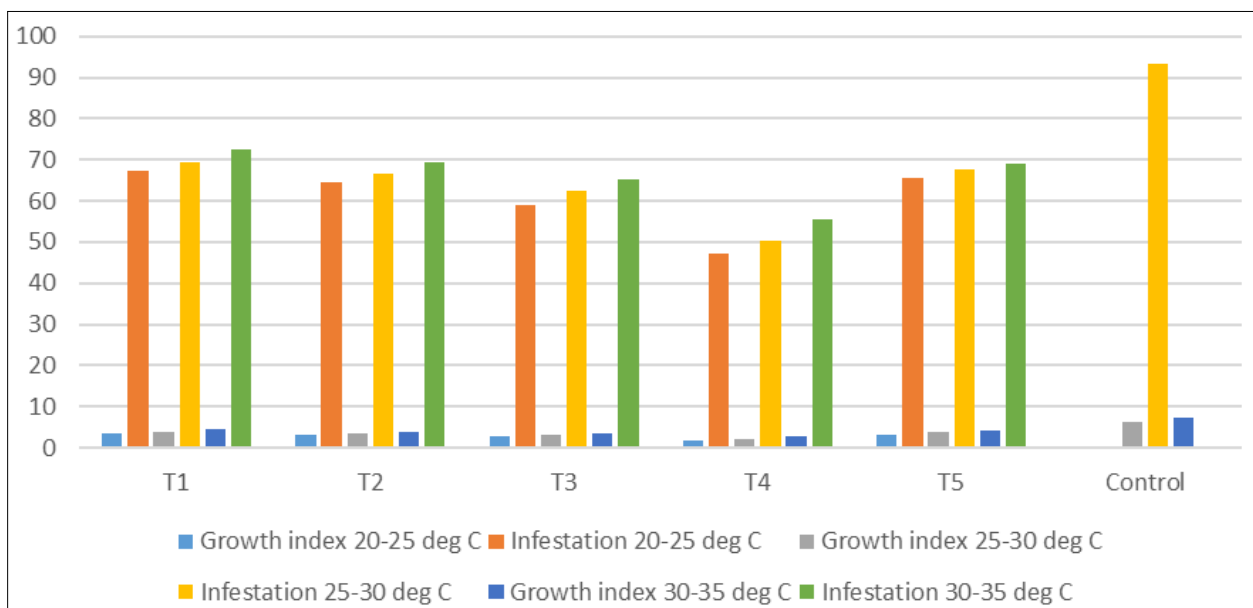
S.No.		20-25 (°C)		25-30 (°C)		30-35 (°C)	
		Growth index	Infestation	Growth index	Infestation	Growth index	Infestation
1.	T1	3.37	65.63	3.67	67.33	3.98	70.66
2.	T2	2.66	62.38	2.81	64.47	3.15	66.72
3.	T3	2.58	57.33	2.62	59.82	2.89	62.46
4.	T4	1.63	45.69	1.69	47.26	1.83	49.38
5.	T5	2.47	61.47	2.73	63.72	3.01	65.33
6.	Control	-	-	-	-	6.95	92.87



**Chart 2:** Growth index and infestation at 20-40 % of humidity with different temperature

**Table 4:** Growth index and infestation at 40-60 % of humidity with different temperature

S. No.		20-25 (°C)		25-30 (°C)		30-35 (°C)	
		Growth index	Infestation	Growth index	Infestation	Growth index	Infestation
1.	T1	3.44	67.37	3.89	69.45	4.58	72.34
2.	T2	2.95	64.50	3.57	66.63	3.96	69.53
3.	T3	2.67	59.00	3.15	62.36	3.47	65.34
4.	T4	1.88	47.33	2.10	50.27	2.68	55.67
5.	T5	3.01	65.45	3.66	67.50	4.03	69.15
6.	Control	-	-	6.33	93.28	7.13	94.99



**Chart 3:** Growth index and infestation at 40-60 % of humidity with different temperature



**Fig 1:** Female *Sitophilus zeamais* with its curved snout. **Fig 2:** Mating in *Sitophilus zeamais* **Fig 3:** Infestation due to *Sitophilus zeamais* in *Zea mays* variety *Vijay*.

## Result

T1- Karimnagar (Telangana)- High temperature with high humidity showed annual high temperature of 33.93°C and annual low temperature of 23.62 °C with humidity 52.49% (as shown in Table 1&2). The value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 3.37, 3.67 & 3.98 (table-3) whereas for 40-60% humidity showed 3.44, 3.89 & 4.58 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4). However the trends in infestation showed that at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 65.63, 67.33 & 70.66 (table-3) whereas for 40-60% humidity showed 67.37, 69.35 & 72.34 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4)

T2- Ghaziabad (U.P.) Moderate temperature with average humidity showed annual high temperature of 34.1°C and annual low temperature of 23.09°C with humidity 41.84% (as shown in Table 1&2). The value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 2.66, 2.81 & 3.15 (table-3) whereas for 40-60% humidity showed 2.95, 3.57 & 3.96 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4). Though the inclinations in infestation showed at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 62.38, 64.47 & 66.72 (table-3) whereas for 40-60% humidity showed 64.50, 66.63 & 69.53 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4).

T3- Karnal (Haryana) Average temperature with above average humidity, annual high temperature of 31.88°C and annual low temperature of 21.73°C with humidity 45.47% (as shown in Table 1&2). The value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 2.58, 2.62 & 2.89 (table-3) whereas for 40-60% humidity showed 2.67, 3.15 & 3.47 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4). The trends in infestation showed at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C were 57.33, 59.82 & 62.46 (table-3) whereas for 40-60% humidity showed 59.00, 62.36 & 65.34 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4).

T4- Bhilwara (Rajasthan) High temperature with low humidity of 33.06°C and annual low temperature of 22.32°C with humidity 39.31% (as shown in Table 1&2). The value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 1.63, 1.69 & 1.83 (table-3) whereas for 40-60% humidity showed 1.88, 2.10 & 2.68 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4). The trends in infestation showed at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C were 45.69, 47.26 & 49.38 (table-3) whereas

for 40-60% humidity showed 47.33, 50.27 & 55.67 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4).

T5-. Kapurthala (Punjab) Average temperature with average humidity showed annual high temperature of 33.32°C and annual low temperature of 21.14°C with humidity 42.51% (as shown in Table 1&2). The value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 2.47, 2.73 & 3.01 (table-3) whereas for 40-60% humidity showed 3.01, 3.66 & 4.03 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4); but the trends in infestation showed at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C were 61.47, 63.72 & 65.33 (table-3) whereas for 40-60% humidity showed 65.45, 67.50 & 69.15 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4).

## Discussion

T1- Karimnagar (Telangana)- High temperature with high humidity showed the value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 3.37, 3.67 & 3.98 whereas for 40-60% humidity showed 3.44, 3.89 & 4.58 of growth index at 20-25 °C, 25-30 °C & 30-35 °C and infestation at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 65.63, 67.33 & 70.66 whereas for 40-60% humidity showed 67.37, 69.35 & 72.34 of growth index at 20-25 °C, 25-30 °C & 30-35 °C which was the highest infestation and growth index amongst the others. However when the temperature was increased a gradual increase in the growth and infestation was seen. However, based on Lu et al. (2023), if fed on wheat rice, weevil adults can withstand RHs with values from 40 to 70% which was also true for maize weevil because when they were fed with rich amylopectin content maize grains, the pests could withstand relatively high relative humidity which was clearly observed in this experimental setup.

T2- Ghaziabad (U.P.) Moderate temperature with average humidity showed the value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 2.66, 2.81 & 3.15 (table-3) whereas for 40-60% humidity showed 2.95, 3.57 & 3.96 of growth index at 20-25 °C, 25-30 °C & 30-35 °C (table-4). Though the inclinations in infestation showed at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 62.38, 64.47 & 66.72 (table-3) whereas for 40-60% humidity showed 64.50, 66.63 & 69.53 of growth index at 20-25 °C, 25-30 °C & 30-35 °C which was relatively more than T3, T4 & T5 but it was still lower than T1 in 20-40% of humidity. The results altered when the experimental setup was kept in 40-60% of humidity where T2's growth index

and infestation was better than T3 and T4 but not than T5 & T1.

T3- Karnal (Haryana) Average temperature with above average humidity the value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 2.58, 2.62 & 2.89 whereas for 40-60% humidity showed 2.67, 3.15 & 3.47 of growth index at 20-25 °C, 25-30 °C & 30-35 °C. The trends of infestation showed at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C were 57.33, 59.82 & 62.46 whereas for 40-60% humidity showed 59.00, 62.36 & 65.34 of growth index at 20-25 °C, 25-30 °C & 30-35 °C which was relatively more than T3, T4 & T5 but it was still lower than T1 in 20-40% of humidity. The results altered when the experimental setup was kept in 40-60% of humidity where T2's growth index and infestation was better than T3 and T4 but not than T5 & T1. This clearly states that humidity and temperature are not only the deciding factor causing the rise in the infestation and growth index.

T4- Bhilwara (Rajasthan) High temperature with low humidity the value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 1.63, 1.69 & 1.83 whereas for 40-60% humidity showed 1.88, 2.10 & 2.68 of growth index at 20-25 °C, 25-30 °C & 30-35 °C. The trends in infestation showed at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C were 45.69, 47.26 & 49.38 whereas for 40-60% humidity showed 47.33, 50.27 & 55.67 of growth index at 20-25 °C, 25-30 °C & 30-35 °C which was lowest amongst all the treatments. Hence, it is evident that if the stored grains are kept in dry and cold storage conditions there are less chances of the thriving of the pest.

T5-. Kapurthala (Punjab) Average temperature with average humidity showed the value of growth index with 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C was 2.47, 2.73 & 3.01 whereas for 40-60% humidity showed 3.01, 3.66 & 4.03 of growth index at 20-25 °C, 25-30 °C & 30-35 °C; but the trends in infestation showed at 20-40% humidity for 20-25 °C, 25-30 °C & 30-35 °C were 61.47, 63.72 & 65.33 whereas for 40-60% humidity showed 65.45, 67.50 & 69.15 of growth index at 20-25 °C, 25-30 °C & 30-35 °C which showed higher growth index and infestation than T4 only at 20-40% of humidity. The trends altered when T5 was subjected to 40-60% humidity which helped the pest to thrive better than the T2, T3 & T4 treatments. Based on Lu et al. (2023), the activity of adult insects can be affected by the lower humidity level. Lack of water can cause death (Lu et al., 2023). According to Mason and McDonough (2012), rice weevils favour higher temperatures for their development, which was also confirmed for maize weevil in our study. However T5 was still showing less growth index and infestation than T1 in both the conditions which means other factors may affect the same.

## Conclusion

T1- Karimnagar (Telangana)- High temperature with high humidity showed the highest infestation and growth index amongst the others. However when the temperature was increased a gradual increase in the growth and infestation was seen. T2- Ghaziabad (U.P.) Moderate temperature with average humidity showed relatively more infestation and growth index than T3, T4 & T5 but it was still lower than T1 in 20-40% of humidity. The results altered when the experimental setup was kept in 40-60% of humidity where T2's growth index and infestation was better than T3 and T4 but not than T5 & T1. T3- Karnal (Haryana) Average

temperature with above average humidity showed relatively more than T3, T4 & T5 but it was still lower than T1 in 20-40% of humidity. The results altered when the experimental setup was kept in 40-60% of humidity where T2's growth index and infestation was better than T3 and T4 but not than T5 & T1. This clearly states that humidity and temperature are not only the deciding factor causing the rise in the infestation and growth index. T4- Bhilwara (Rajasthan) High temperature with low humidity showed lowest infestation and lowest growth index amongst all the treatments. Hence, it is evident that if the stored grains are kept in dry and cold storage conditions there are less chances of the thriving of the pest. T5-. Kapurthala (Punjab) Average temperature with average humidity showed higher growth index and infestation than T4 only at 20-40% of humidity. The trends altered when T5 was subjected to 40-60% humidity which helped the pest to thrive better than the T2, T3 & T4 treatments. However T5 was still showing less growth index and infestation than T1 in both the conditions which means other factors may affect the same.

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**Declaration: Conflicts of interest-** I, Safia Asgher, hereby declare that there is no conflict of interest regarding this research work.

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