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Calculation of optimal environmental indices, to preserve/conserve melipona bees in the State of Puebla

Cálculo de índices ambientales óptimos, para preservar/conservar abejas meliponas en el Estado de Puebla

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Abstract

The objective of this investigation is to verify that the environmental factors of temperature (°C) and wind (m/s) in the meliponaria of the State of Puebla are optimal for the reproduction of the Melipona Bee. The applied methodology contemplates 3 phases: 1) Analysis of environmental conditions of the region, 2) Selection of measurement devices: Use of two types of thermometers, the Steren Thermo-Hygrometer thermometer assigned for temperature measurements (°C), and the UA-965 Thermo-Anemometer thermometer to quantify temperature and wind speed, 3) Statistical studies of environmental factors of temperature and wind (random sampling) . The contribution is exposed socially, economically and culturally, with respect to the social environment, the optimal levels of temperature and wind are indicated, this action will benefit 70% of the meliponiculturists with the increase in the levels of bee reproduction, this increase will cause greater quantities of products (honey, propolis, wax) which, when sold, will attract greater economic uptake for meliponiculturists. Finally, the cultural contribution focuses on the conservation and preservation of the region's native bees, fostering a reproduction system with adequate environmental conditions.

Environmental conditions, Wind, Temperature, Meliponaria

Resumen

El objetivo de esta investigación es verificar que los factores ambientales de temperatura (°C) y viento (m/s) en los meliponarios del Estado de Puebla sean óptimos para la reproducción de la Abeja Melipona. La metodología aplicada contempla 3 fases: 1) Análisis de las condiciones ambientales de la región, 2) Selección de los dispositivos de medición: Uso de dos tipos de termómetros, el termómetro Steren Thermo-Hygrometer asignado para mediciones de temperatura (°C), y el termómetro UA-965 Thermo-Anemometer para cuantificar temperatura y velocidad del viento, 3) Estudios estadísticos de factores ambientales de temperatura y viento (muestreo aleatorio) . La contribución se expone social, económica y culturalmente, con respecto al ámbito social, se indican los niveles óptimos de temperatura y viento, esta acción beneficiará al 70% de los meliponicultores con el incremento en los niveles de reproducción de las abejas, este incremento provocará mayores cantidades de productos (miel, propóleos, cera) que al ser comercializados atraerán mayor captación económica para los meliponicultores. Finalmente, la contribución cultural se centra en la conservación y preservación de las abejas nativas de la región, fomentando un sistema de reproducción con condiciones ambientales adecuadas.

Condiciones ambientales, Viento, Temperatura, Meliponaria

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Introduction

In natural situations, each species occupies a reasonably defined ecological niche where individuals tolerate or adapt to most variations in the physical environment. Therefore, an adapted living being is one that is in perfect harmony with its environment.

However, from the diversity of interrelated factors that make up the environment, the climate turns out to be relevant due to the effects caused to the vegetation and fauna. From this perspective, the fauna turns out to be an element that requires greater preservation. In the case of the State of Puebla, the conservation of native fauna turns out to be one of the primary objectives, with the preservation of the native bee being a priority, which is distinguished by procreating within the meliponaria of the region and area of influence.

In the experience of the meliponiculturists of the region, the adaptability of the melipona bee turns out to depend directly on the temperature conditions and the affectation that the wind causes to the hives established in the meliponaria, although it is true that the optimal reproduction conditions focus In a hot climate, the native bee of the region seeks means that provide regular temperature and wind conditions, for this reason it is important to create the appropriate environment for the proliferation and conservation of these, what has been described above turns out to be an emerging problem in the Municipality of Huauchinango belonging to the State of Puebla where the exposed research was developed, in which the optimal environmental parameters (wind temperature) are established to increase productivity and preserve existing hives.

Specifically, the research carried out analyzes the affectation of environmental conditions on the reproduction of the native species, considering a random sampling in a period of 12 months (January-December 2021), in which measurements were taken with devices (2 different thermometers) to know the real conditions, these random samplings were carried out at different times and days that make up the period, in the same way a follow-up of the existing hives was shown to know the productivity and generation of main products, according to the environmental conditions that were observed. presented.

Once the sampling was carried out, a comparison is made using statistical studies, this comparison links the variables of temperature and wind with the levels of productivity of the hives, seeking to determine if there is a correlation between the aforementioned factors, Once the correlation is detected, we proceed to establish the optimal parameters of temperature and wind that must be fostered for the significant improvement of the productivity of the bees., to finalize the investigation, a quantitative validation of the effectiveness achieved is carried out, through the measurement of the amount of honeyed product (honey, propolis, wax) obtained from the establishment of optimal conditions, it is important to mention that the benefit achieved is notorious in the social, economic and cultural sphere, supporting SDG 15: Life of terrestrial ecosystems "Agenda 2030", which establishes the generation of sustainable methodologies that promote the p reservation of terrestrial ecosystems within the regions and areas of influence.

Objectives

General objectives

Analysis of environmental factors (air and temperature) to verify the optimal indices that maintain and increase the reproduction of the Melipona bee in the meliponaria established in the Huauchinango region, Puebla, through the use of random sampling and correlational analysis with software technological.

Specific objectives

A. Analyze the characteristics of the environment for the reproduction of the Melipona bee in the region.

B. Identify the suitable instruments to quantify the variables of air and temperature.

C. Use the instruments to measure environmental factors through random sampling and make an assertive record of the data.

D. Determine the optimal environmental factors for the conservation, preservation and increased productivity of the native melipona bee.

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Rationale

The investigation is proposed to know if the air and the current temperature in the region of Huauchinango, Puebla, is favorable to preserve and conserve the reproduction of the Melipona bee, considering that within the region the contribution to preservation is of vital importance. of the native terrestrial ecosystems. In the same way, the economic benefit for the meliponiculturists of the State of Puebla is sought, taking into account that the contribution of the sale of the products sustains the family economy, having as antecedent that the affectation of the variables (air/temperature), brings with it the decrease in productivity levels and the physical affectation of the hives that are located inside the meliponaria.

By providing adequate environmental conditions, it seeks to reduce the main problems and create the correct environment for the natural air conditioning of the meliponaria in the State of Puebla.

Theoretical framework

For a better understanding of the aspects that make up this research, the theoretical foundations that support the formulation of the Analysis of environmental conditions for the reproduction of melipona bees in the State of Puebla are described below.

Climate

In the experience of Torres (2018), the climate is conceptualized as the set of physical conditions coming from the atmosphere for an indeterminate period which directly influence human activities, exerting an influence on natural elements such as vegetation, soils, fauna.

Climatic classification

It is known as the topographic action that results from environmental influence, which generates various climatic changes according to the homogeneous characteristics of each area, these characteristics combine to establish two temperature zones, exposed in two sections: 1) Effective zoning (Climate changes are linked to the existence of native vegetation or fauna), 2) Genetic zoning (Formed from the dynamic events that occur in the circulation of the atmosphere) (CEPAL, 2020).

Types of weather

According to the zone analyzed in the present investigation, two types of climate are evident during the year: Warm, temperate.

Hot weather

Characterized by presenting high temperatures because the areas expose low latitudes, causing the sun's rays to have a greater impact due to the inclination (López, Sánchez and Valverde, 2019).

Temperate climate

In the experience of Flores (2019), this type of climate maintains moderate temperatures, leaning towards cold temperatures at certain times of the year.

Elements of weather

Rivas (2018) indicates that the elements of the climate are represented by the following factors: a) Temperature, b) Precipitation, c) Wind, d) Humidity, e) Atmospheric pressure and cloudiness, according to the theme exposed in this research will define below the elements that infer the most:

Temperature

It is considered as a physical indicator of the degree of heating of the air, establishing the following correlation: the greater the heating of the air, the greater the molecular agitation. The unit with which it is measured internationally is the °C.

Wind

It is contextualized from the movement of the air by means of gusts that move through the physical unit of m/s, this displacement is carried out with a route that goes from the high areas to the low areas, regularly showing three dimensions spatial (X, Y, Z).

Measuring instruments

According to the measurement variables, it is decided to use the following means: 1) UA-965 thermometer, 2) Thermo-Anemometer to quantify temperature and wind speed.

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Meliponiculture in the State of Puebla

Currently meliponiculture in the State of Puebla, represents the livelihood of various municipalities in which Cuetzalan and Huauchinango stand out, these municipalities contemplate the preservation and reproduction of native bees, with 5% of the producing families depending directly and indirectly on this economic activity, it is important to mention that in recent years various problems have arisen that bring with them the decrease in the production levels of the main honeyed products, among which honey, propolis and wax stand out, these problems in the Most of the cases are derived from the lack of control of the environmental conditions of the region and area of influence, being these a factor that requires prompt control and the taking of actions that contribute to the conservation of native bees (Ávila, 2021).

Environmental conditions for the reproduction of bees

Environmental conditions turn out to be determining variables for the preservation and conservation of native bees, according to the main abiotic factors that affect or benefit the proliferation of bees are the following (González, Flores and Chiappa, 2019):

a) Environmental temperature.

b) Luminous intensity

c) Relative air humidity.

d) Wind speed

As we can see, temperature is one of the factors that generate the greatest negative effects when they are extreme or positive when they are moderate, this in response to the fact that honey bugs are characterized by being apiform organisms. Wang, Liu, Li, & Song , (2009). deduce that the correlation between the different species of native bees and environmental factors is relevant, indicating that the increase in temperature and the decrease in relative humidity notably increases the feeding of these insects, causing honeyed products of considerable quality, the existing correlation (R^2=R2) for sunlight exposes the following statistical relationship (1):

$$> \text{Sunlight} = \text{R2}(0.7426) \quad (1)$$

While for temperature the relationship is (2):

$$> \text{Temperature} = \text{R2}\ (0.7901) \quad (2)$$

On the other hand, the statistical relationship of the wind with honey bugs is contemplated within the following parameters (3):

$$< \text{Wind} < \text{Humidity} = \text{R2} = 0.674 \quad (3)$$

Methodology

Below is the methodological description by which the calculation of optimal environmental indices was carried out, to preserve/conserve the melipona bees in the State of Puebla (Figure 1. Phases of the methodological process for the development of the research).

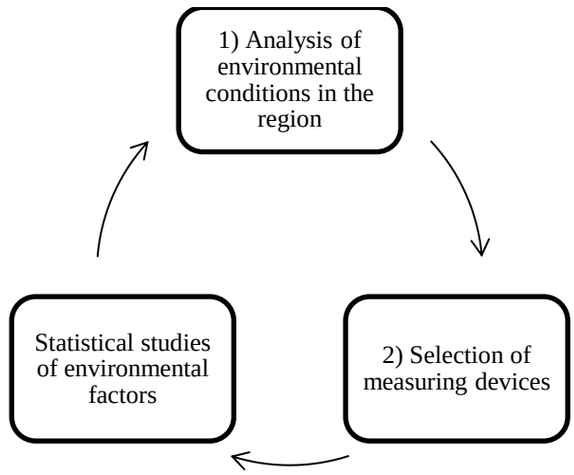

Figure 1 Phases of the methodological process for the development of the research
Source: Own elaboration

Phase 1) Analysis of environmental conditions in the region

In this phase, we proceed to theoretically investigate the environmental factors that have occurred in the last annual period, determining the following variables:

Climate Huauchinango Puebla

Specifically, in the research area (Huauchinango Puebla), a temperature ranging from 9 °C to 28 °C is shown and rarely drops below 5 °C or rises above 32 °C, from from March to June (Figure 2. Summary of the Huauchinango Puebla climate).

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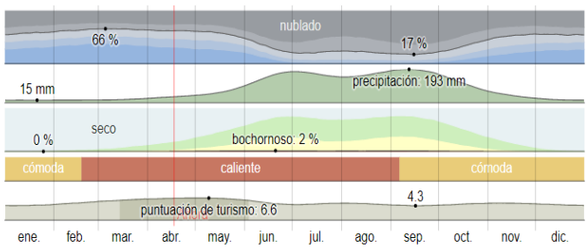

Figure 2 Summary of the Huauchinango Puebla climate
Source: https://es.weatherspark.com/y/6888/Clima-medio-en-Huauchinango-M%C3%A9xico-durante-todo-el-a%C3%B1o#Sections-Humidity

Temperature Huauchinango Puebla

The temperate season lasts for 2.3 months, from March 27 to June 6, with an average daily high temperature above 80°F. The hottest day of the year is May 10, with an average maximum temperature of 28 °C and an average minimum temperature of 15 °C (Figure 3. Average hourly temperature).

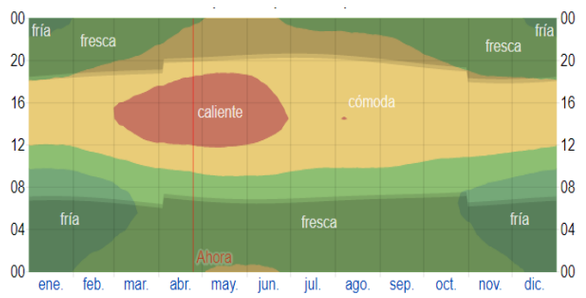

Figure 3 Average hourly temperature
Source:https://es.weatherspark.com/y/6888/Average-weather-in-Huauchinango-M%C3%A9xico-during-all-a%C3%B1o#Sections-Humidity

Wind Huauchinango Puebla

For the case analyzed, the gusts of wind indicate that the wind is a climatic condition exposed during 7.8 months, from February 19 to October 13, with average wind speeds of more than 8.2 kilometers per hour. Specifically, the windiest day of the year on April 29, with an average wind speed of 9.5 kilometers per hour (Figure 4. Average wind speed).

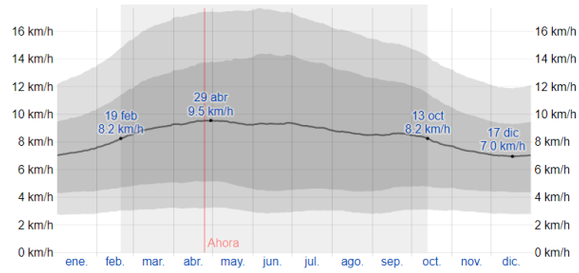

Figure 4 Average wind speed
Source: https://es.weatherspark.com/y/6888/Clima-medio-en-Huauchinango-M%C3%A9xico-durante-todo-el-a%C3%B1o#Sections-Humidity

Phase 2) Selection of measurement devices:

According to the stated need, two models of thermometers are selected, which are:

1. Steren Thermo-Hygrometer assigned for temperature measurements (°C) (Figure 5. Steren Thermo-Hygrometer).

Figure 5 Steren Thermo-Hygrometer
Source: Own elaboration

2. UA-965 Thermo-Anemometer to quantify temperature and wind speed (Figure 6. UA-965 Thermometer).

Figure 6 UA-965 thermometer
Source: Own elaboration

Phase 3) Statistical studies of environmental factors

Once the variables have been determined, a sequence of random samplings of the temperature and wind variables is carried out (Table 1. Abstract of taking measurements).

Day	Steren Thermo-Hygrometer	UA-965 Thermometer
01/03/2021		
06/22/2021		
10/10/2021		

Table 1 Abstract of taking measurements
Source: Own elaboration

These samplings are carried out over a period of 12 months and the results are recorded by means of a control log (Table 2. Abstract of measurement records).

Sampling	Date	Time	Teren Thermo-Hygrometer °C					UA-965 °C					m/s		
			-	X1 _	X2 _	+	-	X1 _	X2 _	+	-	X1 -	X2 _	+
1	05/03/2021	10:00	24.2	27.6	28.8	27.3	26.6	28.6	29.7	29	0	0	0.5	1.5
2		12:00	30.2			30.5	30.5			31.1	0			0
3		2:00 p.m.	28.4			28.7	28.8			28.9	0			0
4	05/05/2021	9 o'cloc k	27.7	30.7	30.9	27.9	25.1	29.7	31.1	28.9	0	0	3	1.8
5		11:00	32.3			32.6	32.2			32.3	0			3.2
6		13:00	32.1			32.2	31.9			32.1	0			4
7	05/07/2021	10:00	27.3	27.8	28.7	28.3	27.8	28.2	28.9	29.1	0	0	2	0.9
8		12:00	27.9			29.3	28 .6			29 .3	0			23
9		2:00 p.m.	28.2			28.6	28.1			28.4	0			2.8

Table 2 Abstract of measurement records)
Source: Own elaboration

Results

The first beneficial result for the present investigation is exposed with the taking of measurements directly from the meliponarios located in the Sierra Norte of the State of Puebla, these measurements allowed to observe the climatic changes and the affectations to the meliponarios. According to the results obtained from the applied measurements, two statistical analyzes are carried out, the first statistical analysis contemplates the decrease or increase of honeyed products (honey, propolis, wax) on a monthly basis due to the affectation of the temperature and the second implies the affectation by the wind (Table 3. Comparison of behavior of environmental factors with production levels).

Average monthly temperature	Wind speed	Productivity levels (Average in grams) per hive Honey	Propolis	Wax
26°C	4m/s	600	13	5.4
33°C	9 m/s	550	12.2	8.8
30°C	3m/s	700	15.6	8.2
21°C	4m/s	450	13.9	3.4
28°C	2m/s	600	14	7.8
21°C	1m/s	350	16	5.2
29°C	4m/s	670	25	15.2
21°C	8m/s	375	24	5.8
26°C	7 m/s	800	28	7.5
31°C	3m/s	870	fifteen	eleven
22°C	6m/s	500	19	5
30°C	6m/s	470	22	8.9
$\bar{X}$ =26.5°C	$\bar{X}$ =4.75 m/s			

Table 3 Comparison of behavior of environmental factors with production levels
Source: Own elaboration

Temperature inference

The first comparison seeks to determine the influence of the temperature factor to obtain higher levels of productivity. This statistical analysis is carried out for each product.

A. Statistical analysis of honey/temperature

As we can see, the correlation between temperature and honey production follows the following relationship, the higher the temperature, the greater the amount of honey production (Graph 1. Honey productivity levels 2021).

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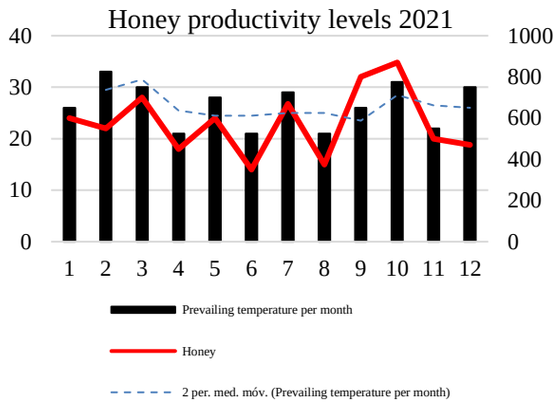
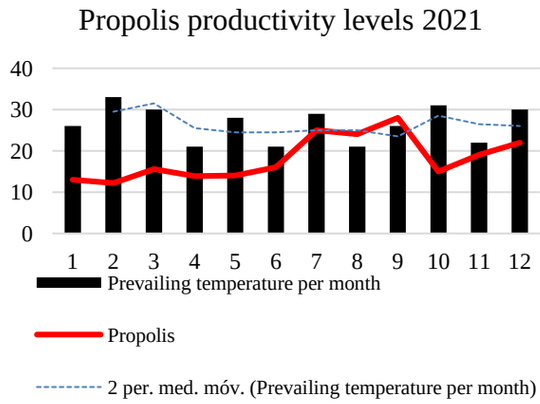


Graphic 1 Honey productivity levels 2021
Source: Own elaboration

B. Statistical analysis of propolis/temperature

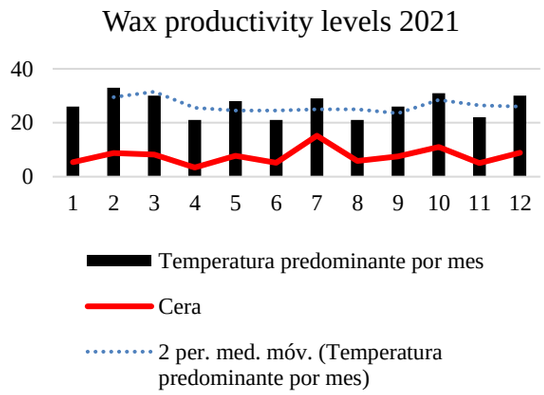
According to the exposed analysis, propolis production does not show an affectation or benefit according to temperature (Graphic 2. Propolis productivity levels 2021).



Graphic 2 Propolis productivity levels 2021
Source: Own elaboration

Wax/temperature statistical analysis

For this specific product, it is notorious that there is an interrelationship with respect to the amounts produced per hive, as we can see the higher the temperature, the greater the amount of wax produced (Graphic 3. Wax productivity levels 2021).

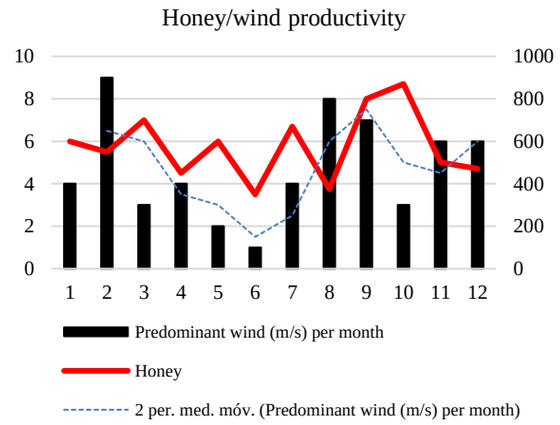


Graphic 3 Wax productivity levels 2021
Source: Own elaboration

Wind inference

A. Honey/wind statistical analysis

For this statistical analysis, it can be deduced that there is a positive correlation between both measured variables, concluding that the less wind, the higher the honey production index (Graphic 4. Honey/wind productivity levels 2021).



Graphic 4 Honey/wind productivity levels 2021
Source: Own elaboration

B. Statistical analysis of propolis/wind

According to the information analyzed, it is concluded in this variable that the lower the amount of wind, the higher the propolis productivity levels will be (Graph 5. Propolis/wind productivity levels 2021).

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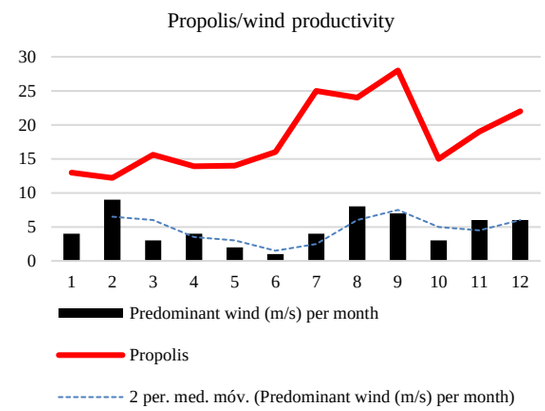
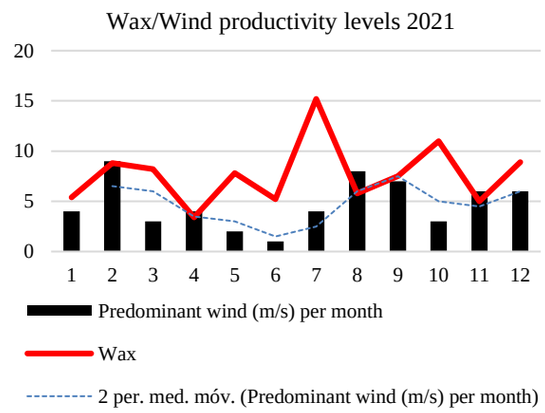


Graphic 5 Propolis/wind productivity levels 2021
Source: Own elaboration

C. Statistical wax/wind analysis

In this last product, it is notorious that the increase or decrease in wind gusts does not affect or benefit (Graph 6. Wax/wind productivity levels 2021). Now, concluding with the statistical analysis, it is considered that the wind and the existing relationship with honey, propolis and wax derive from a particular source of origin, which is: If the wind gusts are high, they tend to destroy the hives or disorient the insect, causing loss of hives and a decrease in the population of meliponas.



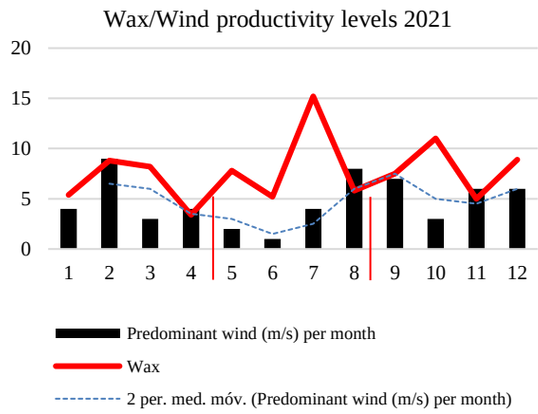
Graphic 6 Wax/wind productivity levels 2021
Source: Own elaboration

In accordance with the above, it is notorious that there is a correlation between the environmental factors of temperature and wind with the reproduction and conservation of the melipona bee, quantitatively a level of affectation is observed in two of the main products in the case of inferred temperature. in honey and wax, while the environmental factor of wind is correlated with honey and propolis, for which these environmental factors greatly influence the meliponaria.

This brings with it that the optimum values of temperature and wind are determined. that must be maintained, for the calculation of these indices the sampled values (Phase 3) are taken as a reference, and they are subjected to two normal distribution tests, contemplating for the temperature an average ($\bar{X}$)= 26.5° C and for the wind a mean ($\bar{X}$)= 4.75 m/s with a sigma σ level of +-3 σ and an interval of 0.5.

Test 1: Normal distribution (Temperature)

As we can see, the minimum acceptable temperature is 23.5° C, while the maximum is 29.5° C, bringing with it that the ideal parameters to meet the objective of the research carried out are established from 25.5° C-27.5° C (Graphic 7. Behavior of the temperature variable °C).



Graphic 7 Behavior of the temperature variable °C
Source: Own elaboration

Test 2: Normal distribution (Wind)

As we can see, the minimum displacement of the gusts of wind is 1.75 m/s, while the maximum displacement is 7.75° m/s, bringing with it that the ideal parameters to meet the objective of the research carried out are established at 3.75 ° C-5.75° C (Graph 8. Behavior of the wind variable m/s).

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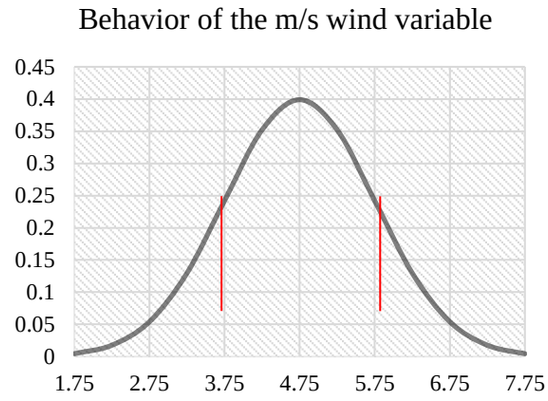

Graphic 8 Behavior of the m/s wind variable
Source: Own elaboration

Gratitude

To the Instituto Tecnológico Superior de Huauchinango and the Industrial Engineering Division for the facilities provided for the preparation of this chapter.

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Not applicable, carried out with own resources.

Conclusions

During the time in which the investigation was carried out, we worked on the quantitative and qualitative analysis of the abiotic factor (wind) and the physical factor (temperature), through the use of measuring instruments (Thermo-Hygrometer and Thermo -Anemometer) whose unit of measurement is m/s and in degrees Celsius (°C), undoubtedly these factors directly affect the levels of productivity and the preservation of the melipona bees established in the meliponaria of the State of Puebla. It should be noted that currently environmental conditions are decisive for the increase or decrease of the main products (honey, propolis and wax) that are produced within the hives or colonies.

However, according to the experience of the meliponiculturists of the region, the null control of these factors brings about the destruction or weakening of the hives and the decrease in the populations of insects that are born and reproduce in the different colonies, in response to this problem, a statistical study was generated to determine the exact parameters to which the meliponaria should be maintained, the study was classified according to the normal distribution, with $\bar{X}$ according to the samplings carried out in a period of 12 months and a sigma level of +- 3 σ, it is important to mention that when establishing the optimal indices, it was recommended to the meliponiculturists that due to the climate that the area presents in periods where humidity or wind is higher, they should condition or air-condition the meliponaries to maintain or reach the levels indicated., to finish the investigation carried out in Huauchinango Puebla turns out to be of great benefit for the population because contributes to the conservation and preservation of the melipona bee, which is the native insect of the region.

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