EXECUTIVE SUMMARY

PROJECT
DEVELOPMENT AND VALIDATION OF TECHNIQUES TO MODIFY THE PRODUCTION OF PARTHENOCARPIC FRUIT IN ATAULFO MANGOS IN THE STATES OF NAYARIT, CHIAPAS AND GUERRERO



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For full report, please click here: https://buff.ly/2Uxt8mn

General Objective

Increase productivity and improve the quality of *Ataulfo* mango fruit, through the research and validation of techniques related to the use of growth regulators during the flowering, fruit set, and development stages of *Ataulfo* mango fruit in the states of Nayarit, Chiapas and Guerrero. Additionally, validate the mathematical model under other environmental conditions for the purpose of designing strategies to adapt to future climate variability.

Activities Carried Out

The study was conducted on commercial mango farms in the states of Nayarit, Chiapas and Guerrero, with significant production of *Ataulfo* mangos and a substantial presence of parthenocarpic fruit. For this purpose, four subprojects were carried out.

Subproject 1. Validation of mathematical model and its relationship to the development of inflorescence and the production of parthenocarpic fruit.

Objectives

1. Determine the impact of climate variability on the development of inflorescence, as well as the production of seedless fruit.
2. Validate a mathematical model based on meteorological conditions that are linked to the development of inflorescence and the production of seedless fruit in *Ataulfo* mangos.

Procedure

Research was conducted in Nayarit, Guerrero and Chiapas on the development of inflorescence during the various flowering flushes based on the scale developed by Pérez *et al*. (2009), and climate factors were studied to generate the floral development and seedless fruit production models.

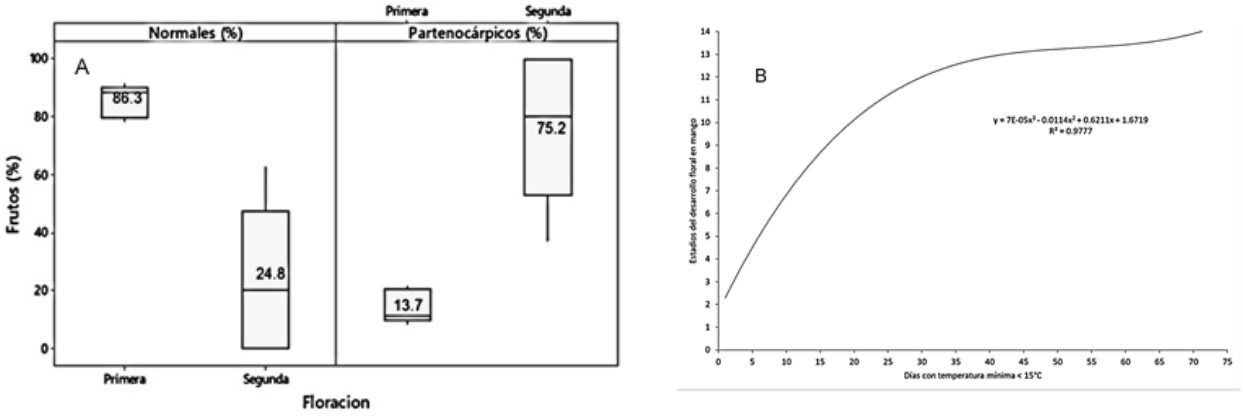
Results

Temperatures associated with floral development allowed for highly predictive mathematical modeling to be carried out in the three states. These were generated based on the aggregated amount of cold days. The models will lead to the creation of forecasting and early warning systems for extreme temperature events that could affect their development.

With regard to fruit production, in Nayarit, the largest production of parthenocarpic fruit occurred during the second flowering flush. This was related to the period in which petal fall occurred (E 13) and fruit

set (E 14), as well as the presence of minimum temperatures below 15°C and greater than 35 °C during that phase.

Climate conditions present during the floral development of *Ataulfo* fruit in Nayarit, Guerrero and Chiapas contrasted between them, therefore, the issue of parthenocarpic fruit for this cultivar was not caused by a fixed temperature threshold.



Percentage of fruit based on flowering flush (A) and Mathematical model of floral development in Nayarit, Second group (B).

Subproject 2. Studies on pollination, fertilization and fruit set in *Ataulfo* mangos: Floral biology.

Objective. Understand the effect of growth regulators, pollinators, and pheromones on pollination, fertilization, and fruit set.

Procedure. Three experiments were developed in order to achieve the objective.

Experiment 1. Effect of thidiazuron (TDZ) and gibberellic acid on pollination (AG_3), fertilization and fruit set. This work was carried out in the state of Nayarit on a commercial farm that produces *Ataulfo* mangos with a significant presence of parthenocarpic fruit (80 %); two doses of cytocinines (0 and 50 $mg \cdot L^{-1}$), and gibberellins (0 and 50 $mg \cdot L^{-1}$) were evaluated in simple and combined applications at different phenological stages: onset of flowering, full flowering, after full flowering (petal fall).

Results

Regulators that were applied during full flowering (cytocinines) produced an effect on fertilization and fruit set; additionally, fruit was retained until the moment of harvest. Similar results were obtained when the regulators (cytocinines + gibberellins) were applied after full flowering. The conclusion was that the application of TDZ + AG_3 15 after full flowering improved fruit set, as well as pollinated and parthenocarpic fruit, which were outcomes that provided the basis for the study on the effect of these regulators on production and fruits size on both pollinated and seedless fruit.

Experiment 2. Studies on pollination, fertilization, and fruit set through the use of pollinators and pheromones.

The work was carried out on commercial farms located in different sites that produce *Ataulfo* mangos and have a high incidence of parthenocarpic fruit (80%). The experiment employed two pollinators, *Tommy Atkins* (Site 1) and *Haden* (Site 2), and one pheromone (Splat Bloom©) at both sites, as well as trees without pheromones or pollinators as a control group.

Results

At Site 1, the largest production of pollinated fruit was obtained from *Ataulfo* trees with pheromones, although it was found to be statistically equal to the production of the *Ataulfo* farm with no pollinators or pheromones. At this site, none of the orchards produced parthenocarpic fruit, which can probably be attributed to the advanced flowering achieved through the application of PBZ in all of these farms that produce *Ataulfo* mangos.

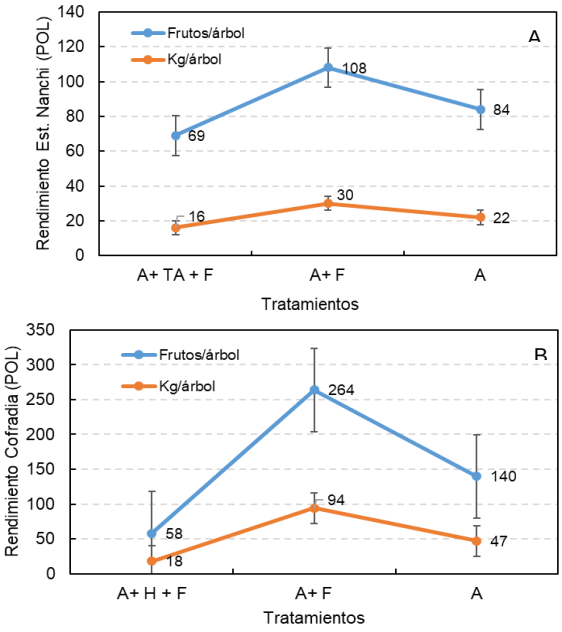
Site 2. The largest production of pollinated fruit occurred on the *Ataulfo + pheromones* farm and the lowest production occurred in *Ataulfo* combined with *Haden* and pheromones.

These results indicate that, at both sites, regardless of whether the pollinator was near or intermixed with the *Ataulfo*, there was no improvement in the production of pollinated fruit, but the application of pheromones at both sites contributed to a higher yield.

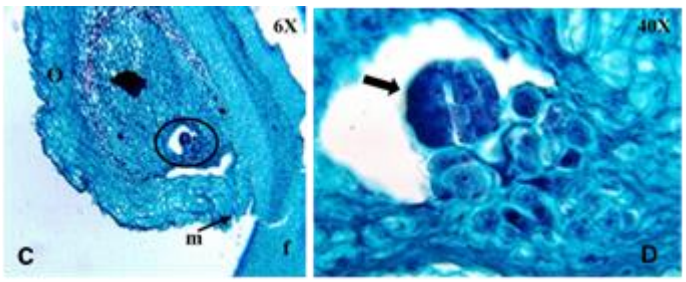
Experiment 3. In the search for the causes that lead to the presence of parthenocarpic fruit in *Ataulfo* mangos, or the damage or impact provoked by extreme temperatures (<15 and/or >33 °C) in the floral development or growth of the fruit, a study was carried out on embryo development.

Results

Aborted embryos were found from the initial development stages of the fruit (4 – 5 mm in length) through the full development stage of the fruit (4 – 5 cm in length). Aborted embryos found at different developmental stages of the fruit are an indication that pollination and fertilization took place, but the embryos were damaged by temperatures lower than 15 °C and higher than 35 °C that were present from E13 through E14, making these fruit stenospermocarpic, a form of parthenocarpy in which pollination and fertilization occurs, but the recently fertilized embryo is aborted.



Production of pollinated fruit (POL) using pollinators and pheromones at two sites, Estación Nanchi (A) and Cofradia (B).



Observation of aborted embryo during fruit set (between 1 and 2 cm in length), the circle indicates the presence of the embryo in a globular aborted state; **D**, globular aborted embryo observed at a higher scale.

Subproject 3. Validation of techniques created to increase the fruit set and size of parthenocarpic fruit in *Ataulfo mangos*.

Objective. Validate the technologies created in the state of Nayarit based on growth regulators used to increase fruit set and size of parthenocarpic fruit.

Procedure.

This subproject validated technologies created in previous studies conducted on farms that produce *Ataulfo* mangos with a high incidence (80 %) of parthenocarpic fruit in the states of Nayarit and Chiapas.

Technology 1. TDZ + AG_3 4X applied 15, 30, 45 and 60 days After Full Flowering (DPF).

Four applications of TDZ mixed with AG_3 in doses of 50 mg L^{-1} each. The first application was made at fruit set (fruit 3 – 5 mm in length) or petal fall, approximately 15 days after full flowering (DPF), the second application 30 days DPF, the third application 45 days DPF, and the fourth application 60 days DPF.

The subproject was conducted in the state of Nayarit over the course of two years, 2018 and 2019, on a 15-year-old commercial farm that produces *Ataulfo* mangos, in an 8 x 8 m row/tree configuration (156 tress/hectare) with an incidence of parthenocarpic fruit of 80%. The trees were under drip irrigation conditions.

Technology 2. TDZ 1 time during full flowering and AG_3 4 times at 15, 30, 45 and 60 days DPF (After Full Flowering).

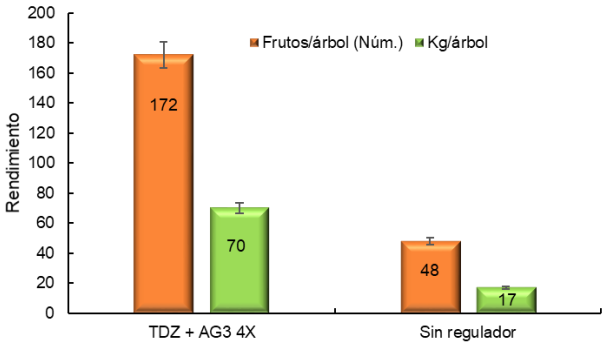
An application of 50 mg L^{-1} of TDZ during full flowering and three to four subsequent applications of 50 mg L^{-1} of AG_3 at 15, 30, 45 and 60 days DPF were conducted in the states of Nayarit and Chiapas on farms that produce *Ataulfo* mangos with an incidence of 80 % of parthenocarpic fruit. The trees were 8 years old, set up in a 6 x 4 m configuration (416 trees / hectare) and managed under drip irrigation conditions in Nayarit.

In Chiapas, the work was carried out on the “Las Andreas” farm with more than 80% of parthenocarpic fruit. The farm uses agronomical management practices (pruning, fertilization, phytosanitary practices, etc.) and irrigation. Both of the technologies mentioned previously were applied on this farm.

Results in Nayarit

The results obtained during the experimental phase in terms of the increase in size of the parthenocarpic fruit (weight, length, and diameter) were corroborated with the application of regulators during its commercial phase, and they also favored the production of pollinated fruit.

Both technologies increased the size of the parthenocarpic fruit, as well as that of the regular fruit, though the technology based on the mixture of TDZ + AG_3 at a dose of 50 mg L^{-1} of water for each regulator with four applications starting at fruit set every 15 days yielded better results.



Production and size of parthenocarpic fruit treated with 50 mgL-1 of TDZ + AG_3 (4X) starting at fruit set without regulator.

Results in Chiapas

Four applications of the treatment mix TDZ+AG_3 at the indicated doses and the scheduled applications every 15 days starting at full flowering on *Ataulfo* mango trees in Soconusco, Chiapas increased the growth of parthenocarpic fruit above the official size considered as the standard 118 g in the Official Federal Register (DOF).

An average yield of 5.3 tons per hectare was achieved, which is acceptable from an economic standpoint in the Soconusco, Chiapas region, and is also an indication that there was an increase in the production of fruit with seed.

Subproject 4. Effect of nutrition on the production of parthenocarpic fruit in *Ataulfo* mangos.

Objective. Determine the effect of nutrition on the production and size of parthenocarpic and pollinated fruit in *Ataulfo* mangos.

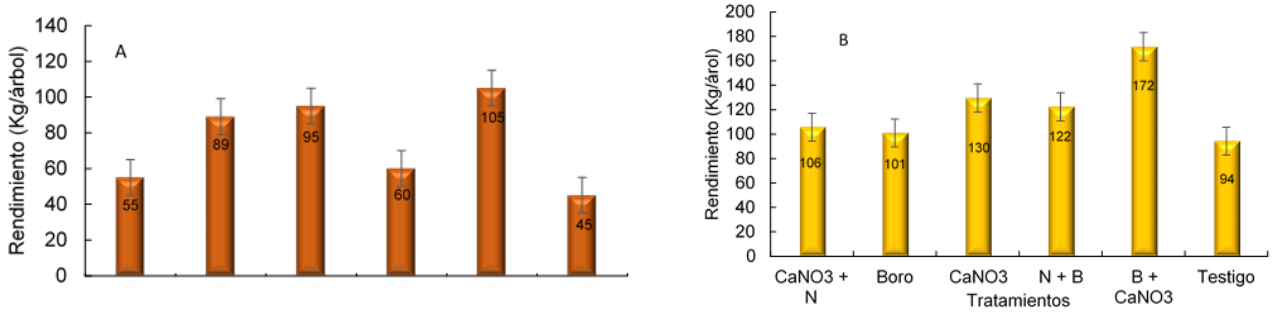
Procedure

Experiments were conducted in the states of Nayarit (two experiments) and Guerrero (one experiment) on the *Ataulfo* cultivar. In Nayarit, farms with a high incidence of parthenocarpic fruit or dwarf mangos (80 %) were selected in the municipality of Tepic (5 de Mayo Site) and San Blas (Cofradía and Las Palmas Site).

Experiment 1. Various treatments were applied during full flowering and 15 days later, as a function of the combination of nutrients that favor pollination and fertilization such as nitrogen, boron, and calcium. The treatments were as follows: T1, calcium + nitrogen; T2, boron, T3, calcium; T4, nitrogen + boron; T5, boron + calcium and T6, control (without the application of nutrients). All of the nutrients were used at a 1% concentration in two applications, one during full flowering and the other one 15 days after the full flowering (fruit set; fruit 4 - 5 mm in length).

Results

The results on nutrition over two years indicate that this has a positive effect on the production of fruit with seed and demonstrate a trend toward the reduction of incidence with the foliar application of Boron + Calcium at a dosage of 1% during full flowering and fruit set (15 days after full flowering). Increases in the fresh weight of parthenocarpic fruit (21%), as well as that of fruit with seed (10%) were observed. In conclusion, two calcium + boron applications using foliage spraying, one during full flowering and the second one 15 days later (fruit set), increased the production of pollinated fruit and improved the size of parthenocarpic fruit.



Yield in kg of pollinated fruit from *Ataulfo* mango trees as a result of the effect caused by nutrition in 2018 (A) and 2019 (B).

Experiment 2. Sustainable physio-nutritional replacement strategies to increase size in pollinated and parthenocarpic *Ataulfo* mango fruit. Work was done on *Ataulfo* mangos using irrigation at the 5 de Mayo and Cofradía, San Blas Municipality sites, on plantations configured in 5 X 4 and 10 X 10 m layouts, 5 and 20 years old, neutral pH (7.1) and slightly acidic, respectively.

Results

Larger improvements in the size, weight and quality of pollinated and parthenocarpic fruit were achieved with two different alternatives 1) mixed organic fertilizer sourced from enriched bokashi vermicompost identified as Balmix: four applications of 15% lixiviate, starting from fruto cerillo, in a biweekly application + two biweekly applications of solid manure, 2 kg per tree, after the first lixiviate, and 2) amino-acid and nutrient complex identified as Aminoác cR, at a dosage of 1.5 L ha^{-1}; four applications, one every two weeks, starting from fruto cerillo. With these same applications, the incidence of pollinated fruit was 71 and 81%, and that of parthenocarpic fruit was observed to be 19-29%.

Experiment 3. In the state of Guerrero, the work was conducted on a commercial farm that produces *Ataulfo* mangos with a high incidence of parthenocarpic fruit (>80 %), in the municipality of Atoyac, located in the Costa Grande region. The treatments were as follows: mango integrated management (MIM1), modified mango integrated management (MIM2), control group producer management, and during the first two treatments nutrition was a key factor.

Results

The best treatment was found to be MIM1 with a higher number of fruits with seed (46,600) and with yields of 19,942 kg ha^{-1}. MIM1 included the application of hydro soluble fertilizers N, P, K and Mg using formula 30-13-20-6 divided into two applications, pre-flowering and fruit growth; dolomite (Ca 53% and Mg 44%) 500 kg ha^{-1}; foliar fertilizer, 2 L ha^{-1} of chelated boron micronutrient, with two applications; two sprayings of 2% phosphonitrate during the pre-flowering stage; pest and disease management with seven applications of chemical fungicides and insecticides.

Production of pollinated (POL) and parthenocarpic (PRT) fruit per ha^{-1} under management control groups

TRATAMIENTOS[1]	**POL**				**PRT**			
	No. ha^{-1}		**Kg ha^{-1}**		**No. ha^{-1}**		**Kg ha^{-1}**	
MIM1	46,600	a[2]	19,942	a	62,240	b	10,166	b
MIM2	26,540	b	10,920	b	59,400	b	9,702	b
Testigo	15,680	b	5,994	b	88,320	a	14,426	a

[1]Mango Integrated Management (MIM1), Modified Integrated Management of Mangos (MIM2) and Control Group; [2]Values with the same letter are statistically equal (P≤ 0.05)