



## Temperature and Humidity Effects on Fruit Fly abundance and Distribution "Comparative Study"

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### Keywords:

*Bactrocera Zonata*  
*Bactrocera Oleae*  
*Ceratitis Capitata*  
Climate change  
Temperature  
Relative humidity

### ABSTRACT

Living organisms are affected by climate changes, and this affects their reproduction or extinction. In this study, it was shown that when temperatures rise, a type of fly, *Ceratitis Capitata*, increases and decreases with the entry of the cold months and there is a positive relationship between them with a correlation coefficient of 0.13, and with an increase in relative humidity the relationship is negative with this type decreasing with a correlation coefficient of -0.01, while the opposite happens with each of the species *Bactrocera Zonata* and *Bactrocera Oleae*, which increase with decreasing temperatures and decrease with increasing temperatures. The type of correlation was strong negative, about -0.67. -0.46, respectively, while their quantities increase with high humidity and decrease with low humidity, where the positive relationship is about 0.27 and 0.13, and by clarifying the climate variables represented in temperature and relative humidity with the three types of flies using the marginal probability function, it turns out that the species *Bactrocera Zonata* is suitable for the climate for this period.

### تأثير درجة الحرارة والرطوبة على انتشار وتكاثر ذبابة الفاكهة "دراسة مقارنة"

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### الكلمات المفتاحية:

ذبابة الخوخ  
ذبابة الزيتون  
ذبابة البحر المتوسط  
تغير المناخ  
درجة الحرارة  
الرطوبة النسبية

### الملخص

تأثر الكائنات الحية بالتغييرات المناخية، ويفتر ذلك على تكاثرها أو انقراضها، وقد تبين في هذه الدراسة أنه عند ارتفاع درجات الحرارة يزداد نوع من الذباب وهو *Ceratitis Capitata* وهناك علاقة طردية بينهما ويقل مع دخول الأشهر الباردة بمعامل ارتباط 0.13، ومع زيادة الرطوبة النسبية تكون العلاقة سلبية مع هذا النوع يتناقص بمعامل ارتباط -0.01، بينما يحدث العكس مع كل نوع، ومن الأنواع *Bactrocera Zonata* و *Bactrocera Oleae* التي تزداد بانخفاض درجات الحرارة وتقل بارتفاع درجات الحرارة، وكان نوع الارتباط سلبي قوي حوالي -0.67. -0.46 على التوالي، بينما تزداد كمياتها مع ارتفاع الرطوبة وتنخفض مع انخفاض الرطوبة، حيث تكون العلاقة الموجبة حوالي 0.27 و 0.13، ومن خلال توضيح المتغيرات المناخية المتمثلة بدرجة الحرارة والرطوبة النسبية مع أنواع الذباب الثلاثة باستخدام دالة الاحتمالية الهاشمية، تبين أن النوع هو المناسب للمناخ لهذه الفترة من السنة *Bactrocera Zonata*.

### 1. Introduction

Numerous factors, categorized according to the scale at which they have the greatest effects, affect the distribution of insects over time and space [1]. The Tephritidae family of fruit flies has about 4300 identified species spread over about 500 genera worldwide [2]. These are common agricultural pests that contaminate a wide variety of fruits and vegetables, leading to significant financial losses [3]. According to [4], *ceratitis capitata* is currently recognized in North Africa, the Mediterranean region, Europe, South and Central

America, Australia, and Hawaii. Fruit fly species pose a threat to the biodiversity of various ecological and agricultural systems in the Mediterranean region. Notably, three species of fruit fly, *Bactrocera oleae* Rossi, *Bactrocera zonata* Saunders, and *Ceratitis capitata* Wiedemann (Diptera: Tephritidae), are thought to be highly economically significant [5, 6,7].

Any species in the Tephritidae family is a fruit fly, and they are among the most devastating pests in the world. Their larvae mostly

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consume fruit, particularly apple, guava, pear, grape, and cherry. orange, avocado. Citrus fruits [8, 9, 10, 11]. demonstrating that the most substantial harm to fruit production and marketing is thought to be caused by *C. capitata* infestations. The most dangerous pest to olives globally, the olive fruit, fly *B. oleae*, is responsible for major impairment to olive output [7, 12, 13]. While the peach fly, *B. zonata*, is considered one of the most dangerous insect pests, attacking a variety of fruit trees, the Mediterranean fruit fly, *C. capitata*, is considered one of the most dangerous and economically significant pests, infecting all types of citrus fruits as well as the fruits of deciduous and stone trees [14]. Fruits and vegetables are just a few of its many hosts [15].

The population and attack rates of fruit fly species are influenced by meteorological elements including temperatures, humidity, and rainfall, which can vary depending on the ecological conditions. These species can occur throughout the year and be found in a wide range of climate conditions [16]. Temperature and humidity are the two main variables that affect insect biology; the length of time that fruit flies develop is also a key component [17]. Alongside the known changes in the global climate over the past few decades, there has been an increase in average worldwide temperatures [18].

Global climate change poses significant challenges to ecosystems and the environment, and even small adjustments to the main climate variables can have a significant impact on the population dynamics and spatial distribution of many harmful organisms, including fruit flies, which are major pests and have a significant economic impact in areas where they reproduce year-round. [19], and taking into consideration effects of climate change on the distribution of species and the requirement for creative solutions to heightened invasion threats [16].

### Objectives

- 1- The effect of climate factors on the diversity of fly species
- 2- Review previous studies on the effect of climate and its impact on the biological diversity of fruit flies.

### Study area and data

The study area was at the agricultural research station at the University of Tripoli, Libya, at latitude 32.846 and longitude 13.223. Traps were set for three types of flies (*Ceratitis Capitata*, *Bactrocera Zonata*, *Bactrocera Oleae*), for the time period from 1/6/2022 to 31/12/2022, and the climate data for Temperature (C°) and relative humidity (%) at the same location from the NASA website [20] for the same time period.



Figure 1: Study area

### Distribution of flies types with temperature and humidity

The month of June is considered the beginning of the summer season and is characterized by a gradual rise in temperatures and a gradual decrease until the end of the year. By collecting samples of the types of flies from the beginning of month 6 to the end of month 12, Figure 2 shows that the species *Ceratitis capitata* increases in prevalence with an increase in temperature, and while the type The second type, *Bactrocera Zonata*, has a higher prevalence when temperatures decrease, while the third type, *Bactrocera Oleae*, which increases in prevalence with a decrease in temperatures, as shown in Figure (2, a). It is known that humidity begins to rise at the end of the summer and the beginning of the fall, and it has been shown Figure (2, b) shows the relative humidity with the spread of fly species. It is shown that with *Ceratitis Capitata* it decreases with an increase in relative humidity, and in contrast with *Bactrocera Zonata* its spread

increases when the humidity is high, and similarly with the *Bactrocera Oleae* species it increases with high humidity. Figure (3, a) shows the total average of the samples he collected for the flies and the total average of temperatures and relative humidity. It was shown that the largest reproductive number is *Bactrocera Zonata*, as the climate is suitable for it during this period, unlike *Ceratitis Capitata* and *Bactrocera Oleae*. Variation analysis was conducted for these three species. Which was shown to have a statistically significant relationship at the level of significance p<0.001, as in Figure (3, b).

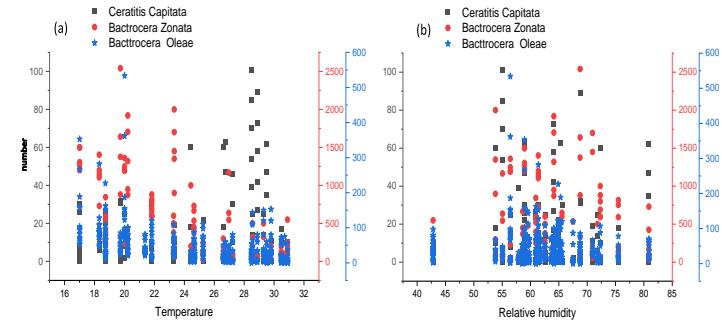


Figure 2: Distribution of types of flies with: (a) Temperature C°, (b) Relative humidity %, during the period from 6-12 months of 2022.

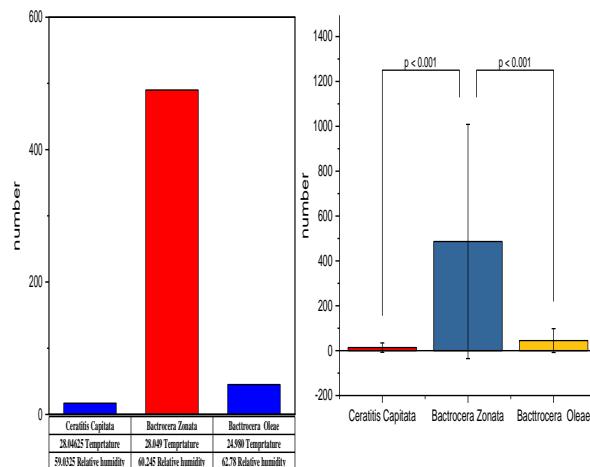


Figure 3. (a) Total average of fly species, Temperature, and Relative humidity, (b) Analysis of variance for the three fly species, during the period from 6-12 months of 2022.

### Materials and Methods

Using the Pearson correlation between Relative humidity, Temperature and The three types of flies (*Ceratitis Capitata*, *Bactrocera Zonata*, *Bactrocera Oleae*).was taken coefficient of the following formula:

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \quad (1)$$

The terms in that formula are:

n= the number of data points.

values of the x-variable in the data set (Relative humidity (%)), Temperature (C°), and values of the y-variable in the data set (three types of flies (*Ceratitis Capitata*, *Bactrocera Zonata*, *Bactrocera Oleae*) (number)).

And the marginal distribution was used to determine the marginal probability density function for both the Relative humidity (%), Temperature (C°) (X), and three types of flies (*Ceratitis Capitata*, *Bactrocera Zonata*, *Bactrocera Oleae* (number) (Y), through the following formulas:

The marginal probability density function:

$$f(x, y), \{a \leq x \leq b, c \leq y \leq d\}, \int_a^b \int_c^d f(x, y) dy dx \quad (2)$$

$$\text{Where } \{a \leq x \leq b\}, \int_a^b f_x(x) dx \quad (3)$$

$$\{c \leq y \leq d\}, \int_c^d f_Y(y) dy \quad \dots \quad (4)$$

The probability density function of  $X$ , denoted by  $f_X(x)$ , is called the marginal probability density function of  $X$ , and the probability density function of  $Y$ , denoted by  $f_Y(y)$ , is called the marginal probability density function of  $Y$  (Ramez.K, 2018) [21].

We have the following:

$$f_X(x) = \sum_y f_{X,Y}(x,y) \quad \dots \quad (5)$$

$$f_Y(y) = \sum_x f_{X,Y}(x,y) \quad \dots \quad (6)$$

For an ongoing condition:

$$f_X(x) = \int_{-\infty}^{\infty} f_{X,Y}(x,y) dy \quad \dots \quad (7)$$

$$f_Y(y) = \int_{-\infty}^{\infty} f_{X,Y}(x,y) dx \quad \dots \quad (8)$$

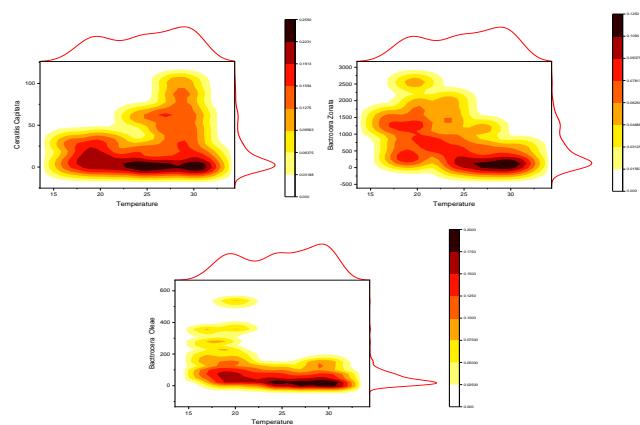
## Rusults and Discussion

Climate is an important indicator of the biological diversity of living organisms on the surface of the Earth, and this is what we see through the effect of temperature and relative humidity on different types of flies. It was found that the effect of temperature on the *Ceratitis Capitata* species increases and the correlation is positive about 0.13, while the *Bactrocera Zonata* species decreases with an increase in Temperatures have a strong negative correlation coefficient of about -0.67, and the species *Bactrocera Oleae* also decreases with temperatures and reaches a negative correlation coefficient of about -0.46, and this is reflected by an increase in temperature and a decrease in humidity, as the species *Ceratitis capitata* is affected by relative humidity with a negative correlation coefficient of about -0.01, while the species *Bactrocera Zonata* and *Bactrocera Oleae* have a positive correlation coefficient with relative humidity of about 0.27 and 0.13, respectively. See Table 1.

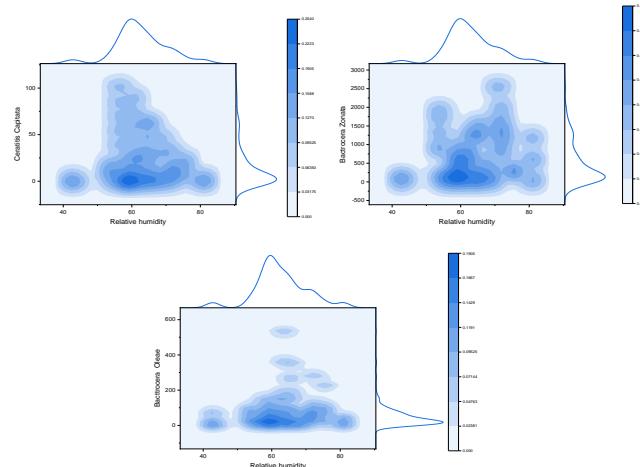
**Table 1:** Pearson correlation coefficient for the three types of flies with Temperature and Relative humidity from the period 6-12 months of 2022

Correlation	Relative humidity	Temptrature
<i>Ceratitis Capitata</i>	-0.01	0.13
<i>Bactrocera Zonata</i>	0.27	-0.67
<i>Bactrocera Oleae</i>	0.13	-0.46

Applying the marginal distribution was used to determine the marginal probability density function, for each of the relative humidity (%), temperature (C0), and three types of flies: *Ceratitis Capitata*, *Bactrocera Zonata*, and *Bactrocera Oleae* (number), as shown in Figure 4. The marginal probability density function shows the degree of Temperature with the three types of flies. It has been observed that the number of *Ceratitis Capitata* increases with increasing temperature and decreases with decreasing temperature. This is explained by the marginal probability density, where the distribution of number between 0-50 is higher than the number of 50-100, while *Bactrocera Zonata* increases with decreasing temperatures and decreases with increasing temperatures. The number from 0-500 is more dense than the numbers from 550-2500, and the third type, *Bactrocera Oleae*, also decreases with increasing temperatures, as Figure 4 shows that the density of numbers from 0-200 is higher than 200-600, and in Figure 5, which shows the probability density function. The marginal probability of relative humidity with the three species, where with *Ceratitis Capitata* the number decreases with high relative humidity while the number increases with low humidity, and in two species *Bactrocera Zonata* and *Bactrocera Oleae* it increases with an increase in relative humidity as shown in Figure 5 showing the marginal probability density distribution.



**Figure 4:** Marginal distributions between Temperature (C°) and three types of flies during the period of 6-12 months of 2022.



**Figure 5:** Marginal distributions between Relative humidity (%) and three types of flies during the period of 6-12 months of 2022.

## Conclusion

Climate plays an important role in the biological diversity of insects. It was shown during this study that when temperatures rise, a type of fly, *Ceratitis Capitata*, increases, as the relationship between them is positive, and decreases with an increase in humidity, and the relationship is negative between them, while the opposite happens with both *Bactrocera Zonata* and *Bactrocera Oleae* species, as they increase with lower temperatures and decrease with higher, and the type of correlation was strong negative, while their quantities increase with high humidity and decrease with low humidity, where the positive relationship, confirming it using the marginal probability distribution function, the path of the spread of fly species with humidity and temperature.

It was noted that the period from 6-12 of the year 2022 is considered somewhat not high, and this is explained by the low numbers of *Ceratitis Capitata* species with the entry of the cold months, which began to fade, in return, the proliferation of both *Bactrocera Zonata* and *Bactrocera Oleae* with lower temperatures and an increase in relative humidity.

## RECOMMENDATIONS

- 1- Supporting the field of research in universities and research centers on fruit flies from an environmental and economic perspective.
- 2- Raising awareness among farmers about the importance of olive trees and fruit trees, applying prevention and treatment instructions on time, and preserving production in the right ways at all stages until it reaches the final consumer.

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**Conflicts of Interest:** The writers declare no conflicts of interest.

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