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Comparative study between natural, entomophilic and manual pollination in soursop (*Annona muricata* L.)

Estudio comparativo entre polinización natural, entomófila y manual en guanábana (*Annona muricata* L.)

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Abstract

This research was carried out in the communities of Tonino and Divisadero municipality of Compostela, Nayarit, Mexico with the objective of studying the effect of natural, entomophilic and manual pollination of soursop fruits. Pollinations were carried out during the June-July period of 2017 (summer flowering). Which treatments consisted of the natural pollination that only perforated bagging was placed, The variables were: peduncle diameter, brush or strawberry diameter, percentage of yield, percentage of fruit fall, dynamics or general kinetics of growth variables and general behavior of loss and fruit fall. Percentage yield as it was low from 6 to 21% and this decreased as the evaluation time elapsed due to the fall in fruit. The fall of the fruit of the three treatments was considered to have a very important factor whereby they fell, the lack of coverage with fungicides or insecticides.

Pollination, Types of pollination, Soursop, Insects

Resumen

La presente investigación se realizó en las comunidades del Tonino y Divisadero municipio de Compostela, Nayarit, México con el objetivo de estudiar el efecto de la polinización natural, entomófila y manual de frutos de guanábana. Las polinizaciones se llevaron a cabo durante el periodo de junio-julio del año 2017 (floración de verano). Las cuales los tratamientos consistieron en la polinización natural que únicamente se le colocó el embolsado perforado, Las variables fueron: diámetro de pedúnculo, diámetro de cepillo o frutilla, porcentaje de prendimiento, porcentaje de caída de fruto, dinámica o cinética general de variables de crecimiento y comportamiento general de prendimiento y caída de fruto. Porcentaje prendimiento ya que fue bajo de un 6 al 21 % y este disminuyó conforme transcurrió el tiempo de la evaluación debido a la caída de fruto. La caída de fruto de los tres tratamientos se les consideró que tuvieron un factor muy importante por la cual cayeron los mismos, la no cobertura con fungicidas ni tampoco insecticidas.

Polinización, Tipos de polinización, Guanábana, Insectos

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Introduction

Soursop (Annona muricata L.) is native to tropical America, it is dispersed in Mesoamerica, the West Indies and Brazil. In the United States it only grows in South Florida (Can Pech, 1981). The genus Annona groups around 100 native species of the American continent, however, only six have commercial importance: soursop (A. muricata L), saramuyo (A. squamosa L), ilama (A. diversifolia Safford), chincuya (A. purpurea), custard apple (A. reticulata L), custard apple (A. cherimola Mill.) and the atemoya hybrid (A. cherimola XA squamosa) (Nakasone and Paul, 1997).

Soursop is one of the most appreciated fruit trees in the tropics of Central and South America, due to its pleasant taste and aroma, since these have allowed increasing demand in the foreign market and its commercial value (Saunders and Coto, 2001).

Among the countries with the largest sown area of soursop is Mexico with 2,964.10 ha, distributed as follows: Nayarit with 1,985.10, Colima 368.00, Michoacán 240.00 and Guerrero 177.00 ha respectively. According to statistical production data for the soursop case, 1,985.10 ha were sown in Mexico, 1,711.10 ha were harvested with a production of 10,695.06 t of fruit and yields ranging from 6.25 to 12.7 t.ha-1 with a national average of 7.98 t .ha-1. The cultivation area occupied by the Guanabana Nayarita is located in the municipality of Compostela, between Las Varas and La Peñita de Jaltemba with a cultivated area of 1,907.00 ha and production of 10,137.00 t; and San Blas, with 52.40 ha and production of 401.38 t in the coastal zone of the State (SIAP, 2015).

Soursop cultivation presents several problems among them, pollination stands out, these flowers in technified crops are artificially pollinated for a growth between 18 and 23% of production (Melo, 2002).

On the other hand (Guzmán, 1991) in the soursop, custard apple and atemoya crops it was able to increase the production between 30 and 50% which was additionally reflected by the increase in weight, size and greater mooring of fruits per plant.

The processes of pollination and fertilization in flowers of A. muricata L, are limited by characteristic phenomena of the flower, the gynoecium is apocarpic, formed by the union of numerous pistils (Manica, 1997), in addition to pre-synthesis and early precedent the flower presents a closed structure, hindering pollination by wind and relatively large insects (Cogez and Lyannaz, 1994), do not produce nectar; also presenting the phenomenon of heterostilia (Pinto and Genú, 1984).

The ignorance of the physiology of flowering is based on the fact that the soursop flower is hermaphroditic and as such, it is assumed that, by presenting the male and female organs in each flower, pollination and fertilization will be successful. However, even if it is arranged in the same place, the anonaceae present the problem of protogyneal dicogamy (early maturation of the gynoec in relation to androceous), which prevents successful pollination and fertilization (Guzmán, 1981).

Due to the above, it seeks to solve the problem of pollination, mooring and deformity of soursop fruits with the application of the pollination technique.

Objective

The objective of this work was to study the effect of natural, entomophilic and manual pollination on the mooring of soursop fruits.

Methodology to be developed

The present investigation was carried out in a soursop orchard located in the town "El divisadero", in the municipality of Compostela, Nayarit, Mexico. Geographically it is located at 21º 08 '34.54 ”N, 105º 12' 38.82” W, with an altitude of 197 m (Available at: https://es.wikipedia.org/wiki/Municipality_of_ Compostela (Nayarit). Accessed March 2 from 2017).

Trees from a soursop orchard, approximately 10 years old, were used; with a distance between plants of 7 x 7 m. A randomized block design with five repetitions was used. The experimental unit was formed by a tree, in which 20 flowers were selected.

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The treatments consisted of applying three flowers pollination techniques (table 1) of soursop distributed in trees located in an orchard in Compostela, Nayarit, Mexico.

Treatment	Pollination	Process
1	Natural	Natural maturation of carpels and stamens
2	Entomophilic	A beetle of **Phyllophaga spp** was placed by flower
3	Manual	Pollen application with the help of a brush on receptive flowers

Table 1 Soursop flowers pollination techniques (Annona murucata L) in an orchard located in Compostela, Nayarit Mexico

Pollinations were carried out during the June-July period of 2017 (summer flowering).

The natural pollination consisted of placing the bagging in flowers that were in a state of maturity or receptive equal to those that would be pollinated entomophilically and manually, piercing the bags to avoid water accumulation

For entomophilic pollination, beetles (Phyllophaga sp.) Collected manually during the night were used, using the light from the houses as a trap. The beetles were placed in a perforated container, which were impregnated with pollen from the same flowers that had been collected the day before; the individuals were placed in a previously perforated plastic bag. This container was placed on the newly opened flower for a time of 24 hours.

Manual pollination consisted of collecting mature (open) flowers of state IV of the soursop phenology, the flowers were collected during an afternoon prior to pollination, the flowers were allowed to rest in paper bags at room temperature, the next day the chalice and petals were removed, only stamens with pollen were preserved, this powder was deposited in the stigma of slightly open flowers presenting states II and III; These stages indicate the induction and floral initiation (formation of buds), respectively. This process was carried out from 9:00 am to 12:00 pm with the support of a # 7 brush with soft hair.

Evaluated variables

Peduncle diameter (cm). This variable was obtained by measuring the thickness with the help of a flexometer every 7 days from 36 days after the pollination of flowers.

Brush or strawberry diameter (cm). The diameter of this variable was measured with the help of a flexometer every 7 days from 36 days after pollination.

Percentage of yield of fruits by pollinated flowers (%). For this variable, the number of lit flowers multiplied by one hundred was determined, among the number of pollinated flowers

Percentage of fall of fruit by some pathogen (%). The number of fruit drop per hundred was determined, among the number of pollinated flowers.

General dynamics or kinetics of growth variables. This variable was obtained from the general averages of the five samples of the growth variables referred to in peduncle length, peduncle diameter, brush length, and brush diameter.

General behavior of loss and fall of fruit. This variable was obtained from the general averages of the five samples of the percentages of yield and fall of fruit.

Statistic analysis

Variance analysis was applied to the variables evaluated and those that showed significant differences were tested for means using the Tukey method ($\alpha = 0.05$). For this, the statistical package SAS (Statistical Analysis System) (Castillo, 2011) was used.

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Results

During the evaluation of three pollination techniques in soursop flowers distributed in 10-year-old trees, the results were as follows. The yield of the fruits occurred at 36 days after pollination (pdp), among these, in the pollination techniques a significant statistical presence is observed in percentage of yield with 12.5% and highly significant in peduncle diameter with 1.88 cm On average, at (43ddp) there was a significant difference in percentage of yield decreasing according to 36 ddp with 10% due to the fall of the flowers due to the presence of fungi and insects, in the last variable this difference is maintained at the 50 ddp, which indicates that the response of these variables was a function of the type of pollination (Table 2).

VARIABLE	P>F	GENERAL MEAN
36 days after pollination		
Peduncle length (cm)	0.1908ns	2.53
Brush or strawberry length (cm)	0.1251ns	2
Peduncle Diameter (cm)	<.0001**	1.88
Brush or strawberry diameter (cm)	0.0009**	2.91
Percentage of ignition (%)	0.0112*	12.5
Fruit Drop Percentage (%)	0.005**	88.33
43 days after pollination		
Percentage of ignition (%)	0.0359*	11.88
Fruit Drop Percentage (%)	0.0107*	93.67
50 days after pollination		
Percentage of ignition (%)	0.1192ns	10
Fruit Drop Percentage (%)	0.025**	94.67

Table 2 Results of the analysis of variance and general mean of the variables evaluated in soursop flowers naturally pollinated, by Coleoptera of Phyllophaga spp and manual with brush support. When Pr> F is less than 0.05, there are significant differences. * Presence of differences. ns Absence of differences

In (36 ddp), the coefficient of variation (table 3) ranged from 51.66 to 7.23%, values that according to the development of the experiment are considered to be within a justifiable range, since it corresponds to the settling response and fall of fruit, variables that can be related by poor or late pollination (Escobar et al., 1986).

VARIABLE	CV (%)
36 days after pollination	
Peduncle length (cm)	12.78
Brush or strawberry length (cm)	61.17
Peduncle Diameter (cm)	15.47
Brush or strawberry diameter (cm)	49.23
Percentage of ignition (%)	51.66
Fruit Drop Percentage (%)	7.23
43 days after pollination	
Percentage of ignition (%)	36.06
Fruit Drop Percentage (%)	6.24
50 days after pollination	
Percentage of ignition (%)	41.33
Fruit Drop Percentage (%)	5.37

Table 3 Results of the coefficient of variation of the variables evaluated in naturally pollinated soursop flowers, by Phyllophaga spp beetle and manual with brush support

The low percentage of yield or fruit set of manually pollinated fruits could be due to the inadequate selection of flowers during pollination (lack of receptivity) which resulted in the absence of fertilization, events occurred in this experiment and that decreased and increased the yield percentages respectively as the study period elapsed; Escobar et al. (1986), indicate that this situation can be overcome by manual pollination technique.

The R2 indicates that the model used explains 88 and 72% of the variability in the growth variables; that is to say, for pedicel diameter and brush diameter, respectively, and 56 and 59% for percentage of pregnancy and percentage of abortion; in these last variables, the proportion decreased and increased gradually, as the evaluation time elapsed (Table 4).

VARIABLE	R^2
36 days after pollination	
Peduncle length (cm)	0.26
Brush or strawberry length (cm)	0.31
Peduncle Diameter (cm)	0.88
Brush or strawberry diameter (cm)	0.72
Percentage of ignition (%)	0.56
Fruit Drop Percentage (%)	0.59
43 days after pollination	
Percentage of ignition (%)	0.74
Fruit Drop Percentage (%)	0.53
50 días después de la polinización	
Percentage of ignition (%)	0.57
Fruit Drop Percentage (%)	0.46

Table 4 R^2 results of the variables evaluated in naturally pollinated soursop flowers, by Phyllophaga spp coleoptera and manual with brush support

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Conclusiones

The type of pollination affected the growth, yield and fall of fruits.

Natural pollination contributed to a higher proportion of yield and a lower proportion of fruit fall compared to entomophilic and natural pollination, as well as a larger peduncle diameter.

Based on the diameter of the brush or strawberry, it was observed that natural pollination exceeded that of manual and entomophilic way.

It was identified that the three different types of pollination have a highly low yield percentage ranging between 6 and 21%.

It was observed that the trend was directly proportional, as the days after pollination go by they grow both in length and in diameter.

It was attributed that the lack of coverage with fungicides and insecticides could be a very important factor for the fall of the fruit since it developed symptoms that reflected fungal diseases.

The use and handling of perhaps infected materials were also part of the fall of pollinated flowers and developed fruits.

The selection of flowers is very important for pollination in the three treatments since if the flowers are not yet ready for this process it can reduce fruit set.

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