Organic cultivation of two species of pitahaya (Selenicereus undatus and Selenicereus megalanthus) in the Southeast of Mexico

Abstract

Both species of Pitaya Selenicereus undatus and Selenicereus megalanthus, were established on the 25th of May and the 26th of June, 2019. Three hundred and forty-four cuttings were planted. The seedlings used were 30cm long, previously rooted at the ranch for three months with vegetable soil and worm-compost in a protective cultivation system using horticulture shadowed cloth with 70% sunlight penetration. The substratum that was used to plant was of organic existence enriched with worm-compost and mountain microorganisms. These plants were planted in rows of high density with a distance of 50cm interspersing between the two species. The organic products that were used to enrich the plants were created at Rancho Alegre by mountain microorganisms, cattle, sheep, and horse manure, vegetable carbon, wood ash, milk, molasses, saltwater, garlic, onion, habanero chile (Capsium Chinese Habanero Group), Neem tree leaves (Azadirachta indica), soap, rock flour, yeast, Sulfur (S), Potassium hydroxide (KOH), vegetable oil, and Calcium oxide (CaO), the schedule is ongoing cyclically. Three hundred kilograms were produced in the first year, a total of 8 groups every 19 days, with fruit up to 960 grams, where the normal weight of pitahayas in the Southeast of Mexico is between 350-450 grams. It was concluded that the use of organic products demonstrated a significant difference between production and time of fruit bearing. A favorable result is observed between the use of products and the results obtained in this production of pitahaya, that, given the first year, greatly surpasses other reference production results.

Keywords: pitahaya, hyllocereus, selenicereus, organic, epiphyte, cactaceae, hemiepiphyte

Abbreviations: Kg, kilogram

Introduction

Pitayhas have been cultivated on family farms since ancestral times and more recently given the physiological characteristics of the cacti such as the adaptability and the resistance to long periods of drought, different environmental conditions and the scarcity of water that is required to grow, have made it possible that its cultivation is easy and economically profitable in many parts of the world, in addition to the delicious flavor and the consistency of the fruit that it brings of high economic value. This has stimulated a commercial market of exotic fruit in Europe, Asia, and the Americas being highly valued in national and international markets. It is consumed primarily as a dry fruit and can be used in fruit salads, sodas, marmalades, jams, beer, and wine, among others.

The pitahaya fruit, given its physical and chemical features offer a wide market of exportation as a dry fruit, or frozen pulp and its ample and diverse forms of consumption, constitute productive and viable alternatives as long as the internal market is strengthened, promoting the habit of consumption (Meráz, 2003). On the other hand, pitahaya is a native plant that is highly adaptable to the tropical regions and conditions of seasonal variability of precipitation and light, with a lifespan of 25 to 30 years. (De Alba, 2003) (Martínez, 2006.)

Pitayha [Hylocereus undatus (Haworth) Britton & Rose], is a native plant that is grown throughout a vast part of Mexico, Central and South America. In Mesoamerica, this fruit was one of the main food sources of ancestral Mexicans to survive in hard times (Meráz, 2003). Currently, there are approximately 10,000 hectares of specialized pitahaya plantations around the world, in traditional production systems, semi-specialized and specialized, found throughout Florida, Mexico, Guatemala, El Salvador, Nicaragua, Costa Rica, Venezuela, Panama, Uruguay, Peru, Brazil, Ecuador, Colombia, Thailand, Indonesia and Vietnam. Ecuador and Nicaragua are the main producers of H. undatus in Latin America as well as Colombia with variations of yellow pitahaya (Selenicereus megalanthus). In the same fashion, Vietnam and Thailand are the main global producers of H. undatus, consequentially developing modern cultivation technologies. (Ana Lid del Angel Pérez, 2012).

In Mexico, the cultivation of pitahaya is mainly located to two regions: the first is comprised of the states of Puebla and Oaxaca, where the cultivation has an average life of 20 years. Crop production is from May to September and the average yield is roughly 3 tons per hectare. The second region includes the Yucatan peninsula (Yucatan, Campeche, Quintana Roo) and the state of Tabasco where crop production is from July to October (Martínez, 2006.). At the beginning of the current century, Mexico with 100 cultivated hectares, approximately 300 tons of fruit were extracted each year, equivalent to 3 tons per hectare; half of the surface area and production volume corresponded to the Yucatan peninsula, where farms and various communities that belonged to the Henequen zone of the state of Yucatan, began to specialize in its cultivation. The remaining was located in Tabasco, primarily in the Chontalpa region, the state of Puebla in the Cañada zones, the Valley of Tehuacan and the Mixteca as well as the Cañada zone in Oaxaca and in Autil and Sayula in the state of Jalisco where production came from small farms. It is...
estimated that in 2002, there existed 145 cultivated hectares of *H. undatus* in the country, from which approximately 450 tons of fruit were obtained annually.6

In this current project, the reach and the results obtained in organic cultivation of two species of pitahaya (*Selenicereus undatus* and *Selenicereus megalanthus*) are shown in the Southeast of Mexico, for their high demand in traditional use of Mexican cuisine, in addition to the importance of producing fruit from organic management, in an ergonomic system for harvesting focused on sustainability.

**Cultivation characteristics**

*Selenicereus* (A. Berger) Britton & Rose family subgenre of Cactaceae forming part of the Hylocereae tribe, the most recent subdivision includes the species *Hylocereus* and *Selenicereus* and the species *Weberocereustonduzii* (F.A.C. Weber) G.D. Rowley and *W. glaber* (Eichlam) G.D. Rowley7 comprised mostly of hemiepiphytes, climbers with angled stems, arial roots, large nocturnal flowers, generally white with globe like fruit.8 Originally from tropical America with a distribution in Southern Mexico, the Caribbean, Central America, North and South America and the Southern part of the United States.9 Th species *Selenicereus undatus* (Haworth) D.R. Hunt and *Selenicereus megalanthus* (K. Schumann ex Vaupel) Moran are hemiepiphyte cacti with large white nocturnal flowers, the *S. undatus* are from pink to red in color and yellow in *S. megalanthus*, they are known as red pitahaya, yellow pitahaya or simply pitahayas.

In the last 20 years red pitahaya and yellow pitahaya have been cultivated extensively for their commercialization on a global level. In Central America and Israel *S. undatus* is mainly cultivated,10 in the case of *S. megalanthus*, Colombia is the main producer of yellow pitahaya in the world, followed by Israel and Mexico.5 The price of red pitahaya on the international markets is very elevated as it is considered an exotic fruit; in Europe a kilo costs between 7 and 10 dollars (Castillo-Martínez 2006), in Israel the price per kilo has reached 26 dollars in the Hebrew and European markets.11 In Mexico, the states that have shown interest for the cultivation of these plants are: Puebla, Veracruz, Jalisco, Chiapas, San Luis Potosí, Michoacán, Oaxaca, Campeche, Yucatán and Quintana Roo, of which the Yucatan Peninsula is the greatest surface cultivated with more than 300 hectares of production.5 In Mexican regional markets, a kilo of red pitahaya can cost between 10 and 20 pesos reaching up to 30 pesos wholesale and retail reaching up to 60 Mexican pesos.4

The *Selenicereus* fruit have great significance in the industry, natural dyes can be obtained from the peel and the pulp, the seeds given their unsaturated fatty acid content have potential for food, cosmetic or pharmaceutical use.12 The importance of the cultivation of *S. undatus* and *S. megalanthus* for their commercialization has allowed for the development of a wide variety of studies about the quality of the fruit, commercialization, nutritional composition, cultivation, phenology, organic fertilization, physical chemistry, genetics, post-harvest management, morphology and production systems.13–22

**Materials and methods**

On May 29th, 2019 organic pitahaya planting began in the determined estate of Rancho Alegre located in the community of Cuxcuchapa belonging to the city of Comalcalco, Tabasco and property of Victor Manuel Mendoza Barrera, agronomic engineer (Figure 1).

The two species that were planted were *Selenicereus undatus* and *Selenicereus megalanthus* beginning on the 25th of May of 2019 and on June 26th there were 344 cuttings established, as shown in Table 1.

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**Figure 1** Location of estate.
Organic cultivation of two species of pitahaya (Selenicereus undatus and Selenicereus megalanthus) in the Southeast of Mexico

Table 1 Established cuttings

| Number | Seed time | Selenicereus undatus | Selenicereus megalanthus | Total |
|--------|-----------|----------------------|--------------------------|-------|
| 1      | 05/29/2019| 24                   | 12                       | 36    |
| 2      | 05/31/2019| 24                   | 12                       | 36    |
| 3      | 05/31/2019| 24                   | 12                       | 36    |
| 4      | 06-10-2019| 30                   | 0                        | 30    |
| 5      | 06-11-2019| 30                   | 0                        | 30    |
| 6      | 06-12-2019| 24                   | 12                       | 36    |
| 7      | 06/13/2019| 24                   | 12                       | 36    |
| 8      | 06/13/2019| 24                   | 12                       | 36    |
| 9      | 06/25/2019| 24                   | 12                       | 36    |
| 10     | 06/27/2019| 20                   | 12                       | 36    |
| Total  |           | 248                  | 96                       | 344   |

The seedlings used were 30 cm long (Figure 2) previously germinated at the ranch for three months with vegetable soil and worm-compost in a protected cultivation system using horticulture shadowed cloth with 70% sunlight penetration. The purpose of this system is to avoid the entrance of predators such as birds, squirrels, foxes, etc. However, also preventing the entrance of pollinators consequentially using hand pollination technique. This is a species of the cacti family that only blooms at night; therefore, pollination is nocturnal.

Figure 2 Cuttings used and distance between plantings.

The substratum that was used to plant was the existing organic floor enriched with worm-compost and mountain microorganisms. They were planted in high density in a line with a distance of 50 cm interspacing one species from another (Figure 3).

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The organic products are produced at Rancho Alegre by mountain microorganisms, cattle, sheep, and horse manure, vegetable carbon, wood ash, milk, molasses, saltwater, garlic, onion, habanero chile (Capsicum Chinese Habanero Group), Neem tree leaves (Azadirachtaindica), soap, rock flour, yeast, Sulfur (S), Potassium hydroxide (KOH), vegetable oil, and Calcium oxide (CaO), the schedule is ongoing cyclically. (Table 2).

Table 2 Program of application of organic products in pitahaya production area

| Date            | Products                                              |
|-----------------|-------------------------------------------------------|
| August 5th, 2019| Mountain microorganisms                               |
| August 12th, 2019| Biol (fermented liquid organic fertilizer) + ormus |
| August 19th, 2019| CaldoSulfocálsico (organic fungicide)                |
| August 26th, 2019| Biol (fermented liquid organic fertilizer) + ormus |
| September 2nd, 2019| Biochar                                               |
| September 9th, 2019| Organic Insecticide (potassium soap)                |
| September 16th, 2019| Biol (fermented liquid organic fertilizer) + ormus |
| September 23rd, 2019| Caldo de cenizas (organic insecticide)              |
| September 30th, 2019| Biol (fermented liquid organic fertilizer) + ormus |
| October 7th, 2019 | Organic Insecticide (potassium soap)               |
| October 14th, 2019 | Biol (fermented liquid organic fertilizer) + ormus |
| October 21st, 2019  | CaldoSulfocálsico (organic fungicide)          |

Results

From the hand pollination technique, a 95% fruit bearing was obtained (Figure 4).

From use of organic fertilizers, the following results were obtained:

The fruit ripening of the first crop was achieved in only 19 days (June 18th, 2020 first blossom, - July 7th, 2020 the first ripening) with pitahaya weighing up to 960 grams as observed in Figure 5.

Figure 4 (left) General view of the initial fruit production (right) Quality of fruit.

Figure 5 Weight in grams of harvested fruit.

Eight crops were obtained up to the last harvest on Tuesday, November 3rd, 2020 for a total of 300 kg. In Figure 5, the kilograms of the harvested fruit are shown, the quantity and weight of each species obtained is observed.

With regards to the average values obtained, the following was recorded as shown in Table 3, with an estimated equivalent total of more than 4 thousand kilograms of fruit, which greatly surpasses the estimated amount for the first year of production.

Table 3 Average values of fruits for the first year of production

| Species             | Average production / of plant (kg) | Average weight/fruit (kg) | Estimated performance /Ha |
|---------------------|-----------------------------------|---------------------------|---------------------------|
| Selenicereus undatus| 1.9                               | 0.723                     | 2908                      |
| Selenicereus megalanthus| 1.25                         | 1.25                      | 1938                      |

Discussion

In general, the bibliography indicates that in the first year we can obtain one or no pitahaya, from 4-5 crops per season that normally take from one month to 45 days; however, this project came to obtain a total of 300 kg obtained in an area of 617 m² the first year, with a total of 8 crops obtained every 19 days, which surpasses the reports by Rodriguez. This production consisted of 179.4 kilograms of Selenicereus undatus and 119.6 kilograms of Selenicereus megalanthus, respectively. The highest recorded weight of Selenicereus undatus was 960 grams while the highest recorded weight of Selenicereus megalanthus was 775 grams, compared to the
normal weight of pitahaya as in Southeast Mexico which are typically between 350-450 grams.

Estimated production for this project for both species was 4.845 tons per hectare exceeding the approximate production of 3 tons of fruit per hectare in Mexico at the beginning of the century. Estimated production of red pitahaya was 2.908 tons per hectare while production of yellow pitahaya was 1.938 tons per hectare.

The flavor obtained, from the fruit produced with organic products was more bittersweet, agreeable, and palatable than commercial convection, tests of fruit quality remain to be completed.

**Conclusion**

The use of organic products showed a substantial difference between production and time of fruit bearing. A favorable use of the products and obtained performance of pitahaya production is observed that given the first year, greatly surpasses the performance expressed in other reference projects.

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**Conflicts of interest**

No conflicts of interests exist.

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