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Production of four varieties of Cocoa (*Theobroma cacao L*), in Úrsulo Galván, Veracruz, Mexico

Producción de cuatro variedades de Cacao (*Theobroma cacao L*), en Úrsulo Galván, Veracruz, México

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Abstract

Currently, research in the introduction of crops in an area, region, or zone, is essential to determine the potential that the species being introduced may have. Therefore, the importance of introducing four species of cocoa (*Theobroma cacao L*), in the region of Úrsulo Galván, under a completely randomized experimental design. Specially in those places where monocultures predominate, since the option provided as an alternative must meet several characteristics, among which the main ones are: adaptation, growth, development, production and commercialization. To determine which of the species are those that adapt to the climatic conditions, as well as edaphic conditions of the area. If we add to the above economic improvements in terms of the income received per hectare, it will be much more attractive for producers. However, proposals should also be sought that contribute to reforestation, carbon dioxide capture and that benefits the local species. All the above with the intention of implementing sustainable polycultures and improving the characteristics of the region where they are established, as well as diversifying crops.

Research, Sustainability, Polycultures

Resumen

En la actualidad, la investigación en la introducción de cultivos en un área, región o zona, es fundamental para determinar el potencial que pueda tener la especie que se pretende introducir. Por ello, la importancia de introducir cuatro especies de cacao (Theobroma cacao L), en la región de Úrsulo Galván, bajo un diseño experimental completamente al azar. Especialmente en aquellos lugares donde predominan los monocultivos, ya que la opción que se brinde como alternativa debe cumplir con varias características, entre las cuales las principales son: adaptación, crecimiento, desarrollo, producción y comercialización. Determinar cuáles de las especies son las que se adaptan a las condiciones climáticas, así como edáficas de la zona. Si a lo anterior le sumamos mejoras económicas en cuanto a los ingresos percibidos por hectárea, será mucho más atractivo para los productores. Sin embargo, también se deben buscar propuestas que contribuyan a la reforestación, a la captura de dióxido de carbono y que beneficien a las especies locales. Todo lo anterior con la intención de implementar policultivos sustentables y mejorar las características de la región donde se establezcan, así como diversificar los cultivos.

Investigación, Sostenibilidad, Policultivos

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Introduction

The production of cacao (*Theobroma cacao L*), in many parts of the world is classified mainly by its aroma and flavor qualities, this has a great impact on social characteristics, as well as on economy, which influence the productive aspect (León-Villamar, *et al.* 2016).

Nowadays cocoa faces competition at national and even international levels (Unda & Carrillo, 2017). In addition to its yields, organoleptic properties are sought, as well as high nutritional requirements (Puentes-Páramo, *et al.* 2016).

Additionally, we could say that according to De La Cruz-Landero, *et al.* (2015), it is recommended to redesign or apply planting methods which in a shorter term increase the profitability of cocoa cultivation through higher population densities, as well as train producers, technicians, or managers of the orchards, to carry out a plan or program that includes genetic certified material and increasingly resistant to pests such as *Crinipellis perniciosa* and *Monilia roreri* (Hernandez- Gómez *et al*. 2015).

However, it is also very important to investigate, test or experiment, the behavior of different materials according to climatic and soil conditions determined in an area, zone or region, in order to be sustainable and incorporate the three sectors that make up this concept: society, environment and economy, as well as increase production (Cerda *et al*. 2014); with the intention of incorporating strategies such as the 2030 agenda, to contribute with solutions to the political proposals and achieve the objectives set.

Mexico is a producer of cocoa worldwide, because only in the year 1999-2000, it contributed with 1.2% of the world production and contributes with 80% of its production, the main producing area is Chontalpa, (Córdova-Ávalos, 2001). This region contributes 97.24% of the state area to the aforementioned crop (INEGI, 1999). In addition, it constitutes 16.38% of the state area and contributes 17.4% of the state's agricultural production (SAGARPA, 2000).

It is for all the above and many more things the importance it takes to implement this type of research in regions other than where it expresses its genetic potential, but that nevertheless, can also be alternatives to produce this crop, mainly if we analyze that it is a crop with a great economic potential, but that also preserves the principles of sustainability that are so needed in these times where climate change is in order of the day and severely affects the weather conditions of different places, also affecting the fauna, because it does not have areas or forests to have an ecological niche.
Finally, we could say that this type of work contributes to generating knowledge and a reference to the null or little information that exists in these topics.

Materials and Methods

Location

The area of influence that comprises this project is the entire municipality of Úrsulo Galván, where it is important to mention that basically this area, zone, or region, is dedicated to agriculture.

The experimental research was carried out at the facilities of the Tecnológico Nacional de México (TecNM) Campus Úrsulo Galván, which is located in the same municipality of Úrsulo Galván, Veracruz, Mexico, at the coordinates 19° 24 48.91" north latitude and 96° 21 09.10" west longitude of the Greenwich meridian, at a height of 9 meters above sea level.

Method design

The experiment was a completely randomized design, with 4 treatments and 10 repetitions, using a total of 40 cacao plants of the four varieties to be evaluated.

The varieties or experimental materials are:

INIFAP 4 = Treatment 1
INIFAP 8= Treatment 2
INIFAP 9= Treatment 3
Almendra Blanca = Treatment 4

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E N S 0	T4R4	T4R10	T4R1	T3R6
	T2R10	T1R9	T2R2	T4R3
	T1R10	T3R5	T4R5	T3R3
	T3R4	T1R4	T1R7	T3R2
	T2R3	T1R5	T1R1	T3R9
	T3R1	T3R10	T2R9	T2R5
	T2R1	T2R8	T2R4	T4R6
	T1R2	T1R3	T4R9	T2R6
	T2R7	T4R7	T4R2	T3R7
	T3R8	T1R6	T1R8	T4R8

Table 1 Distribution of treatments in the field
Source: Own

Vegetative material used

In this experimental research, 4 varieties of this crop were used, which were developed by the National Institute of Forestry, Agricultural and Livestock Research (INIFAP), of Huimangillo Tabasco, they are varieties with high yields and resistant to diseases such as moniliasis and black spot, which allow a production between 700 to 1,100 kilograms per hectare under field conditions (SAGARPA, 2018). And that they were provided by the company Nestlé for its establishment.

Variables to be evaluated

– **Cob weight**

To determine this variable, all the cobs harvested in the experimental unit were weighed and an average per experimental unit was obtained, after having weighed them in a granataria balance (CEESA brand, with a maximum capacity of 2,610 g). This variable is carried out after the cut.

– **Equatorial diameter of the cob**

With an electronic vernier (Truper brand of 150 mm). Each of the harvested cobs was measured. This variable is carried after the cut.

– **Polar diameter of the cob**

With an electronic vernier (Truper brand of 150 mm). Each of the harvested cobs was measured. This variable is carried out after the cut.

– **Weight of seed with pulp**

The cocoa cob must be cut, and the seed must be removed, as well as the pulp, then weighed on a granataria scale (CEESA brand, with a maximum capacity of 2,610 g). This variable is carried out after cut.

– **Weight of seed without pulp**

To collect this variable, the seed is dried and then weighed in a granataria balance (CEESA brand, with a maximum capacity of 2,610 g). This variable is carried out after the cut.

– **Equatorial diameter of seeds**

With a vernier (Truper brand of 150 mm) after drying the seeds outdoors, the diameter of 10 seeds per cob will be determined. This variable is carried out after the cut.

– **Polar diameter of each seed**

After performing the same drying process as in the variable equatorial diameter of each seed, this variable is determined with an electronic vernier (Truper brand of 150 mm), repeating the same previous procedure. This variable is carried out after the cut.

– **Weight of the dry seeds**

Once the seeds are dry, the seeds of each treatment are weighed on an analytical scale (OHAUS brand). This variable is carried out after the cut.

Results

For the variable number of cobs, we find in the ANOVA, α0.05 that there is no statistical difference when performing the test of comparison of means by the Tukey method. However, within the treatments we find a numerical difference.

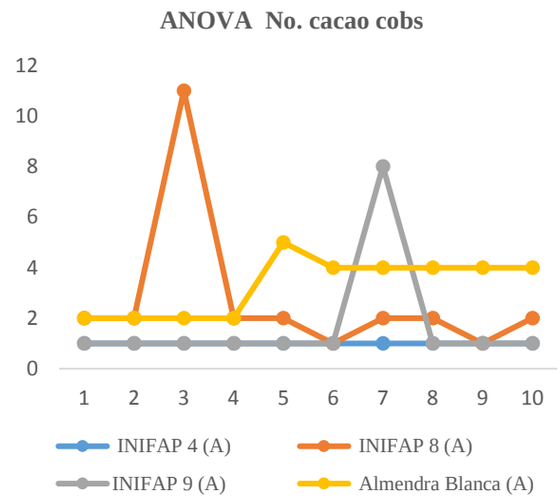

Figure 1 Analysis of variance of the number of cobs plant[1]
Equal literals indicate that there is no statistical difference
Source: Own

While, for the variable polar diameter of cob, when performing the ANOVA, α0.05, we find that there is a statistical difference when performing the mean comparison test by Tukey's method. Treatment 1 (INIFAP 4) is statistically superior compared to the rest.

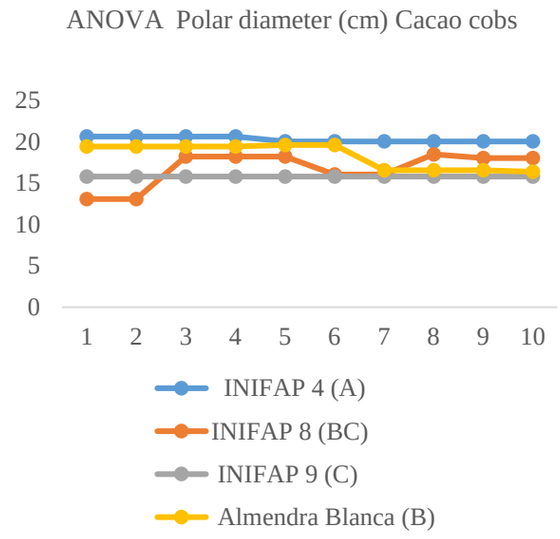

Figure 2 Analysis of variance of the polar diameter of cobs plant^{-1}
Different literals indicate that there is statistical difference
Source: Own

As far as the variable equatorial diameter of cobs is concerned, we find in the ANOVA, α0.05 that there is no statistical difference when performing the mean comparison test by Tukey's method. However, within the treatments we find that there is a numerical difference.

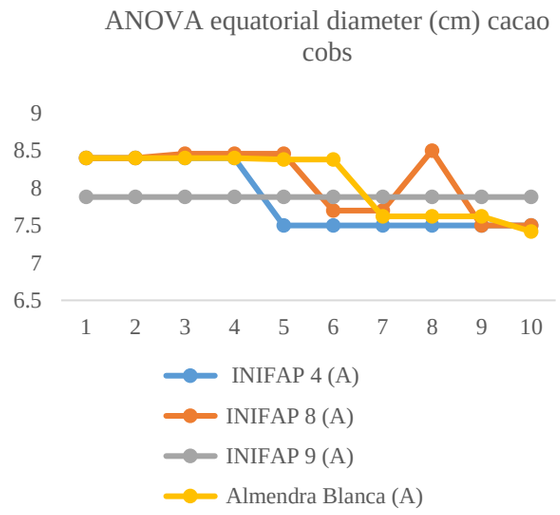

Figure 3 Analysis of variance of the equatorial diameter of cobs plant^{-}
Equal literals indicate that there is no statistical difference
Source: Own

As for the variable total weight of the fruit of cobs, we find in the ANOVA, α0.05 that there is no statistical difference when performing the test of comparison of means by the Tukey method. However, within the treatments we find that there is a numerical difference.

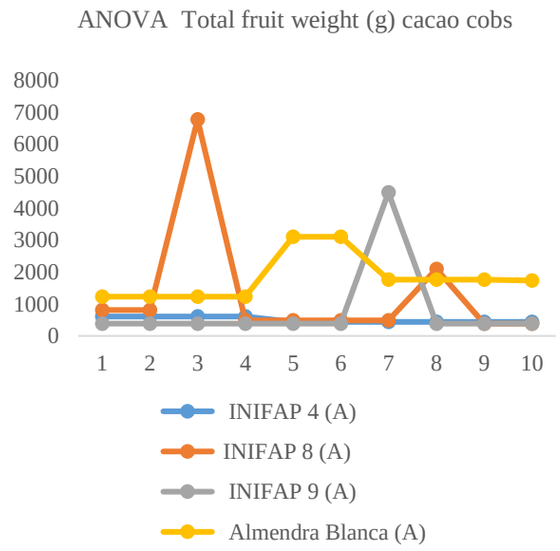

Figure 4 Analysis of variance of the total fruit weight of cobs plant $^{-1}$
Equal literals indicate that there is no statistical difference
Source: own

For the variable weight of the pulp with seed of the fruit of cobs, we find in the ANOVA, α0.05 that there is no statistical difference when performing the test of comparison of means by the Tukey method.

However, within the treatments we find that there is a numerical difference.

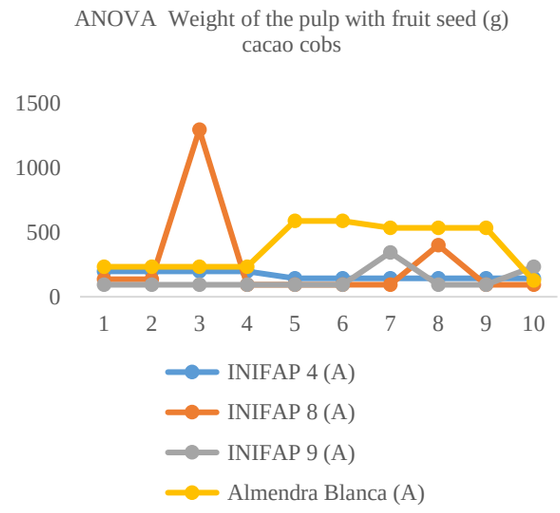

Figure 5 Analysis of variance of the weight of the pulp with fruit seed of cobs plant $^{-1}$
Equal literals indicate that there is no statistical difference
Source: Own

Regarding the variable weight of the dried seed of the fruit of cobs, we found in the ANOVA, α0.05 that there is a statistical difference when performing the test of comparison of means by the Tukey method. Being the treatment 4 (Almendra Blanca), the one that comes out statistically superior to the rest.

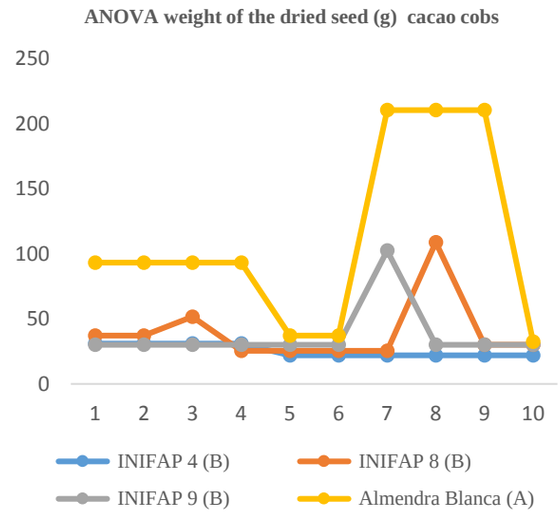

Figure 6 Analysis of variance of the weight of the dried seed of cobs plant^{-1}.
Different literals indicate that there is statistical difference
Source: Own

For the variable equatorial diameter of dried seed of the fruit of cobs, we found in the ANOVA, α0.05 that there is statistical difference when performing the test of comparison of means by the Tukey method. Being the treatment 4 (Almendra Blanca), the one that comes out statistically superior to the rest.

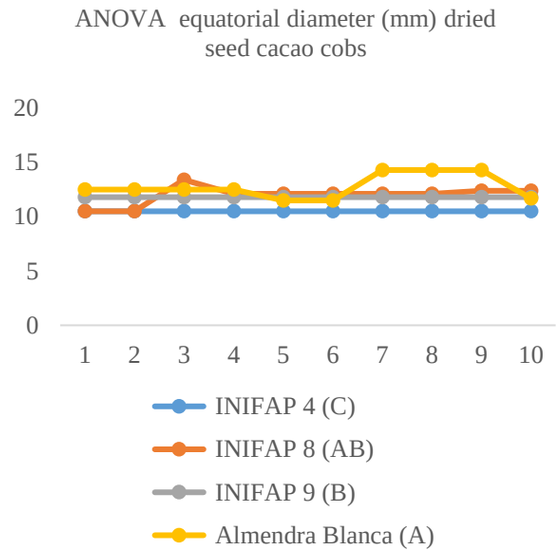

Figure 7 Analysis of variance of the equatorial diameter of the dried seed of cobs plant^{-1}
Different literals indicate that there is statistical difference
Source: Own

Finally, for the variable polar diameter of dried seed of the fruit of cobs, we found in the ANOVA, α0.05 that there is statistical difference when performing the test of comparison of means by the Tukey method. Being the treatment 3 (INIFAP 9), the one that comes out statistically superior to the rest.

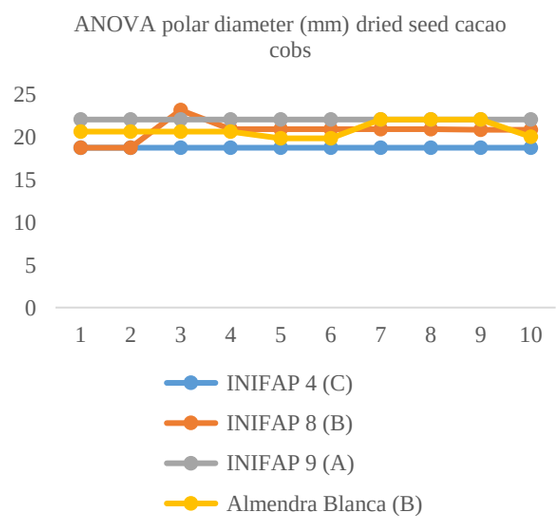

Figure 8 Analysis of variance of the polar diameter of the dried seed of cobs plant^{-1}.
Different literals indicate that there is statistical difference
Source: Own

Conclusions

Based on the results obtained we could say at first that at least for the variables: number of cobs, equatorial diameter of the fruit, total weight of the fruit, weight of the seed with pulp and polar diameter of the dried seed there is no statistical difference, this is quite logical because the treatments had the same management.

However, we found that for the variable polar diameter of the cob, treatment 1 (INIFAP 4) is the one that stands out from the rest, possibly this is due to a characteristic of the aforementioned variety, so if you want to achieve these measures we recommend that treatment.

While for the variable weight of the dry seed, treatment 4 (Almendra Blanca) is the one that comes out higher statistically, this is probably due to a characteristic of the material used, so the use of this material is recommended for the aforementioned variable.

For the variable polar diameter of the dry seed, we find that treatment 3 (INIFAP 9) is statistically superior to the rest of the treatments, possibly a characteristic of the material used, so if this characteristic is sought, the aforementioned material should be used.

Finally, despite finding statistical differences in some treatments and not in others, it is recommended to continue evaluating the treatments so that with more cuts, the results of the present research can be corroborated and there will be more reliability in the data, however in general terms we could say that any of the materials tested adapt to the soil and climatic conditions of the Úrsulo Galván region.

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