FINAL REPORT

STRATEGIES TO AVOID IRREGULAR FLOWERING AND MODIFY THE HARVEST PERIOD FOR EXPORT MANGOS THROUGH THE USE OF AN INTEGRATED MANAGEMENT APPROACH

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Introduction

The main issue that the Mango Product System has is the uncertainty of the environmental conditions, since low cultivar productivity is directly attributable to them, especially temperature and humidity, which are present during the flower development process and, hence, give rise to irregular flowering. There is research that has been done globally that documents the positive effect caused by gibberellin inhibitors to obtain regular flowering, move up the harvest period, and improve the production of mango fruit. That is also the case with paclobutrazol, which has demonstrated excellent results with different mango cultivars (Singh and Bhattacherjee, 2005; Rodríguez *et al*., 2007), albeit with potential contamination risks, especially when its application is inadequate or done incorrectly. At present, other gibberellin synthesis inhibitors such as calcium prohexadione (P-Ca), which is applied directly to the foliage, has proven to be effective at regulating vegetative growth in 'Tommy Atkins' and 'Kent' mangos (Do Carlos-Mouco *et al*., 2011). Others, such as Uniconazole (UCZ), have proven to be effective at reducing vegetative growth, moving up the harvest period, and increasing the production of fruit in mango cultivars such as Alphonso (Gopu et al., 2017), Palmer (de Sousa et al., 2016) and Kent (Silva et al., 2010); in the case of both regulators, the applications are directed at the foliage.

On the other hand, pruning is necessary to synchronize the age of the buds that will be induced towards flowering; additionally, it's possible to modify the flowering through the use of this practice, depending on its period and severity (Pérez *et al*., 2016, Davenport; 2006).

Regarding nutrition, the decision-making is associated with an understanding of the physiology of the flowering process (Sandip *et al*., 2015). Some studies report that floral initiation depends on maintaining a high C:N ratio, whereas a low ratio favors vegetative growth. As such, an adequate reserve and the availability of carbohydrates is vital for floral initiation (Upreti *et al*., 2014). The use of bioregulators such as agricultural algae, organic fertilizers, amino acids, acquired systemic resistance inductors, and bio-inputs in general, along with the opportunity for their application, are sustainable alternatives and are assessed as an alternative to ensure flowering.

General Objective. Increase the productivity and quality of export mangos through the use of an integrated management approach that includes pruning, nutrition, and the use of growth regulators that are friendly to the environment and human health.

Specific Objectives

Year 1

1. Explain gibberellin actions and the differentiation of floral buds.
2. Understand nitrate actions on mango bud latency and floral differentiation.
3. Determine the effect of nutrition on floral differentiation.
4. Identify climate vulnerabilities for the main varieties of export mangos.

Year 2

1. Validate a forecasting model or system to monitor the status of flowering (anthesis), fruit set, and harvest for different mango cultivars, in order to prevent production risks and ensure proper agricultural management and decision-making.
2. Determine the number and season for the application of gibberellin synthesis inhibitors, separately or combined, to ensure an abundant and earlier flowering for mangos, with the ultimate goal of finding an effective substitute for PBZ.
4. Determine the effect of pruning combined with nutrition on mango flowering.
5. Evaluate the use of bio stimulants in conjunction with nutrition related to the demand and physiology of the tree, as part of the sustainable alternatives to promote compaction for flowering and modify the harvest season for “Ataulfo” mangos.

Year 3 (2020-2021)

Same objectives as in year **2**.

Achievement. The following activities were carried out from June 2018 to September 2021:

Experiment 1) Climate characterization, its variability, and forecasting system associated with flowering and harvest processes in two mango production areas in Mexico.

The production area located in the states of Nayarit and Colima, was defined using the geo-referencing records obtained from the Produce Information System (SIAP). Additionally, using data from National Meteorological Service stations, we obtained daily meteorological variables including maximum and minimum temperatures, and average rainfall (1981-2017). We organized the information using a database management software (Access - version 10), characterizing each variable on graphic diagrams using the Minitab software (version 17). Using the characterization data, an information platform was designed to provide weather forecasting data as well as recommendations for appropriate crop management based on environmental conditions.

Experiment 2) Gibberellins and their effect on floral induction and differentiation (reproductive development stage of the apical bud).

From 2018 to 2020, two (2) experiments were carried out, one on the Kent variety in Nayarit and the other one on the Tommy Atkins variety in Colima. In order to assess the reproductive development of the apical bud, we employed the scale generated by Pérez *et al.*, (2009), whereby E 1 corresponds to vegetative bud, E 2, floral initiation, E 3 bud tending towards flowering, and E 4, differentiated bud.

For Nayarit, the treatments are shown in Table 1.

Table 1. Treatments evaluated for the Kent cultivar in Nayarit

Treatment number	Regulator	Dose ($mg \cdot L^{-1}$)	Applications		Type of pruning
			01/dec	15/dec	
1	AG_3*	25	X	X	
2	AG_3*	50		X	
3	AG_3*	50	X	X	
4	AG_3 + Pruning**	25	X		Light
5	AG_3 + Pruning**	50	X		Severe
6	Control				

*Light pruning after harvest (25 cm crop)

Kent trees were pruned on August 9, 2018 with a light pruning, of approximately 20 cm long from the apex of the bud to the center of the tree, with the exception of the trees in treatments 4 and 5 with an application of 25 $mg \cdot L^{-1}$ of AG_3 plus light (20 cm) and severe (50 cm) pruning one month after the August pruning, and the absolute control group that was not subjected to any pruning or application of AG_3.

From 2018 to 2020, an assessment was conducted of five gibberellin-based treatments carried out on Tommy Atkins mangos from Colima (Table 2), a control group was included, as well.

Table 2. Assessment of Treatments Applied to Tommy Atkins Mangos in Colima

Treatment number	Regulator	Dose ($mg \cdot L^{-1}$)	Applications		Type of pruning
			20/nov	5/dec	
1	AG_3*	50	X	X	Producer
2	AG_3*	100		X	Producer
3	AG_3*	100	X	X	Producer
4	AG_3 + Pruning**	50	X		Light
5	AG_3 + Pruning**	100	X		Severe
6	Control				Producer

From 2020 to 2021, in Nayarit, given the null results that were obtained for the Kent cultivar, an assessment was conducted of the gibberellin-based treatments carried out on Tommy Atkins mangos using the prescribed dosages for that cultivar in Colima. During that same period, the Tommy Atkins cultivar was replaced with the Ataulfo cultivar in Colima.

Experiment 3) Nitrates and their relationship with bud latency and floral differentiation. This work was carried out from 2018 to 2019 in the state of Nayarit on Ataulfo and Kent cultivars. In both cases, an assessment was conducted of different nitrate-based treatments (calcium nitrate, phosphonitrate, and potassium nitrate). With the 'Ataulfo', all the trees were pruned on August 8 of 2018 with lopping cuts, approximately 40 cm long from the apex of the bud to the center of the tree. In addition to the application of nitrates, an assessment was conducted of trees that received the application of PBZ as a standard control, and trees without the application of nitrates, or PBZ as the absolute control groups.
With the Kent variety, all the trees were lightly pruned at an approximate length of 20 cm from the apex of the bud to the center of the tree and, in contrast to the experiment with the 'Ataulfo' variety, only the absolute control group without the application of nitrates was used.

Experiment 4. Study of gibberellin inhibitors as an alternative to PBZ, and their effect on the flowering process in mango cultivars.
The study was carried out in Nayarit and Colima using the Tommy Atkins and Ataulfo cultivars, respectively, during the period from 2018 to 2021.
The study focused on dosage, number, and period of applications of growth regulators that inhibit gibberellin synthesis as an alternative to PBZ, among them, calcium prohexadione (P-Ca), and Uniconazole (UCZ), both of which were applied by spraying the compound directly on the foliage. PBZ was used as the standard control group, and applied to the soil, in addition to an absolute control group (producer handled, without regulator). In some cases, combinations of inhibitors were studied for the purpose of improving or intensifying the response during the flowering process (Table 3). Applications made both to the foliage as well as to the soil were carried out after the emission of the second flow of vegetative growth that emerged after the production pruning.

Table 3. Treatments for Tommy Atkins in Nayarit and Ataulfo in Colima.

Treatment number	Regulator	Dose ($mg \cdot L^{-1}$)	Number of applications and period (DAP)*		
			15	30	45
1	P-Ca	500	X	X	X
2	P-Ca	1500			X

3	P-Ca + UCZ	750 + 500	X	X	X
4	P-Ca + UCZ	750 + 250	X	X	X
5	UCZ	1000	X	X	X
6	PBZ **	2500			X
7	Control				

*DAP, days after pruning. **Applied to the soil, the rest of the treatments were sprayed on the foliage.

From 2020 to 2021, Cycocel was introduced in the treatments at a dosage of 1000 mg L^{-1} in three applications.

Experiment 5) Effect of pruning and nutrition on the flowering process for mango cultivars.

5.1. Season and pruning intensity during flowering and production of 'Ataulfo' mangos. The pruning treatments for Ataulfo were:

Pruning dates: Early (immediately after the harvest), intermediate (two months after the first pruning), late (two months after the second pruning), and control group (without pruning).

Pruning severity or intensity: light pruning, cut approximately 50 cm from the apex of the bud to the center of the tree, and severe pruning, cut approximately 75 cm from the apex of the bud to the center of the tree.

5.2. Nutritional and sustainable integrated management strategies for floral induction and differentiation in Ataulfo' mangos in Nayarit. Treatments are shown in Table 4.

Table 4. Treatment assessed as nutritional strategies

No.	Treatment
1	Organic
2	algae + protocytokines + nutri 1
3	algae + protocytokines + nutri 2
4	Treatment 2 + organic
5	Treatment 2 no pruning
6	Potassium Nitrate
7	Calcium Nitrate
8	Producer control

Except for T5, the rest of the trees were pruned

Except for the control group, all the treatments included sustainable integrated management: pruning, application of organic bio-stimulants to the soil, foliar application of chelated Ca and B, and sustainable pest and disease control.

FINAL RESULTS

Experiment 1) Climate characterization, its variability and forecasting system associated with the flowering and harvest processes in two mango production areas in Mexico.

The climate characterization was completed for two mango production areas located in the states of Nayarit and Colima, using data from National Meteorological Service (SMN) stations. Figure 1A describes weather patterns going back until 1981 for Nayarit, highlighting the warmest months (May and June with a maximum monthly average temperature above 35°C), the coolest (January to March with the minimum average temperature under 15°C), the driest (March to May with average monthly rainfall under 15 mm), and the most humid (July to September with average rainfall ranging from 350 to 450 mm per month). The annual average rainfall it's approximately 1500 mm, the average maximum temperature is approximately 33.7°C and the minimum average temperature is almost 19°C.

Figure 1B shows the monthly rainfall pattern in the mango production region of Nayarit, exhibiting two different seasons (summer and winter). The winter season, due to the El Niño effect, is rainier compared to the La Niña effect which is drier. The summer season exhibits a behavior that is opposite to winter depending on the ENSO phase, that is, the months influenced by the La Niña phase are rainier than the months impacted by the El Niño and neutral phases.

Regarding temperature, during the winter, particularly during the months of December, January, and March, when they are in phase with La Niña, temperatures are cooler and can drop to as low as 13° C (the mango flowering process occurs during this period, and this may be the cause of the adverse conditions that impact this important phenological stage). In contrast, the El Niño or neutral phases present better minimum temperature conditions that are closer to 15° C (Figure 2A). In terms of average maximum monthly temperatures, during winter seasons that are in phase with El Niño the lowest recorded levels for this meteorological variable were observed during the months of December through March, in contrast with the values recorded for the La Niña phase which were always higher, as much as a 2°C difference between phases (Figure 2B).

The climate characterization for Colima is shown in Figure 3A, where it identifies the warmest months, as well as the coolest and most humid. The average annual rainfall is approximately 850 mm, the maximum average temperature is 33.8° C, and the minimum average temperature is approximately 20° C. Figure 3B shows that winters that are in phase with El Niño are rainier than months that are in phase with La Niña (a similar condition to that observed in the state of Nayarit).

Figure 4A shows how the different ENSO phases affect minimum average temperatures. In winter (December to March), when the months are in phase with La Niña, temperatures are cooler and can drop to as low as 15 to 18° C. In contrast, the El Niño or neutral phases exhibit minimum temperature conditions that are superior to the La Niña phase (from 16 to 19° C). The maximum average temperature behavior in Colima is very peculiar (Figure 4A). In the winters that are in phase with El Niño we observed the highest recorded temperatures (compared to the other phases) during the months of December and January, whereas February is cooler when it is in phase with El Niño compared to when it is in phase with La Niña, and in March the neutral phase stands out as the highest recorded value (33.7°C).

A design was developed for the IT platform that would provide climate forecasting information and recommendations for crop management based on environmental conditions.

The search mechanism employs two main inputs for the seasonal forecast:

1. ENSO conditions in region 3.4 of the equatorial Pacific ocean https://iri.columbia.edu/our-expertise/climate/forecasts/enso/current/.
2. The phenological models (flower development, beginning of differentiation up to anthesis, and fruit set) as well as technology verified by INIFAP for the integrated management of the canopy, flowering, and increasing fruit set and fruit size.

By combining these technologies, it would be possible to issue an alert on potential future climate conditions (during the upcoming fall and winter seasons) for the purposes of recommending actions to avoid erratic flowering, a low degree of fruit set, or a higher incidence of parthenocarpic fruit (dwarf mangos). The background and recommendations are listed in Figure 5.

The forecast is updated each month, for the three mango production regions in the state of Nayarit:

Experiment 2). Gibberellins and their effect on floral induction and differentiation (state of reproductive development of the apical bud).

To assess the reproductive development of the apical bud, we used the scale created by Pérez *et al.* (2009) where E 1 corresponds to a vegetative bud, E 2, floral initiation, E 3 bud tending towards flowering, and E 4 differentiated bud.

The results obtained from 2019 to 2020 are shown in Table 5. In 2019, the buds remained vegetative (Stage 1) in buds treated with pruning and AG_3; whereas, the control group with pruning reached a development stage of approximately 2.5, with a low percentage of differentiated buds (18.8%). The opposite was true for the absolute control group since it reached a more advanced development stage (3.8) attaining a differentiated bud percentage of de 85%. This led to a flowering of 0% and 12% in trees with AG_3 and controls with pruning, respectively, and 87% in trees that were neither pruned nor treated with AG_3.

The results obtained in flowering were reflected in the yield, which is why there was no production of fruit resulting from the gibberellin treatments since this regulator, in addition to the pruning of trees, did not favor the floral differentiation or budding described previously. The trees without AG_3 but with light pruning yielded a production of only 4 kg/tree, whereas the absolute control (without pruning and without AG_3) produced almost 47 kg.

In 2020, despite having eliminated the treatments with pruning, differentiation and flowering percentage were null and, hence, there was no production of fruit during this cycle.

In the first year, the gibberellins (AG_3) did not favor floral differentiation or flowering, except for the absolute control (without pruning and without AG_3). This could be attributable to the effect of the gibberellins (AG3), since it's well-known that these generally inhibit flowering by promoting vegetative growth at the expense of the reproductive growth, though it depends on the dose and the phenological stage of application (Boss *et al*., 2004; Wilkie *et al*., 2008); according to Davenport (2007) GAs act as a vegetative promoter in mangoes more than an inhibitor of flowering. Nevertheless, in the control trees that did not receive any pruning treatment or applications of AG_3, the flowering was greater at 80%, which indicates that a simple pruning, albeit light, also had a negative effect on the floral differentiation for this cultivar. The results obtained do not coincide with those obtained by Vázquez and Pérez (2006) for the Ataulfo cultivar, in which they reported an abundant flowering and harvest as well as a six-week delay in the harvest, with two applications of 50 mg L^{-1} de AG_3. This notwithstanding, the 'Ataulfo' trees in this study were not subjected to any pruning.

During the second year (2020), once again the results with gibberellins were null, in fact, during this year the control group did not flower. Along with the application of gibberellins, temperature and moisture conditions during the months of October, November, and part of December were not favorable for the development of an adequate differentiation and an almost null flowering resulted due to one or two inflorescences in only two trees from one treatment. For this reason, there was no significant fruit production in any of the treatments in this experiment.

In the third and final stage (2020-2021), the experiment was conducted with the Tommy Atkins cultivar, given the negative results obtained during prior years with the 'Kent' variety.

But development reached a stage of 3.7 and 3.8, on average, in trees treated with gibberellins, which indicates that a good number of buds were converted to reproductive buds even with the application of gibberellins. In control trees (without gibberellins), the sampled buds reached a stage four of development, that is, all of them differentiated converting into reproductive beds. These results are reflected by a very high percentage of differentiated buds, where the treatments with gibberellins reached between 85 and 95%, while in the control trees 100% of the buds sampled converted to reproductive buds (Table 6).

With regard to the flowering percentage, this varied between 78 and 85% in trees with AG_3, whereas the control group reached 100% flowering. The high dose of gibberellins (100 mg L^{-1}) in two applications caused a lower flowering in the trees. Regardless, the percentage attained was more than 70%, which is considered sufficient for good production of fruit.

The time that elapsed between the last application of gibberellins and the onset of flowering was 65 days in control trees and approximately 85 days in those treated with gibberellins, demonstrating a delay in the flowering of approximately 20 days compared to the control group. The trees that received the application of gibberellins at different doses were not affected, neither in differentiation nor in flowering, achieving an intense flowering of over 80% with doses of 50 mg L^{-1} (2X) and 100 mg (1X), and 78% with 100 mg (2X). Which indicates that a delay of approximately 20 days was reached in 80% of the flowering with the application of the gibberellins. This was also possible due to the low temperatures (< 20°C) that prevailed during the months of January and March that led to a good percentage of buds converting into reproductive buds and subsequently leading to the flowering. All of which means that the effect of the gibberellins acted as a function of favorable climate conditions as mentioned by Boss *et al*. (2004) and Wilkie *et al*. (2008).

Regarding yield, the tree $fruit^{-1}$ number varied between 337 and 413 fruit. The trees in the treatment with two applications of AG_3 (50 mg L^{-1}) exhibited the highest number of fruits compared to the treatment with AG_3 100 mg L^{-1} (1X) and the control (Table 7).

Regarding the kg of fruit per tree, there were no differences between treatments with the exception of the treatment with a single application of AG_3 at a dose of 100 mg L^{-1} that exhibited the lowest yield at approximately 124 kg. The rest of the treatments produced between 136 and 152 kg per $tree^{-1}$ (Table 7). During the harvesting season, all the treatments with AG_3 delayed the harvest by 15 to 20 days compared to the control.

The results obtained in yield, both in the number as well as the kg of fruit per tree, indicate that the gibberellins did not affect or were not antagonistic toward flowering given that according to

Boss et al. (2004) and Davenport (2007) the gibberellins are antagonistic towards flowering since they promote vegetative development. Despite this, Wilkie et al. (2008) mention that the effect will depend on the applied dose and the phenological stage. Additionally, inductive temperatures must prevail (nocturnal < 20°C) to stimulate a delayed flowering. Therefore, the lower temperatures (< 20°C) exhibited during the January and February period favored a delayed flowering and, hence, a delay in the harvest of between 2 and 3 weeks, which favors the price of the product for an out of season harvest.

The size of the fruit was not affected by the gibberellins varying in size from 352 to 369 g, and no differences were observed between length and diameter with an average of 9.3 and 7.8 cm, respectively.

Results of the application of AG_3 on the Tommy Atkins cultivar in Colima.

The results obtained during the first year (2019) on the percentage of differentiated buds and flowering are shown in Table 8. The treatment with AG_3, 100 $mg \cdot L^{-1}$ (two applications) led to the highest percentage of floral bud development (70%) and also recorded the lowest percentage of inactive buds, the treatment with AG_3, 100 $mg \cdot L^{-1}$ + severe late pruning, exhibited the lowest percentage of floral buds with 15% showing statistically significant differences to treatments 2 and 3. Statistically significant differences were observed between treatments in the percentage of total flowering, where the trees in treatment 2 (AG_3 100 $mg \cdot L^{-1}$, 1 application) stood out with a flowering of almost 90%, being statistically the same as treatments 3 and 1 (AG_3 100 $mg \cdot L^{-1}$, 2 applications and AG_3 50 $mg \cdot L^{-1}$, 2 applications). The control group flowered 65%, and the rest (treatments 4 and 5) recorded the lowest flowering. These results coincide with the percentage of differentiated buds. The treatments with gibberellins reached maximum flowering between 77 and 95 days after the last application of gibberellins, achieving a delay of between 18 and 36 days compared to the control, and a percentage between 48 and 89% (5 – 20 of February). During this time, the percentage obtained in the control trees was practically null due to the fact that close to 60% flowered at the beginning of January.

In 2020, the pruning treatments were eliminated because they strongly affected the differentiation of the apical bud and the flowering. Nevertheless, during this second year, the percentage of buds that differentiated was very low among the treatments, regardless of the application of AG_3, and the percentage varied between 20 and 35%. This led to a low flowering between 22 and 43% among the treatments. The results obtained in the second evaluation show a year of irregular flowering stemming from the fact that the temperature conditions (>20°C) were not favorable enough to ensure that the majority of buds could convert into reproductive buds, in addition to the application of AG_3.

Table 9 shows the results of the yield during 2019 and 2020. In 2019, treatment 1 (AG_3, 50 mg L^{-1} two applications) was the one with the highest yield (559 Kg), over and above the control (488 kg), with treatment 2 (AG_3, 100 mg$\cdot L^{-1}$ producer pruning) being the least outstanding (396 kg). In the latter treatment, in addition to having been the highest dose of gibberellins that was applied, consideration should be given to the fact that it was done on only one occasion during the second date in which treatments with this regulator were applied. Most of the control production was harvested at least one week earlier than the rest of the treatments. In 2020, the yield fluctuated between 55 and 100 Kg $tree^{-1}$, very much lower than the yield reached a prior year. The yield of the tree is related to the irregular flowering obtained due to the lack of inductive conditions, in addition to the application of gibberellins.

During the first year of results, there was a delay in the flowering of between 18 and 36 days in most of the treatments with gibberellins and, in contrast to the results in Nayarit, the application of gibberellins did not inhibit differentiation nor flowering budding, achieving a considerable yield, albeit slightly delayed, though this study involved the Tommy Atkins cultivar whereas in Nayarit it involved the Kent cultivar. However, during the second year there was no effect due to the treatments.

During the last phase of the project for the period 2020-2021, the treatments were applied to the Ataulfo cultivar for two reasons, first, because of the inconsistent two-year results for the 'Tommy Atkins' variety and, second, because the farm was no longer available. The same treatments were applied as the 'Tommy Atkins', in addition to two controls, one in trees with flowering at the beginning of the experiment (without gibberellins), and a second made up of trees without flowering and without gibberellins.

The results related to the differentiation of the apical bud and flowering are shown in Figure 6. Treatments 1 (Gibberellins 50 ppm, 2X), 2 (Gibberellins 100 ppm, X), and 3 (Gibberellins 100 ppm, 2X) registered 50, 39.3 and 35.7% of differentiated buds, whereas the control 1 (without flowering at the beginning of the experiment and without gibberellins) registered almost 60% and in excess of 80% for control 2 (with flowering at the beginning of the experiment, without gibberellins).

The flowering fluctuated between 18 and 76%, the treatments with higher percentage where those were no application of gibberellins was made, given that these favored vegetative development at a greater percentage than reproductive development in Ataulfo mangos.

In general, due to the effect of the gibberellins there was a delay in flowering in the trees, in addition to a greater reduction in the flowering as the applied dose of gibberellins was increased. The three treatments with gibberellins were deemed to be inadequate given that the delay in flowering that they exhibited was between 32 and 21 days (Figure 7) when it was calculated based on the control with flowering at the beginning (Treatment 5) and based on the control with later flowering (Treatment 4), respectively. However, in addition to the delay, there was a notable reduction in flowering that occurred in the treated trees. Additionally, given that the producer conducted a general pruning towards the end of October 2021, it's not possible to know if that produced any additional effect in the tree response to the gibberellins. Figure 8 shows that the yield fluctuated between 9.6 and 84.5 kg of fruit/tree, values that corresponded to treatment 2 (Gibberellins 100 ppm, 1X) and treatment 4 (control), respectively. In the treatments with gibberellins, we reached a delay in the harvest of 32 days, compared to the control (Table 7); however, production was affected with a reduction in kg of fruit per tree.

Experiment 3) Nitrates and their relationship to bud latency and floral differentiation.
This work was carried out with the Ataulfo and Kent varieties in Nayarit during the first year of the study, 2018-2019. In 'Ataulfo', all the trees were pruned on August 8, 2018, with crop pruning, approximately 40 cm of length from the apex of the bud to the center of the tree. In addition to the application of nitrates, an assessment was conducted of trees that received the application of PBZ as a standard control, and trees with that application of nitrates, nor PBZ as an absolute control.

Ataulfo Cultivar. The percentage of differentiated buds varied between 8 and 30% in trees where nitrates were applied; the absolute control registered 13% and 67% in trees with the application of PBZ used as a standard control (producer handling). On the other hand, the percentage of inactive buds ranged from 35 to 71%, which led to an irregular flowering in the majority of the treatments, with the exception of the trees with PBZ that reached a percentage of flowering of 81% (Table 10).

With regard to the yield, the trees treated with nitrates and the absolute control, did not exhibit significant differences between them and production varied from 15 to 20 fruits/tree with a yield between 3.9 and 5.5 kg, which reflects the poor flowering obtained in these treatments. Contrary to this, the standard control trees (with pruning + PBZ) yielded a production that was greater than the rest of the treatments, the number of fruits was almost 5 times greater, and the yield increased above 80% (Table 11). There were no significant differences in the size of the fruit with an average weight between 261 and 264 g.

Kent Cultivar. All the trees were pruned with light cropping of approximately 20 cm of length from the apex of the bud to the center of the tree and, in contrast to the experiment with 'Ataulfo', there was only one control without the application of nitrates. The results were similar to those obtained for the 'Ataulfo', except that in this variety the control was absolute without the application of nitrates or PBZ.

Floral differentiation was low, from zero to 8%, resulting in a low or no flowering, an effect that is reflected in the yield. The production of fruit was similar between the treatments, with the exception of the control without pruning that outperformed the rest of the treatments with the production of almost 47 kg/tree, in the latter production varied from 0 to 4 kg/tree (Table 12). In the same figure we can see the average weight of the fruit, being greater in trees without nitrates and with light pruning (535 g), compared with the lower weight fruit from those treated with phospho nitrates at an average of 376 g. Similar results were obtained in the length and diameter of the fruit (Figure 9).

The previous results demonstrate that nitrates do not modify terminal bud differentiation in any of the cultivars. Although, the pruning applied to trees in both experiments also caused a negative effect by inhibiting terminal bud differentiation, since the trees without nitrates but with pruning, also did not exhibit differentiated buds. Contrary to these results, some studies show that pruning combined with spraying the foliage with at doses between 1 to 4%, have a positive effect in accelerating flowering, as well as increasing the number of inflorescences and production of fruit in mango cultivars such as Alphonso (Reddy and Kurian, 2012), Irwin and Tommy Atkins (Quijada *et al*., 2009); although the authors do not mention what type of pruning was carried out, in terms of its severity.

On the other hand, 'Ataulfo' trees´ treated with PBZ and no nitrates exhibit at a high percentage of differentiated buds which led to an abundant flowering, despite the fact that they were pruned. These results coincide with those obtained for 'Uba' mangos, where are they reported positive results and accelerating flowering as well as an increase in the production of inflorescences, without affecting fruit quality, by combining the cropping and paclobutrazol (PBZ) (Pereira *et al.,* 2017). At the same time, in the 'Raspuri' cultivar, the use of pruning and PBZ led to an acceleration in the flowering and productivity for this cultivar (Srilatha and Reddy, 2015).

Experiment 4. Study of gibberellin inhibitors as an alternative to PBZ, and their effect on the flowering process of different mango cultivars.

Results in Nayarit cv. Tommy Atkins

During 2018-2019, this work was carried out on a six-year-old commercial farm with mangos of the 'Tommy Atkins' variety, established at a high density (1333 trees per ha, 3 x 2.5 m) and under a system of hedges. All of the trees were pruned with light cropping after the 2018 harvest.

The results obtained in the flowering process due to the effect of gibberellin inhibitors are shown in Table 13. Two flowering flows appeared, the first during the second half of February and the second during the first half of April.

Significant differences were observed in the percentage of flowering in the different flows and total flowering. In the first flow, the percentage of flowering varied from 0.3 to 57%, the trees with a single application (1X) of PBZ (2500 mg L^{-1}) exhibited the highest percentage, followed by the trees applied with P-Ca at different doses and those treated with UCZ 1000 mg L^{-1} in three applications (3X). In this flow, no positive effect was observed in the acceleration of flowering due to the effect of the treatments, with the exception of the trees treated with PBZ that exhibited 7 days of advanced progress compared to the control. Although this is not significant, since seven days of progress can be easily lost at harvest time.

During the second flow, the P-Ca based treatments stood out (1500 mg L^{-1}; 1X) and P-Ca + UCZ (750+250 mg L^{-1}; 3X) with 49% of flowering, followed by the treatment with UCZ (1000 mg L^{-1}; 3X) at 32%. In this flow, the flowering of the trees with PDZ was practically null (9 %). Both flows, resulted in a total flowering between 35 and 72%, whereby the trees treated with P-Ca + UCZ (750+250, 3X) and without regulator (control) flowered less than the rest of the treatments. The highest percentage was observed in trees with P-Ca 1500 (72 %), although, the trees treated with PBZ exhibited the highest percentage in the first flow 51 days earlier than the rest of the treatments in the second flow.

A relevant aspect in this work is the high density and management of hedges found in the orchard. This created shadows between trees and rows despite the fact they had been pruned, which contributed to an irregular flowering during the first flow in the treatments, with the exception of PBZ. Nevertheless, due to cooler temperature conditions, the rest of the treatments reached a second flowering. Lastly, despite the shadowy conditions, the highest intensity of flowering was observed in trees with P-Ca (1500 mg·L^{-1}, 1X) followed by PBZ (2500 mg L^{-1}; 1X) and P-Ca + UCZ (750+250 mg·L^{-1}, 3X).

Regarding the production of fruit, the majority of the gibberellin-inhibitor based treatments outperformed the yield of the control, and even that of the PBZ. The trees that stood out are those in which UCZ was applied (1000 mg L^{-1}; 3X) and P-Ca + UCZ (750+250 mgL^{-1}; 3X) with a greater number and kg of fruit/tree, which led to an increase between 40 and 66% compared to the production of the trees treated with PBZ and the control (Figure 10).

Regarding fruit size, the average weight varied from 562 to 642 g, this last value corresponds to the fruit of control trees. No significant differences were observed in the length and diameter. It’s important to point out that the farm where the experiment was established experienced water stress during the development of the fruit in the first flowering flow, primarily affecting the trees treated with PBZ. The development of the fruit during the second flow of flowering occurred without water stress, because there was water availability during that period for irrigation.

During the second and third cycles of evaluation (2019-2020 and 2020-2021), and due to the water availability issues experienced at the ‘Tommy Atkins’ farm located in the town of Sauta in the municipality of Santiago Ixcuintla, the experiment was established using the same cultivar and municipality, but in a farm that was 12 years old.

The results obtained in the development of the apical bud and percentage of differentiated buds are shown in Figure 11. In both years and variables, statistical differences were found between the treatments. During the 2019-2020 cycle, in the treatments involving the application of an inhibitor, the assessed buds reached a development stage between 4 and 5, whereas the control developed closer to a stage 3. The results found in the development stage of the buds yielded differentiated bud percentages greater than those exhibited by the control trees, with the exception of the treatment with UCZ at a dose of 1000 mg L^{-1} (3X) which was equal to that of the control with percentages of 55 and 40% of buds that reached floral differentiation, respectively (Figure 11A). From 2020-2021, the results were similar to those in the prior cycle achieving an apical bud development of approximately stage 4 in all the treatments with inhibitors. In the control, the buds reached a stage 3 of development. The percentage of differentiated buds was far superior in the same treatments, exceeding by a vast margin that of the control (Figure 11B).

The flowering percentage obtained during 2020 was 32 to 72%, in which the P-Ca based treatment stood out at doses of 1500 mg L^{-1} (1X) which equaled the PBZ and outperformed the control, the latter exhibiting irregular flowering of only 32% (Figure 12). Significant differences were observed in the percentage of total flowering in 2021, which varied between 35 and 91%. The trees with gibberellin inhibitors registered greater flowering for the control trees (without regulator). Three applications of UCZ (1000 mg L^{-1} c/u), three of Cycocel (1000 mg L^{-1} c/u) and one of P-Ca (1500 mg L^{-1}), were statistically equal to paclobutrazol.

The days (d) that's transpired after the last application of the inhibitor until full flowering were 162 in trees with PBZ, whereas in the control trees full flowering was reached by day 173. The flowering of the trees with PBZ was slightly early, 11 days, compared to the control, and 6 and 7 days in trees that were treated with P-Ca 1500 (1X) and Cycocel 1000 (3X), but did not surpass the control group, statistically speaking.

In regard to the initial fruit set, evaluated at 45 days after full flowering, the number of fruits retained by inflorescences varied from 8 to 15 fruits in 2020, and from 9 to 12 in 2021, where the treatment that stood out was the P-Ca based treatment 1500 mg L^{-1} (1X), followed by cycocel, P-Ca + UCZ and uniconazole, all of which outperformed the control (Table 14). In 2021, the trees treated with cycocel recorded a lower number of fruits (9.4 through inflorescence). It's worth mentioning that during the elapsed time from fruit set to harvest, the fruit continues to fall leaving a lesser number of them on the tree which favors the development of size for those that remain until collection, that's why the final fruit set in the number of fruits through inflorescence varied between 1.5 and 2.2 during both years that were assessed without any statistical differences between treatments.

Significant differences were found between treatments in yield expressed in kg of fruit per tree, the results are shown in Figure 13. In 2020, the yield varied from 88 to 159 kg $tree^{-1}$. The treatments that stood out are the ones with P-Ca at doses of 1500 mg L^{-1} (1X) with 159 kg of fruit and P-Ca at doses of 500 mg (3X) with 146 kg of fruit, outperforming the control which produced 88 Kg $tree^{-1}$, and even the PBZ group. The rest of the treatments were higher than the control and equaled the yield of the trees with PBZ. In 2021, all the treatments that had gibberellin inhibitors registered a higher yield than the control, and, once again, the treatment with P-Ca 1500 mg L^{-1} (1X) $tree^{-1}$ outperformed the control producing 145 kg $tree^{-1}$ versus 90 kg, respectively, and for the second time outperformed the treatment with PBZ.

In 2020, the percentage of fruit harvested on each date is shown in Figure 14, noting that on May 30th 51% of the total production on the tree was harvested (81 kg) in the treatment with P-Ca 1500 (1X) as opposed to 24% of the production in the control (24 kg); on the second date (July 24) more than 60% of the total production was harvested in the control trees (54 kg). These results are evidence that 51% of the harvest in the treatment with P-Ca 1500 was moved up by 25 days, compared to the control. There is evidence that P-Ca accelerates and increases flowering, as well as the yield in mango cultivars such as Kent and Ataulfo, among others (Abdel Rahim *et al*., 2011; Do Carlo-Mouco *et al*., 2011; Pérez-Barraza *et al*., 2018), which coincides with our results, as opposed to these results, in Australia P-Ca doses between 0.18 and 1.1 g of i.a. per liter of water did not have any effect on the flowering of mangos of the 'Kensington-Pride' variety (McConchi, 2018). The difference in the results could be attributable to the cultivar, environment, and doses used. Other inhibitors such as Uniconazol (UCZ) have proven to be effective in reducing vegetative growth, speeding up flowering, and increasing the production of fruit in cultivars such as Palmer, Alphonso and Kent (Silva *et al.,* 2010; de Sousa *et al*., 2016; Gopu *et al*., 2017). These results coincide with those obtained for yield in 'Tommy Atkins' mangos using this inhibitor and exceeding that of the control.

Regarding the size of the fruit, the results are shown in Figure 15 for the second and third cycles that were assessed. In 2020, the largest size for the fruit, 476 g on average, was observed with the application of P-Ca at doses of 500 mg L-1 (3X) surpassing the rest of the treatments. In 2021, the average weight fluctuated between 367 and 521 g, with the standout performer being the treatment with P-Ca 1500 mg L^{-1} which recorded the highest average weight per fruit. It's worth mentioning that during these two years of evaluation the majority of the harvested fruits (80 %) exhibited sizes suitable for export with an average weight above 340 up to 521 g.

The gibberellin synthesis inhibitor products assessed for this study, in particular the P-Ca, could be appropriate as an alternative to PBZ since there is scientific evidence that demonstrates their effectiveness with the flowering and production of mango fruit, as well as others, and our study corroborated the positive effect of these inhibitors as they matched and even outperformed the flowering and yield of PBZ, in some cases.

These experimental results demonstrate the feasibility of having the availability of products that could replace PBZ, with similar effects. Nevertheless, these need to be validated and demonstrated in a larger surface area and on production land.

Results for the Kent cultivar in Nayarit

In the last year of evaluation, a second experiment was established on the Kent cultivar applying the same treatments, except for the P-Ca + UCZ combination, and it was established at the Las Palmas location in the town of San Blas.

The development of the apical bud was assessed only for treatments with the inhibitor, which had maintained a uniform response in 'Tommy Atkins' during the period of study, in addition to the control. In this cultivar, all the treatments reached floral differentiation (E4) of the apical buds that were sampled (100% of differentiated buds) without any statistical differences between treatments (Table 15). Nevertheless, during the period in which the bud reached E4, significant differences were observed. In trees treated with gibberellin inhibitors, the time that transpired since the last application of the inhibitors until the bud reached E4 (differentiated or reproductive buds) was between 118 and 122 days, but in the control trees the time was 138 days. Which indicates that all gibberellin inhibitor-based treatments accelerated the floral differentiation between 18 and 20 days, compared to the control.

The results obtained in bud differentiation were reflected in a flowering of 100% in trees with inhibitors and one of 76% in those where there were no applications of inhibitors. The time that transpired since the last application of inhibitors until fall flowering was between 135 up to156 days. The treatments that stood out were the ones based on P-Ca 500 (3X) and 1500 (1X) with a shorter peer to achieve full flowering, equaling the elapsed time recorded for paclobutrazol. The flowering was accelerated anywhere from 17 up to 21 days compared to the control trees (Table 16).

With regard to initial fruit set, assessed 45 days after full flowering, statistically significant differences were found, whereby the treatment with cycocel 1000 (3X) and UCZ 1000 mg L^{-1} (3X) retained more than 10 fruits through inflorescence, performing better than the control, and even the trees with paclobutrazol (Figure 16). While the trees treated with P-Ca 1500 (1X) obtained the same fruit set as the ones treated with PBZ.

It's important to point out that during the second half of December, the period during which the floral differentiation process occurred in the terminal bud, that is, the change from vegetative to reproductive, there were inductive conditions in the flowering (nocturnal temperatures ≤ 20 °C), that favored the process (Figure 17). The climate data were obtained from the INIFAP National Modelling and Remote Sensor Laboratory which corresponded to WRF forecasts for points of interest where stations were located near the experiments, in our case the towns of

Santiago Ixcuintla and Las Palmas. We resorted to using these forecasts due to the fact that these stations had stopped operating since March of 2020.

With regard to the kg of fruit per tree variables, no significant differences were found between treatments. The production of fruit ranged between 112 and 132 kg tree^{-1} (Table 17). The production of fruit per tree resulted in a yield of between 19 and almost 21 t ha^{-1} considering a density of 156 trees ha^{-1}, with an age of 8 years.

Nevertheless, the harvest period did exhibit some significant differences (P = 0.002) between the treatments. The results are shown in Figure 4 where we can see that all the treatments with gibberellin inhibitors moved up the harvest between 12 and 18 days compared to the control. The treatments that stood out were the ones based on P-Ca 500 (3X) and P-Ca 1500 mg L^{-1} (1X) equaling the effect of the PBZ. The acceleration obtained in this cultivar corresponds to a shorter time frame for the differentiation of the floral bud and, above all, the acceleration observed in the flowering with the aforementioned treatments.

Significant differences between treatments were found in the variables of fresh weight and fruit diameter, though no significant differences were observed in the length, and the fruit exhibited a uniform size between 11.2 and 11.7 cm of length, whereas the diameter of the fruits varied between 10.9 and 11.3 cm (Table 18). Regarding fresh weight results in the same Table, the fruit varied between 615 and 735 g on average, lower weight fruit corresponded to the treatment with P-Ca 500 mg L^{-1} (3X). The increase reached in the weight of the fruit with this treatment was nearly 20%, compared to the control.

Results in Colima cv. 'Ataulfo'.

The results obtained in the percentage of differentiated buds, that is, those converted to reproductive buds, are shown in Figure 18. In the first year, 2019, P-Ca at doses of 1500 mg L^{-1} (1X) reached 80% of differentiated buds, statistically equaling the treatment with PBZ (2500 mg, 1X), and both outperformed the rest of the treatments. In 2020, once again, PBZ outperformed most of the treatments by registering a degree of bud differentiation of 80%, with the exception of the P-Ca 750+UCZ 500 mg L^{-1} (3X) treatment, with a statistically equal percentage to that of PBZ with 75% of differentiated buds.

With regard to the flowering, in 2019 the percentage between treatments varied from 78 to 100%, P-Ca 500 (3X) and the combination of P-Ca 750 + UCZ 1000 mg L^{-1} equaled the effect of the PBZ reaching 87, 88 and 100% of flowering, respectively. The rest of the treatments registered less flowering (Figure 19). During the second year, 2020, the majority of the treatments with inhibitors outperformed the control registering flowering from 80 up to 99%, with the exception of UCZ 1000 mg L^{-1} which was statistically equal to the control and to the treatments with lower flowering with approximately 70%. During the last year of evaluation (2021), despite the fact that the trees received a double pruning when the producer pruned the entire orchard without respecting the experiment that had already carried out a pruning, the treatments with P-Ca at doses of 500 mgL-1 (3X) and 1500 mg (3X) recorded flowering of 76 and 70%, respectively. These were statistically equal to the treatment with PBZ that reached a flowering of 98%.

During the three years of evaluation, the treatment with P-Ca 500 mgL-1 (3X), recorded flowerings of 75 to 90% equaling the effect of the PBZ. Nevertheless, when it comes to modifying the flowering period, PBZ continues to be more effective, followed by the treatments with P-Ca.

The results reached in yield (Kg of fruit per tree) during the three phases of the study (2018-2021) are shown in Figure 20. The trees recorded a production between 145 up to 225 kg tree^{-1}, in which the standout performers corresponded to the treatment with P-Ca at doses of 500 mg L^{-1} in three applications outperforming the PBZ and control groups, the latter being being the group with the lowest production. In 2020, the trees treated with PBZ recorded a yield of 113 kg of fruit per tree outperforming the control trees, followed by the trees treated with P-Ca 750 + UCZ 250 mg L^{-1} in three applications. Once again, during the last year, the trees treated with PBZ registered the highest yield with 120 kg as well as those with P-Ca 500 mg L^{-1} in three applications with a recorded production of 110 kg. During the three years of the study, the trees without application (controls) exhibited the lowest production of fruit.

Experiment 5) Effect of pruning and nutrition on the flowering process of different mango cultivars.

Experiment 4.1. Effect of pruning period and intensity on the flowering and production of mango Ataulfo in Nayarit and Colima.

Results in Nayarit, cv. Ataulfo.

Figure 21 shows the results obtained in the percentage of differentiated buds, that is, buds that converted into reproductive buds. In 2019, we worked on an eight-year-old commercial farm with a density of 320 trees/ha. The trees without pruning and those pruned during the early season (end of June) and those with light pruning (50 cm crop) managed to differentiate almost 100% of the buds. In contrast, in the trees that were treated with late pruning (end of November), the apical bud differentiation was very low (17%) when the pruning was light and practically null when the pruning was severe (75 cm crop). These results correspond with the vegetative buds that emerged after the pruning. In the late light pruning bud production was minimal, and a severe pruning conducted during that same period did not lead to any vegetative buds. During the second year of evaluation (2020), the results were very similar to the prior year. Once again, the control trees and those that received early light pruning reached a higher percentage of differentiated buds. In 2021, the last year of evaluation, the percentage varied between 10 and 100%. A higher number of differentiated buds was recorded even in the treatments with intermediate pruning (end of September), regardless of the intensity, as well as in the late light pruning, but not so in trees with late severe pruning that over the course of two consecutive years exhibited a low differentiation.

With regard to the flowering, the results found are shown in Table 19. In 2019 the percentage fluctuated between 28 and 75%, the most extensive flowering was obtained in the trees that were not pruned or control trees followed by the trees that were pruned in November (late pruning) with a flowering percentage of 70% with light pruning, and in early light pruning with 61%. The flowering in trees with late-light pruning occurred in the pruned branches which, instead of vegetative buds, developed inflorescences. This was likely due to the fact that at the moment of pruning there existed inductive conditions for flowering and bud differentiation was achieved on wood. The intermediate pruning, regardless of severity, exhibited very little effect on the flowering. During the second year (2020) the highest percentage (approximately 70%) was observed in trees without pruning and those with early-light pruning (early July). With the intermediate pruning (early September) the percentage was between 57 and 47% for the light and severe severities, respectively. The trees with late-severe pruning (early November) had the lowest flowering percentage. In 2021, the highest intensity of flowering was obtained in the treatments without pruning and with early pruning, regardless of the severity with flowering above 90%, followed by the treatment with intermediate-light pruning that reached 85%. Once again, the trees with late-severe pruning (early November) registered the lowest flowering percentage.

In general, the results show that severe pruning, regardless of the period, reduces flowering, just like the intermediate o late pruning. On the other hand, the intermediate pruning delayed flowering 30 days and the severe pruning a little over 50 days, with the exception of the first year in which there was no delay due to the fact that the flowering was mostly obtained in the pruned branches and not in emergent buds.

With regard to fruit set, evaluated based on the number of fruits through inflorescences, in 2020 there resulted between 2.3 and 5 fruits at initial fruit set (45 days after anthesis). While in the final fruit set, assessed one week prior to the harvest (physiological maturity), the inflorescences retained between 1.5 and 2 fruits without any differences between treatments. In 2020, for the fruit retained at fruit set, the initial fruit set varied between 2.1 and 7.3 fruits through inflorescence, whereas at final fruit set the number of fruits varied from 1.3 to 3.0 for each inflorescence, with the treatment with late-light pruning being the standout (Figure 22).

With regard to the yield, in 2019 the treatment with the highest production of fruit was the one with early light pruning at 58 kg tree^{-1}, followed by the control treatment at 45 kg, whereas there were no significant differences in the rest of the treatments (Figure 23).

Figure 24 shows the results obtained during 2020 and 2021. During the second year of evaluation, the yield fluctuated between 64 and 196 kg of fruit per tree, with the standout performer being the treatment with early-light pruning that recorded the highest yield, followed by the treatments with early-severe pruning and the treatment with intermediate-light pruning being statistically equal, and the treatment with the lowest yield was the one with late-severe pruning with 64 kg tree^{-1}. In 2021, the yield fluctuated between 137 and 333 kg of fruit per tree, where the treatments that stood out were the ones with early-intermediate pruning at a light intensity (50 cm crop), followed by those with early-severe pruning, which were statistically equal, and the treatment with the lowest yield was the one with late-severe pruning with 137 kg tree^{-1}

During these two years, the harvest of the trees was modified achieving a delay in the production of the different treatments compared to the control where, due to the effect of the period/intensity interaction, highly significant differences were observed. The delay recorded in the harvest in 2020 was between 16 and 56 days compared to the control harvest, achieving a greater delay with the late pruning, regardless of the intensity. With the intermediate pruning the delay was 32 days (Figure 24). In 2021, the delay that was achieved was between 18 and 43 days. Once again, the longest delay occurred in trees with late-severe pruning.

An analysis of the yield (kg tree^{-1}) obtained during the second year of evaluation and the price reached during each period can be seen in Table 20. The price per kg of fruit at the beginning of the 'Ataulfo' mango harvesting season was $ 3.20, when it coincided with the harvest of the treatments with early pruning (50 and 75 cm crop) and control, this generated profits between $485.00 and $632.00 from the production of each tree harvested. With the intermediate pruning, the profits were $ 653.00 on average with a price per kg of fruit of $5.40, whereas with the late pruning the profit was $747.00 on average due to the fact that during that period the price was almost $ 9.00 por kg of fruit. As illustrated by the intermediate-late pruning, even with lower production per tree, the profit was higher due to the price that the fruit was able to collect during the latter part of the season.

Nevertheless, it's important to point out that the late pruning (November) has the risk of inhibiting flowering as a result of the stimulation of vegetative buds during the later stages of the season, emerging in November and reaching their physiological maturity towards the end of December beginning of January. The flowering in those buds only occurs with the presence of favorable temperature conditions (< a 20°C) for flowering once they have reached their maturity as indicated by Davenport (2006). For his part, McConchie (2018) asserts that the late pruning in the Honey Gold and B74 mango cultivars inhibited flowering because the vegetative buds stimulated during that pruning period did not coincide with cold temperatures under 20°C. In this study, there were temperatures under 20°C, albeit intermittently, which caused late flowering, but at a lower percentage in the treatments with intermediate and late pruning, which led to a lower production in the trees with the early pruning and without pruning, but with better quality fruit at a better price.

With regard to fruit size, the results are shown in Figure 25 for average weight and in Figure 26 for average length. In the first year of evaluation the weight fluctuated from 289 to 346 g. The trees pruned during intermediate-severe and late-severe season recorded the highest average fruit weight compared to the control, which led to an increase of 16%. In 2020, the weight recorded among the different treatments ranged from 260 up to 293 g and there were no differences between treatments with the exception of the late-light pruning that outperformed the control by producing fruits weighing 293 g versus 261 g in the control, which represented an increase of 12.3%. During the last year, the average weight fluctuated between 275 and 389 g, and, once again, the fruit from the trees with late-severe pruning recorded the highest average weight compared to the control, the resulting increase was on the order of 41%.

Regarding the length, there were no significant differences between treatments in the first year of evaluation where the length varied between 11.2 and 11.8 cm. And in the second and third years of the evaluation the standout performer was the treatment with late-light pruning that recorded the maximum length (13.1 and 12.3 cm, respectively) compared to the control group that recorded lengths of 10.9 and 10.3 cm, respectively. No significant differences were observed in the diameter of the fruit.

Results in Colima, cv. Ataulfo

The percentage of differentiated buds reached during the three years of the study is shown in Figure 27. In 2019, we reached a higher percentage (85 %) of differentiated buds in the trees that received early light pruning (end of June), followed by the percentage reached in the control trees (65 %). The trees that were treated with early-severe pruning and light severe pruning (end of November) exhibited 55% of differentiated buds, making them statistically equal. The lower percentage was observed in trees that were subjected to intermediate-severe pruning (end of September). During the second year (2020), the treatments with late pruning at both intensities stood out by achieving 100% of differentiated buds. The rest of the treatments exhibited a lower percentage. In 2021, no assessment of this variable was possible due to the pruning carried out by the cooperating producer during the experiment, even when the trees used for the experiment had already been pruned.

Figure 28 shows the results obtained during flowering. In the first year of evaluation, the treatment with early-light pruning exhibited almost 100% of flowering, which corresponds to a greater percentage of buds that converted to reproductive. The rest of the treatments reached a flowering of between 75 and 87%, with the exception of the control that registered the lowest percentage. In 2020, the treatments that stood out were the ones with late pruning at both intensities (light and severe) reaching a flowering of 86 and 91%, respectively. Another standout treatment was early-severe pruning with 87% and, once again, the control registered a lower flowering. During the third and last year of evaluation, the flowering was severely affected because the trees, that had already been pruned during each one of the treatments, received another pruning because the person in charge of managing the farm, while conducting a mechanized pruning, did not respect the experiment and conducted a pruning of the entire farm where the experiment was being conducted.

In general, the intense flowering obtained with the late pruning treatments at both intensities and carried out towards the end of November stimulated a flowering of vegetative buds that were not pruned because they were located closer to the main branches, but the stimulus was greater in the pruned branches, which gave rise to inflorescences instead of new vegetative buds. This could be due to the fact that, during that period, temperature conditions may have been favorable to stimulate the vegetative meristems to convert them into reproductive. This is not desirable because the tree needs leaves to sustain the production of both flowers and fruit.

With regard to the yield, the results are shown in Figure 29. In 2019, the yield fluctuated between 188 and 246 kg of fruit per tree. The lowest yield was obtained in trees with intermediate-light pruning. During the second year, we obtained a yield from 87 up to 133 kg of fruit per tree. The standouts were the trees with late pruning and, like the prior year, the trees with intermediate-light pruning registered a lower yield. In 2021, production dropped to a range between 54 and 68 Kg tree^{-1} and even two treatments (late-light and late-severe pruning) did not exhibit flowering, nor did they produce any fruit due to the double pruning that they received.

The results related to the modification of the harvest period were not very consistent, with the exception of the treatments with late pruning that flowered first, before the rest of the treatments.

Experiment 4.2. Nutritional and sustainable integrated management strategies for floral induction and differentiation in 'Ataulfo' mangos.

In 2019, the first floral buds, with scales detached from the apex (E2) of the proposed scale for mangos by Pérez *et al*. (2009), appeared until November, characterizing its own floral induction stage. The differentiated buds E4, began appearing on the third week of December. The first treatments observed in E4 were the application of organic fertilizer to the soil as well as a foliar application (Balmix SF), the treatment was based on an extract of algae *A. nodosum* + amino acids + cytocinines in a foliar application (A.nod+Am+Ck F), potassium nitrate in a foliar application (KNO_3 F) and *A. nodosum* combined with a leached mixture of organic fertilizer Balmix (A.no+B F). The last ones were the foliar applications of *A. nodosum* combined with amino acids (A.nod+am F) and with KNO_3 (KNO_3 + A.nod F), and the control.

With regard to the flowering, the maximum percentage (≥ 90 %) occurred towards the end of January, and the inflorescences observed in the tree were completely covered by flowers. All the treatments flourished more than 90%. Almost all the petal fall occurred approximately eight days afterwards, giving rise to the presence of needle or matchstick sized fruit. The group that accelerated this process the most was the control trees (Figure 30).

These results suggest that bio stimulants and nutrient supplementation (*A. nodosum*, organic fertilizers, amino acids, potassium phosphite, Ca, B, Zn and Acad S), were relatively able to suppress the irregular flowering, while at the same time synchronizing it. This coincides with Osuna *et al*. (2000) and Espinoza *et al*. (2006) which asserts that physio-nutritional type management practices that include the use of bio stimulants and nutrients, can modify the physiological processes of the tree and favor floral differentiation to synchronize the flowering.

On the other hand, as to the number of fruits that set, we observed a variation of 7.6 fruits in the control, to 12.5 fruits with a foliar application of algae *A. nodosum* + organic fertilizer to the soil as well as a foliar application (A.nod + BF), which represented 44 and 54% of fruit set, respectively (Table 21). Nevertheless, the highest proportion of fruit set (63 %) was registered with the application of organic fertilizer to the soil as well as a foliar application (Balmix SF).

Table 22 shows the results of the number of fruits per tree and fruit weight. With the exception of the foliar application with KNO_3, the rest of the treatments with bio stimulants and nutrition produced a higher number of fruits per tree, fruit weight and yield per hectare compared to the control. KNO_3, registered fruit weights that were similar to those of the control, however, it reached a higher number of fruits per tree.

We estimated an average of 588 fruits per tree, with a standard deviation of 116 fruits. Treatments *A. nodosum*+ foliar organic fertilizer Balmix (Anod B F), Acadian synthetic cytocinines applied to the soil (Acad S), KNO_3 F and the Acadian treatment applied to the soil + foliar Balmix (Acad S+BF), were statistically similar, and produced an average of 665 fruits per tree. The control produced 380 fruits, 43% less than when the bio stimulants were applied.

With regard to fruit weight, the production yielded extra-large fruit of size 14, on average (NOM-188-SCFI, 2012), and of 335 g (± 8 g). The best treatments ($p \leq 0.001$) were organic fertilizer to the soil as well as a foliar application (Balmix SF), *A. nodosum*+ foliar organic fertilizer Balmix (Anod B F) and *A. nodosum* + amino acids + cytocinines in foliar application (A.nod+Am+Ck F), with an average size 12 weight of 358 g (± 42 g) per fruit. The control produced size 16 fruit, with an average weight of 285 g (± 42 g), 21% less.

With regard to yield, the average production was 19.8 T ha^{-1} (± 1.2 kg). The best yields corresponded to the application of *A. nodosum*+ foliar organic fertilizer Balmix (Anod B F), Acadian synthetic cytocinines to the soil (Acad S), Acadian to the soil + foliar Balmix (Acad S+BF), *A. nodosum*+amino acids in a foliar application (Anod+Am F), KNO_3 F and organic fertilizer to the soil as well as a foliar application (Balmix SF), that on average obtained 21.6 T ha^{-1} (± 3.3 kg). The control produced 10.8 T ha^{-1} 50% less than the best treatments.

In 2020, only the treatments that stood out in 2019 were applied. The accumulated flowering percentage varied between 61 and 73% during the cycle.

Table 23, shows that the first floral buds, during the month of January, appeared in the treatment with *A. nodosum* + amino acids + cytocinines in foliar application (A.nodosum +Cks+Am. F). The influence of this treatment was consistent since, notwithstanding an accumulated flowering of 68%, it did not outperform the control (73 %). 71% of its flowering, which corresponds to 48%, appeared towards the end of February, whereas the control only produced 21% during this period. It didn't reach the highest percentage until the end of March which, under the conditions of the study, represents 127% more early flowering (30 days) with the use of bio stimulants. The A.nodosum F+Balmix F treatment equaled the flowering intensity of the control, but the harvest period was similar.

With regard to the yield, Table 24 shows that although a higher number of fruits per tree were produced in the treatment *A. nodosum* +Cks+Am. F (426.14 ± 66.59), the differences between treatments we're not significant due to the variability of the data (mean= 363.25 ± 27.27 with a standard deviation of 32.62), which indicates that all the treatments registered numbers of fruits that were relatively similar to the mean value of the treatment with a higher numerical amount of fruits, *A. nodosum* +Cks+Am. F. Nevertheless, significant differences were generated in yield due to the effect of the treatments and to the fruit weight. *A. nodosum* +Cks+Am. F was the treatment with the highest production with 14 ± 1.12 t ha^{-1}, which indicates that the obtained yield, with a 95% reliability, can vary from 12.8 to 15.1 t ha^{-1}. It proved to be statistically different to *A.nodosum* F+Balmix F, Balmix F+Sue and the control which, on average, produced 11.11 ± 1.47 t ha^{-1}, outperformed by 25.6%.

In this same year (2020), a second experiment was established to evaluate two of the best treatments (Balmix F+Sue and A.nodosum +Cks+Am. F) and a control group without application.

The first indications of inflorescences were observed towards the end of January in the treatments applied with the bio products. However, it wasn't until the February-March timeframe when full flowering appeared, as can be seen in Figure 31, with a greater activity (69.4 %) in the trees that received the application of A.nodosum +Cks+Am. F., outperforming the treatments with Balmix and the control, both statistically similar, with medium flowering of 62.9%, and therefore 37.1% without activity in its floral differentiation, which means that these trees reduced their possibility of flowering by at least 25%, compared to those that received the application of A.nodosum +Cks+Am. F.

The number of fruits per tree, as well as the estimated yield per hectare, are shown in Table 25. The highest number of fruits was registered by the control with 388.73 ± 44.82 fruits per tree, statistically similar (p= 0.031) to A.nodosum +Cks+Am. F (370.78 ± 14.64 fruits), but different from the Balmix F+Sue treatment that produced 321.56 ± 12.17 fruits. However, since the fruit weight of the latter was higher than that of the control, they registered similar results in yield with 12.37 ± 0.69 t ha^{-1}. Whereas the highest production of 14 ± 0.51 t ha^{-1} was obtained with applications of A.nodosum +Cks+Am. F, making it possible under similar study conditions, with a reliability of 95%, to obtain between 13.5 up to 14.5 t ha^{-1}.

The larger sized fruit corresponded to the treatment with A.nodosum +Cks+Am. F with average weight of 324 g, length of 12.2 cm, and diameter of 7.5 cm (Table 26). The same treatment gave rise to fruit with a higher °Brix (15°).

In the last year of evaluation (2021), through the application of bio stimulants and balanced fertilization to the soil, as well as foliar micro-nutrient supplements during the pre-flowering stages, it was possible to not only synchronize the flowering up to 90-94% from February 10 to 20, 2021 (Table 7), but also move up the flowering period by six days, as it occurred with the treatments with Hydro-soluble Fi + algae extracts and their supplements, as well as the granulated Fi + KNO_3 F2, which at 81 days exhibited flowering at a rate of 92.2 and 91.3%, respectively. In contrast, the control had only achieved 57.8% of flowering after six days (Table 27). The rest of the treatments that included the organic Balmix and the different combinations with algae and NO_3K were statistically similar in terms of the synchronicity with the flowering, but from 2 to 5 days later than those already mentioned as the earliest treatments.

With regard to the yield, assessed based on the number of fruits and kg of fruit per tree, the results are shown in Table 28. While estimating the percentage of regular and large sized fruit on the tree, we observed that, based on the type of fertilizer, the highest percentage of large fruit was obtained with granulated fertilizer (46 ± 5.2 %). With an inductor, el NO_3K showed, much like the treatment without an inductor, more regular fruit (74 ± 6.1% fruits tree^{-1}), with the advantage in the application of extracts of algae *A. nodosum* that produced the highest percentage of large size fruit and lowest percentage of regular fruit.

In the interaction (Table 28), the negative effect of the NO_3K along with the Balmix fertilizer and the hydro-soluble fertilizer was evident, based on the highest percentage of regular fruit. In the majority of the cases, the application of algae extracts along with the Balmix fertilizer, granular or hydro-soluble, increases the proportion of large fruit.

In the fruit identified as one of regular size, we obtained weights from 293 ± 11.7 g fruit^{-1} without the application of inductors, up to 334 ± 12.0 g fruit^{-1} with the application of hydro-soluble fertilizer (Table 9). According to the specifications of the NOM-188-SCFI-2012 for 'Ataulfo' mangos, the fruit with weight between 269 and 323 g is considered to be of a large size. Therefore, the fruit visually assessed to be regular, is large, from a size 16 (mean of 287 g ± 10% of tolerance) to a 14, (mean of 332 g ± 10% of tolerance), according to the aforementioned NOM.

Whereas fruit visually categorized as large, the minimum (397 ± 8.4 g) and maximum (425 ± 9.6 g) weights corresponded to the control treatments without inductor and Hydro Fi, respectively. In all cases, the application of inductors improved the size of large fruit > 400 g regardless of the type of fertilization. (Table 8). According to NOM-188-SCFI-2012, the fruit obtained in this category corresponds to an extra-large size (324 to 606 g or more), size12 (mean of 407 g ± 10% of tolerance).

With regard to the yield, we obtained a production of fruit per tree between 74 and 102 kg, which led to yield of 9.9 up to nearly 14 t ha^{-1}(Table 28). The inductor treatment A nod. F1 stood out with the highest yield compared to the control.

Conclusions

Experiment 1) Forecasting system associated with flowering and harvesting processes in two mango production areas in Mexico.

1. The states of Nayarit and Colima were characterized based on climate.
2. The climate-based forecasting system was created as a tool to avoid irregular flowering in 'Átaulfo' mangos. The approval process is still pending with INDAUTOR in Mexico.

Experiment 2). Gibberellins and their effect on floral induction and differentiation.

1. In Nayarit, the Kent cultivar did not exhibit a favorable response to the application of gibberellins to delay the flowering.
2. In Tommy Atkins, during one year of evaluation, two applications of gibberellic acid (AG_3) at doses of 50 mg L^{-1}, delayed the differentiation period, floral budding, and the harvest without affecting the flowering and with greater yield.
3. Under Colima conditions, and during two years of evaluation, the effect of the application of AG_3 was not consistent in the 'Tommy Atkins' cultivar.
4. In the Ataulfo cultivar, during one year of evaluation, the application of AG_3 delayed flowering for more than 30 days, but reduced flowering and yield. Results that were also affected by a double pruning of the trees under study.

Experiment 3). Nitrates and their relationship to bud latency and floral differentiation.

1. The nitrates did not modify the differentiation of the terminal buds in neither the 'Ataulfo' or 'Kent' cultivars under Nayarit conditions. Additionally, the pruning applied to the trees in both experiments had a negative effect by inhibiting the differentiation of the terminal bud in the trees without nitrate, but with pruning.

Experiment 4. Study of gibberellin inhibitors as an alternative to PBZ, and their effect on the flowering process of different mango cultivars.

1. In 'Tommy Atkins', under Nayarit conditions, two treatments equaled the percentage of differentiated buds; calcium prohexadione (P-Ca) at doses of 1500 mg L^{-1} applied 45

days after the flowering (single application; 1X) and cycocel at doses of 1000 mg L^{-1} in three applications (3X) at 15, 30 and 45 days after the pruning (DAP).

2. In this same cultivar, all the gibberellin inhibitors precluded an irregular flowering by promoting abundant flowering and greater yield. The standouts in this regard, P-Ca 1500 mg (1X), cycocel 1000 mg L^{-1} (3X) and uniconazol (UCZ) 1000 mg L^{-1} (3X) at 15, 30 and 45 DAP, equaled the effect of the paclobutrazol (PBZ) and, in some cases, outperformed it.
3. P-Ca 1500 mg (1X) moved up slightly more than 50% of the harvest and produced larger-sized fruits.
4. In the Kent cultivar, under Nayarit conditions, the P-Ca in any of the doses moved up the floral differentiation and budding, as well as the harvest period, in addition to outperforming the effect of the PBZ (only year of evaluation).
5. In the Ataulfo cultivar under Colima conditions, P-Ca at doses of 500 mg L-1 in three applications at 15,30 and 45 DAP, equaled and, in some cases, outperformed the effect of PBZ in the flowering, yield, and acceleration of flowering during the three years of the study.
6. In Nayarit and Colima there exists the possibility of substituting the use of PBZ with Calcium Prohexadione at different doses, though the results would have to be validated.

Experiment 5) Effect of pruning and nutrition on the flowering process of different mango cultivars.

Experiment 5.1. Effect of pruning period and intensity on the flowering and production of mango Ataulfo.

1. In Nayarit, the early intermediate pruning with a 50 cm crop did not reduce the differentiation nor the flowering percentage, leading to a higher number of fruits and yield in ‘Ataulfo’ mangos.
2. The late-severe pruning (75 cm crop) lowered the differentiation and caused less flowering and a lower yield.
3. The intermediate and late pruning in any intensity (light or severe) delayed the harvest, the delay was more significant with late pruning.
4. The delay in the harvest resulted in a better market price for the fruit and increase the productivity of the crop.
5. The largest fruit were obtained with the late pruning regardless of the intensity.
6. In order to modify the flowering and the harvest in Nayarit, the intermediate-light pruning can be a better option, delaying the harvest, and achieving larger and healthier fruit that would collect a better price in the market. Nevertheless, it’s verification is necessary.

7. In Colima, the early light pruning improved the yield.
8. In both states, the late-severe pruning carried out towards the end of November suppressed the emergence of vegetative growth and stimulated flowering in pruned branches.

Experiment 5.2. Nutritional and sustainable integrated management strategies for floral induction and differentiation in 'Ataulfo' mangos.

1. All of the treatments based on biological products favored flowering in excess of 90% and during a period slightly earlier than that of the control.
2. The most outstanding were the application of algae extracts *A. nodosum* + amino acids + cytocinines, in a hydrosoluble granular fertilization, as well as the application of Balmix, supplemented with foliar applications of micronutrients during the pre-flowering stages, avoiding irregular flowering by inducing greater flowering, larger sized fruits, and an increase in yield.

•Plans

Project concluded

•Issues or delays:

The ones encountered in the experiment with gibberellins in 'Kent' with two cycles without response. For the 2010-2021 cycle, the treatments with gibberellins were changed to the 'Tommy Atkins' cultivar in Nayarit and Ataulfo in Colima.

In the last year of evaluation in Colima, the general pruning conducted by the producer in their farm affected the trees pertaining to the experiments with inhibitors and pruning, since they had already been pruned and several of the treatments were even underway.

•Financing received and executed 2019 to 2021:

Funds received ($) US		Funds executed ($US)	Item
2018-2019	65,000	65,000	Printing materials, growth regulators and fuel, per diem and transportation, vehicle maintenance, equipment maintenance, laboratory compounds and materials, inputs (fertilizers), journals, Contractors hired, congresses and conventions.
2019-2020	60,000	60,000	
2020-2021	50,000	65,000	
TOTAL	**175,000**	**175,000**	

• Tables and figures.

Experiment 1) Climate characterization, its variability and forecasting system associated to flowering and harvest.

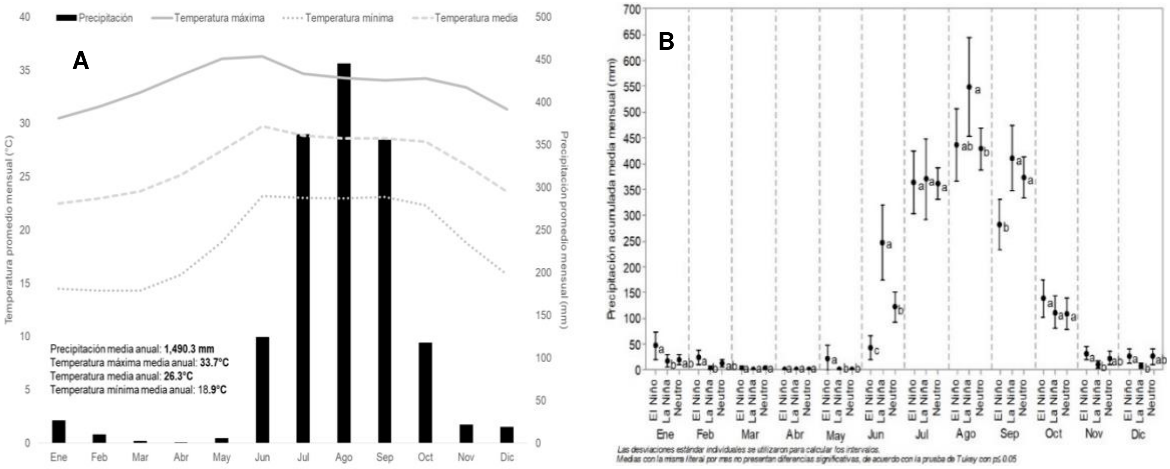

Figure 1. Climograph of the mango producing region in Nayarit (A) and Characterization of the variability of rainfall according to the ENSO phase (B).

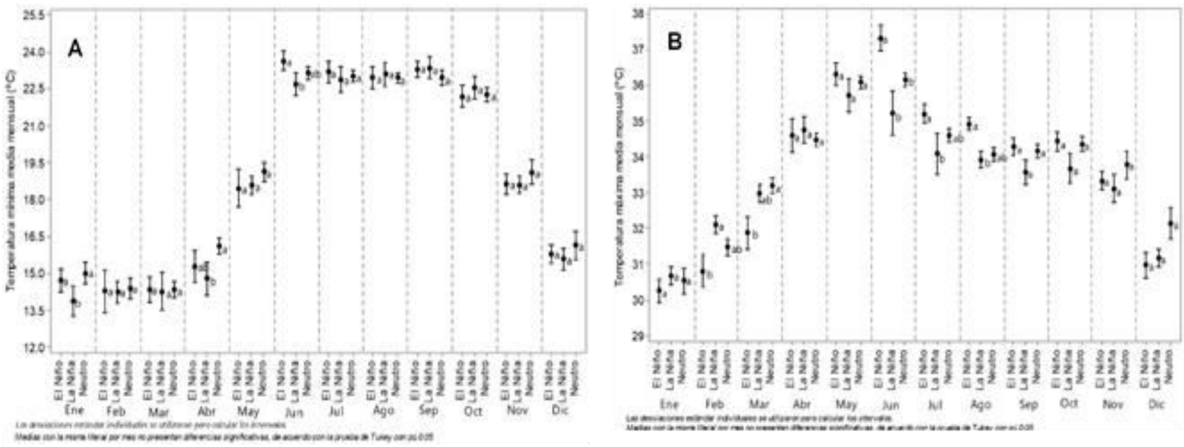

Figure 2. Characterization of the variability of the minimum (A) and maximum (B) temperature according to the ENSO phase in Nayarit.

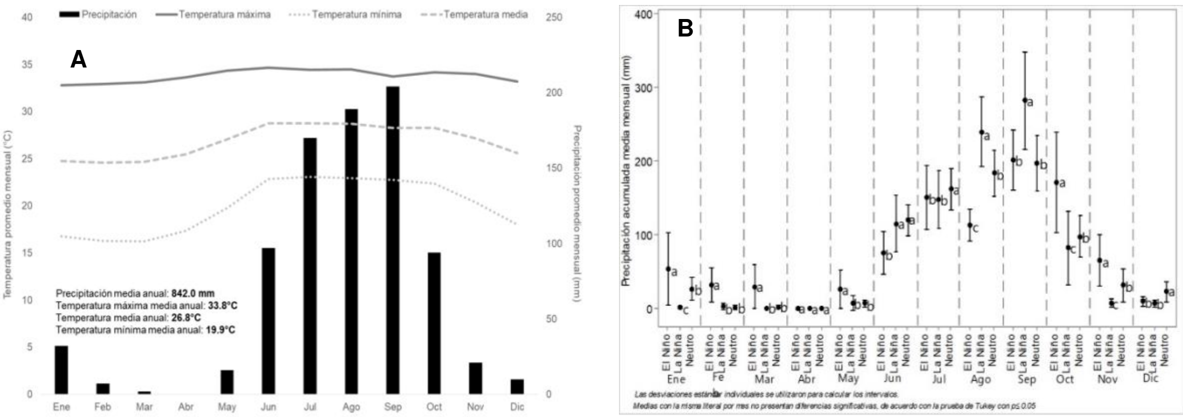

Figure 3 Climograph of the mango producing region in Colima (A) and Characterization of the variability of rainfall according to the ENSO phase (B).

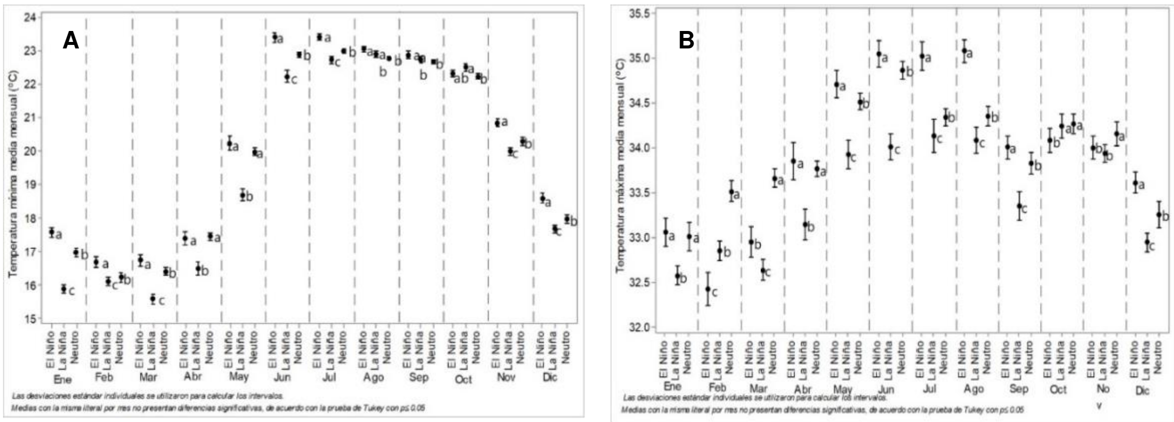

Figure 4. Characterization of the variability of minimum (A) and maximum (B) temperature by phase of the ENSO in Colima.

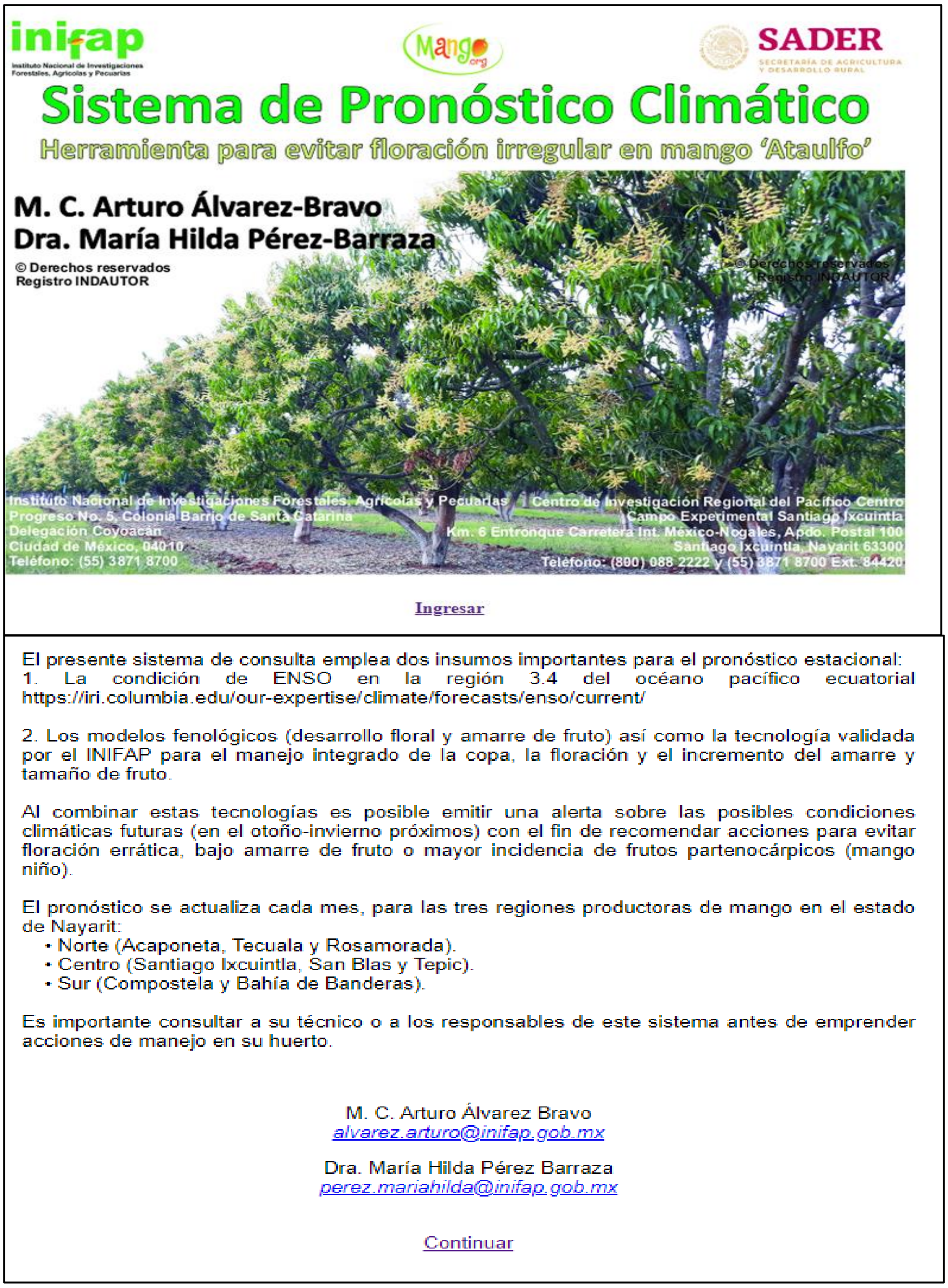

Figure 5. IT Platform for the Search System and Considerations for Its Use. Nayarit 2019-2021.

Experiment 2). Gibberellins and their effect on the flowering process of different cultivars of mango. 'Tommy Atkins' in Nayarit and 'Ataulfo' in Colima.

Table 5. Floral development of the apical bud in 'Kent' mango trees due to the effect of the treatments. Nayarit 2019-2020

Treatment	DB^{y} (%)		Flowering (%)		Yield (Kg/tree)
	2019	2020	2019	2020	2019
1. AG3 25 mgL^{-1} $(2X)^{Z}$	0.0 b	0	0 b	0	0
2. AG3 50 mgL^{-1} (1X)	0.0 b	0	0 b	0	0
3. AG3 50 mgL^{-1} (2X)	0.0 b	0	0 b	0	0
4. AG3 25 mgL^{-1} (1X) + light pruning	0.0 b		0 b		0
5. AG3 25 mgL^{-1} (1X) + severe pruning	0.0 b		0 b		0
6. Control with pruning	18.8 b		12 b		4.1
7. Absolute control without pruning	85 a	0	87 a	0	46.6

^{z}1X, single application; 2X, two applications
^{y} EDY, bud developmental stage; DB, differentiated buds.
^{x} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05

Table 6. Apical bud developmental stage (BD), percentage of differentiated buds (DB), flowering percentage (F), days to full flowering (FF) and delay in flowering (DF) due to the effect of the treatments in ´Tommy Atkins' mangos. Nayarit 2020-2021

Treatment	BDS	BD (%)	F (%)	DF (Days)
1. AG_3 25 mgL^{-1} $(2X)^{z}$	3.7 a^{y}	85 a	85 a	20 a
2. AG_3 50 mgL^{-1} (1X)	3.8 a	95 a	81 a	19 a
3. AG_3 50 mgL^{-1} (2X)	3.8 a	85 a	78 a	20 a
Control	4.0 a	100 a	100 a	0 b

^{z} Doses in mg L^{-1}; 1X = single application and 2X = two applications.
^{y} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

Table 7. Yield, delay in harvest and average fruit weight due to the effect of the treatments on mango ‘Tommy Atkins’. Nayarit 2020-2021.

Treatments	Fruits Tree^{-1} (No.)	Yield (Kg Tree^{-1})	Delay in harvest (Days)	Fruit weight (g)
AG_3 50; 2X^z	413.4 a^y	152.4 a	18 a	369 a
AG_3 100; 1X	336.6 b	124.2 b	15 a	369 a
AG_3 100; 2X	403.8 ab	148.5 ab	20 a	368 a
Control	386.2 b	136.0 ab	0 b	352 a

^{z} Doses in mg L^{-1}; 1X = single application and 2X = two applications.
^{y} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

Table 8. Percentage of differentiated buds and total flowering in mango trees of the Tommy Atkins variety due to the effect of the treatments. Colima 2019-2020.

Regulator and dose (mg L-1)	Differentiated buds (%)		Flowering (%)	
	2019	2020	2019	2020
1. AG_3 50 (2 X)^z	45 ab^y	35 a	79 a	43 a
2. AG_3 100 (1 X)	50 a	33 a	90 a	35 ab
3. AG_3 100 (2X)	70 a	20 b	86 a	31 b
4. AG_3 50 (1 X) + light pruning	30 ab		57 bc	
5. $AG3_3$ 100 (1 X) + severe pruning	15 b		48 c	
6. Control	45 ab	35 a	65 b	22 b

^{z} Doses in mg L^{-1}; 1X = single application and 2X = two applications.
^{y} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

Table 9. Yield obtained in mango trees of the ‘Tommy Atkins’ variety due to the effect of the treatments. Colima, 2019-2020.

Regulator and dose (mg L^{-1})	Yield (Kg tree^{-1})	
	2019	2020
1. AG_3 50 mg·L^{-1} (2X)^z	559 a^y	87 a
2. AG_3 100 mg·L^{-1} (1X)	396 b	100 a
3. AG_3 100 mg·L^{-1} (2X)	490 ab	55 b
4. AG_3 50 mg·L^{-1} (1 X) + light pruning	489 ab	
5. AG_3 100 mg·L^{-1} (1 X) + severe pruning	490 ab	
6. Control without the application of AG_3	488 ab	53 b

^{z} Doses in mg L^{-1}; 1X = single application and 2X = two applications.
^{y} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

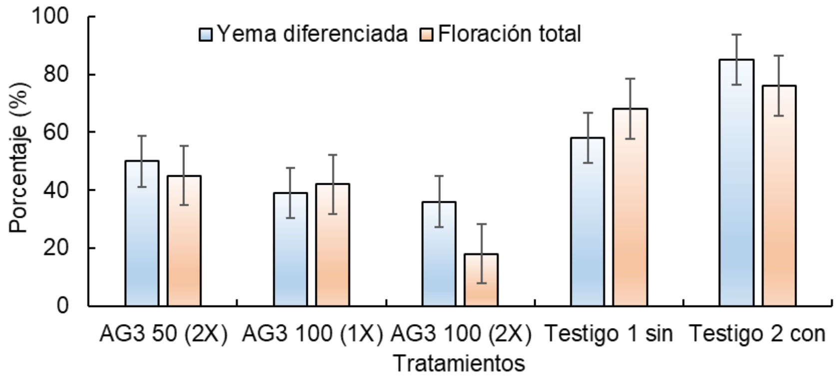

Figure 6. Percentage of differentiated buds and total flowering in mango trees of the 'Ataulfo' variety due to the effect of the treatments. The bars at each point represent the average of 24 buds and six trees per treatment ± standard error. Colima, 2021

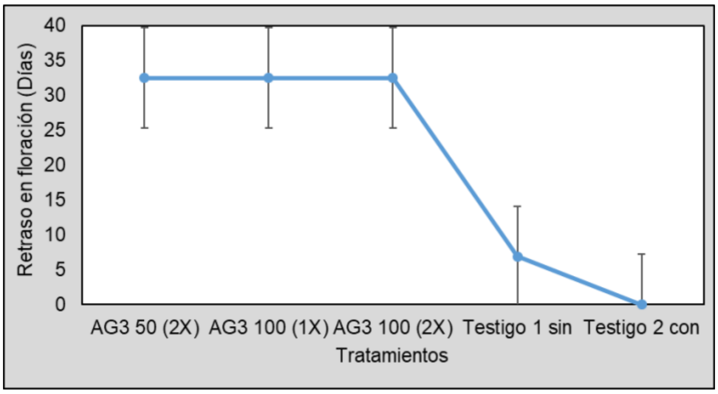

Figure 7. Delay in flowering with gibberellin-based treatments in Ataulfo mango cultivar. The bars at each point represent the average of six trees per treatment ± standard error. Colima, 2021.

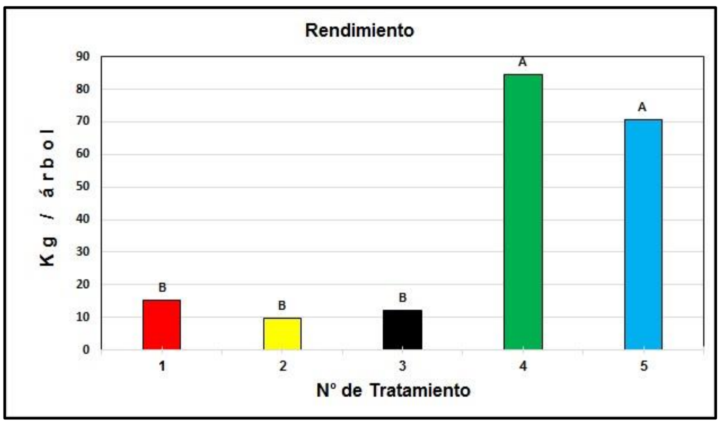

Figure 8. Yield of gibberellin-based treatments in Ataulfo mango cultivar. 1: Gibberellins 50 ppm, 2X; 2: Gibberellins 100 ppm, 1X; 3: Gibberellins 100 ppm, 2X; 4: Control I (without flowering at the beginning); 5: Control II (with flowering at the beginning). Colima, 2021.

Experiment 3). Nitrates and their relationship to bud latency and floral differentiation.

Table 10. Effect of the application of nitrates on the development of the apical bud in 'Ataulfo' mango trees. Nayarit, 2019.

Treatments	DB (%)	YI (%)	Flowering (%)
Dif Stimulator (1%) + $CaNO_3$ (2%)[z]	13 b	46 b	3 b
Dif Stimulator (1%) + $CaNO_3$ (4%)	20 b	60 ab	1 b
Phospho-nitrate 2kg/ tree	30 b	35 bc	5 b
KNO_3 (4%)	8 b	71 ab	2 b
Absolute control	13 b	83 a	2 b
Standard control (PBZ 4ml/ tree)	67 a	8 c	81 a

[z] $CaNO_3$ = calcium nitrate; KNO_3 = potassium nitrate; PBZ = Paclobutrazol.
[y] DB = differentiated bud; YI = inactive bud.
[x] Means with the same letter inside the columns, are not significantly different. Tukey $P \leq 0.05$.

Table 11. Effect of the application of nitrates on mango trees of the 'Ataulfo'. Nayarit, 2019.

Treatments	Fruits/tree (No.)	Yield (Kg/tree)
Dif Stimulator (1%) + CaNO3 (2%)[z]	20 b[y]	5.2 b
Dif Stimulator (1%) + CaNO3 (4%)	16 b	4.2 b
Phospho-nitrate 2 kg/ tree	20 b	5.3 b
KNO_3 (4%)	16 b	4.2 b
Absolute control, with pruning, sin PBZ	15 b	3.9 b
Standard control with pruning and PBZ (4ml/ tree)	108 a	28.0 a

[z] $CaNO_3$ = calcium nitrate; KNO_3 = potassium nitrate; PBZ = Paclobutrazol.
[x] Means with the same letter inside the columns, are not significantly different. Tukey $P \leq 0.05$.

Table 12. Effect of the application of nitrates on mango trees of the 'Kent'. Nayarit, 2019.

Treatments	Fruits/tree (No.)	Kg/tree	Fruit weight (g)
1. Dif Stimulator (1%) + CaNO3 (2%)[z]	7 b[y]	3.1 b	457 ab
2. Dif Stimulator (1%) + CaNO3 (4%)	10 b	4.2 b	437 ab
3. Phospho-nitrate 2 kg/ tree	7 b	2.6 b	376 b
4. KNO_3 (4%)	0 c	0.0 c	0 c
5. Control with light pruning	5 b	2.4 b	535 a
6. Control without pruning	96 a	46.6 a	485 ab

[z] $CaNO_3$ = calcium nitrate; KNO_3 = potassium nitrate.
[x] Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

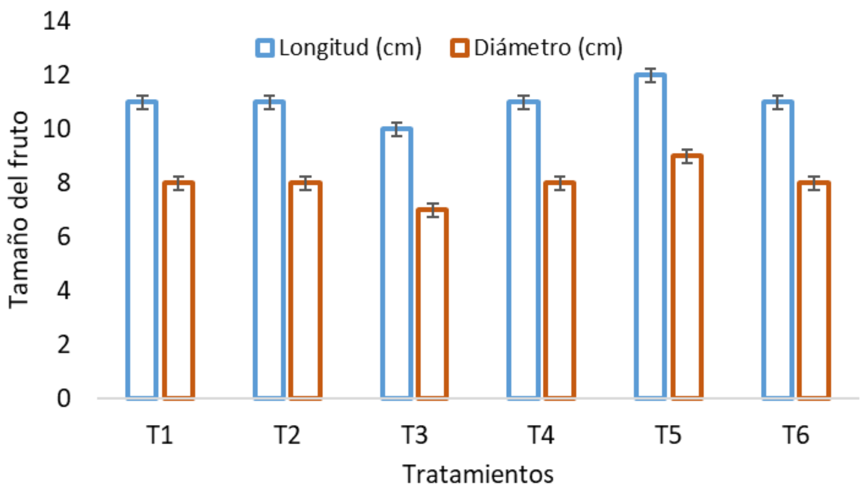

Figure 9. Size of the fruit in trees for the Kent cultivar due to the effect of the treatments. The bars at each point represent the average of six trees per treatment ± standard error. Nayarit, 2019.

Experiment 4. Study of gibberellin inhibitors as an alternative to PBZ, and their effect on the flowering process of different mango cultivars.

Table 13. Effect of gibberellin inhibitors on the flowering process of 'Tommy Atkins' mangos. Nayarit, 2019.

Treatment		12 - 19/2	4 - 17/4	Acceleration (Days)	PFT (%)[x]
Product	Dose (mg L^{-1})	1ª Flowering	2ª Flowering		
1. P-Ca	500 (3X)[z]	26.3 ab[y]	25.3 ab		51.6 ab
2. P-Ca	1500 (1X)	23.0 ab	49.0 a		72.0 a

3. P-Ca + UCZ	750 + 500 (3X)	0.3 b	35.3 a		35.5 b
P-Ca + UCZ	750 + 250 (3X)	13.2 ab	49.0 a		62.3 ab
UCZ	1000 (1X)	24.5 ab	31.5 ab		56.0 ab
PBZ	2500 (1X)	57.5 a	9.0 c	51	66.5 ab
Control	Without regulator	10.3 b	28.3 ab		38.5 ab

^{Z} 1X single application; 3X three applications.
^{y} Means with the same letter inside the columns, are not significantly different. Tukey $P \leq 0.05$
^{x} PFT, Percentage of flowering total

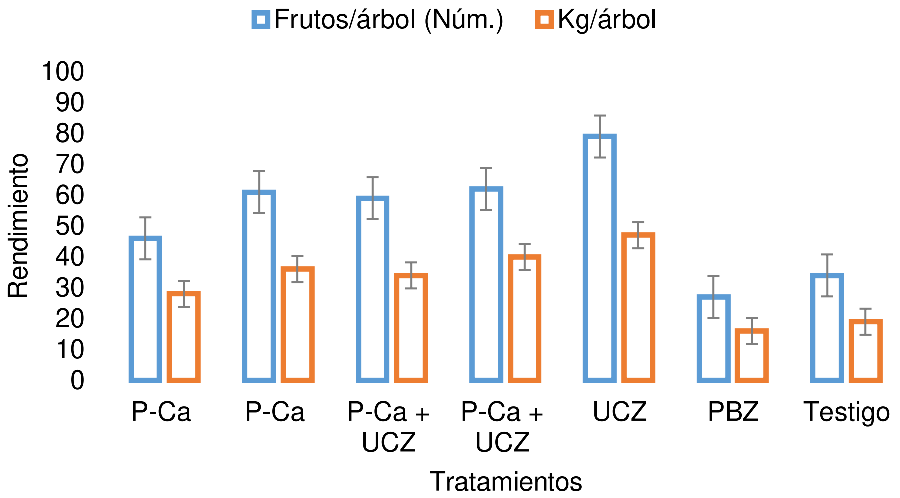

Figure 10. Yield obtained in mango trees of the 'Tommy Atkins' variety due to the effect of the treatments. The bars at each point represent the average of six trees per treatment ± standard error. Nayarit, 2019.

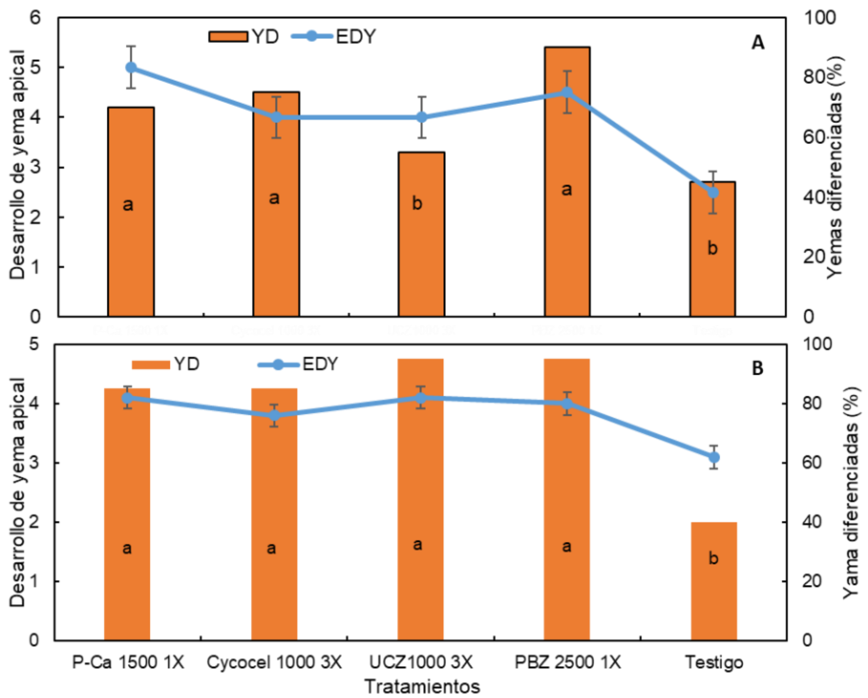

Figure 11. Development of the apical bud and percentage of differentiated buds on 'Tommy Atkins' mango trees due to the effect of the treatments. The bars at each point represent the average of 24 buds per treatment ± standard error. Nayarit, 2020 (A) and 2021 (B).

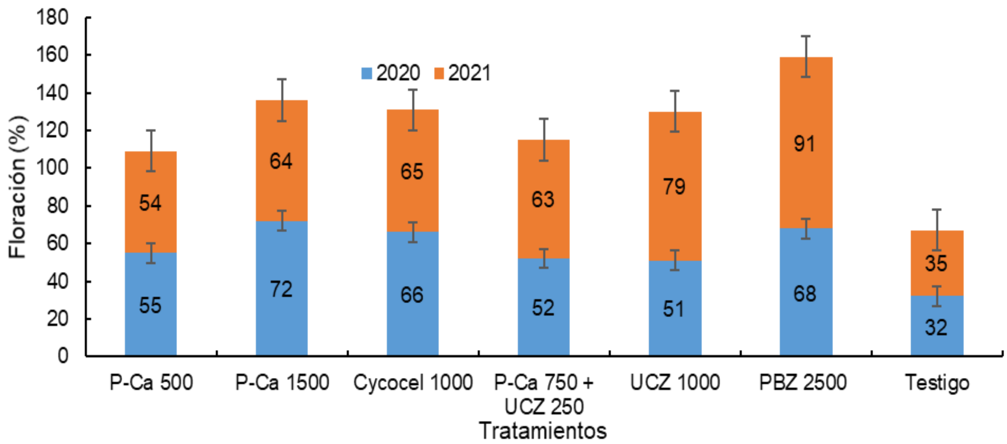

Figure 12. Percentage of flowering obtained in mango trees of the 'Tommy Atkins' variety during 2010 (A) and 2021 (B), due to the effect of the treatments. The bars at each point represent the average of six trees per treatment ± standard error. Nayarit 2020-2021

Table 14. Fruit set evaluated based on the number of fruits through inflorescence 45 days after full flowering (initial) and 8 days prior to the harvest (final). Nayarit, 2020-2021.

Treatments and doses (mg L^{-1})	2020		2021	
	Initial	Final	Initial	Final
P-Ca 500 (3x)[z]	10 bc[y]	1.8 a	12.2 a	2.2 a
P-Ca 1500	15 a	1.7 a	12.0 ab	2.1 a
CYCOCEL 1000 (3X)	14 ab	2.1 a	9.4 b	2.1 a
P-Ca 750 + UCZ 250 (3X)	13 ab	1.8 a	11.9 ab	2.4 a
UCZ 1000 (3X)	14 ab	2.2 a	12.3 a	2.1 a
PBZ 2500 (1X)	12 abc	1.8 a	11.9 ab	2.1 a
Control	8 c	1.6 a	11.0 ab	1.5 a

[Z] 1X single application; 3X three applications.
[x] Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05

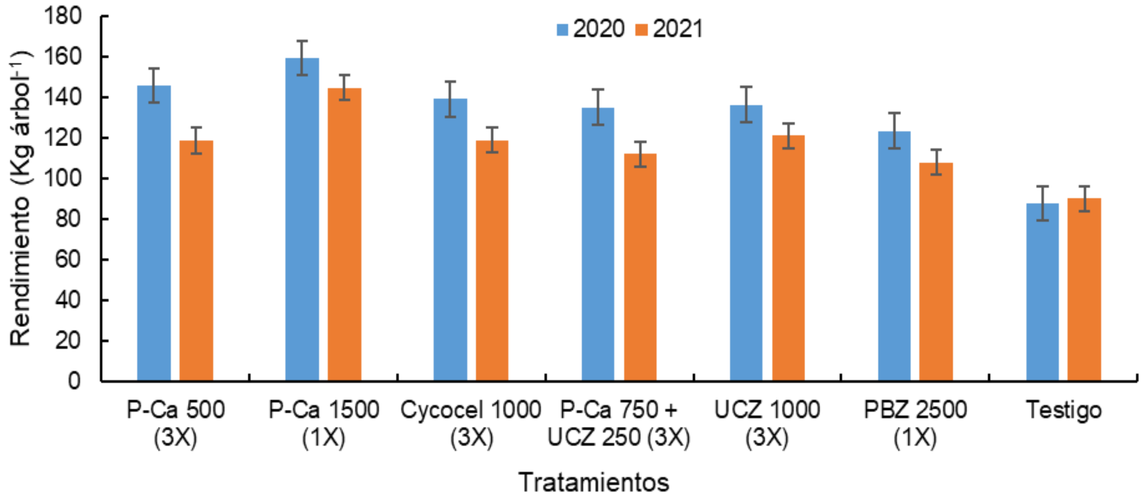

Figure 13. Yield (kg of fruit per tree) recorded in ´Tommy Atkins´ mango trees due to the effect of the treatments. The bars at each point represent the average of six trees per treatment ± standard error. Nayarit 2020-2021

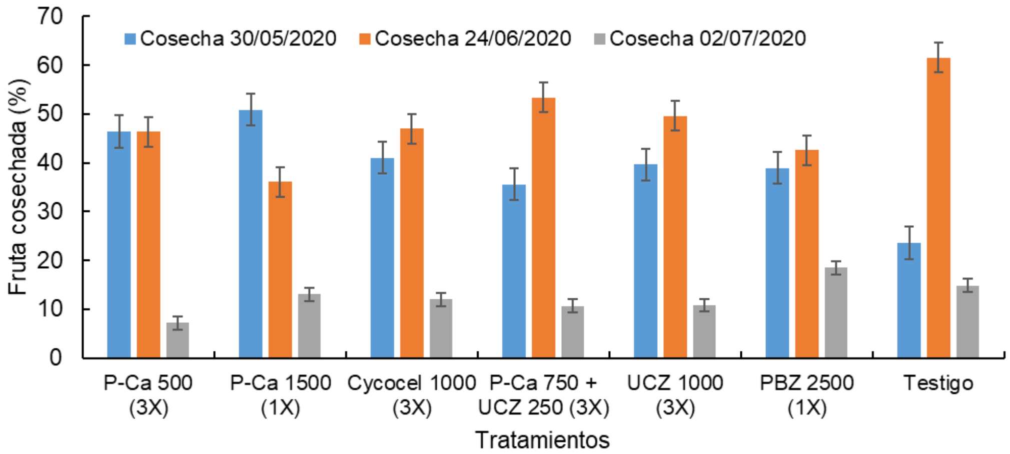

Figure 14. Percentage of fruit harvested on three different harvest dates due to the effect of the treatments on 'Tommy Atkins' mango trees. The bars at each point represent the average of six trees per treatment ± standard error. Nayarit, 2020.

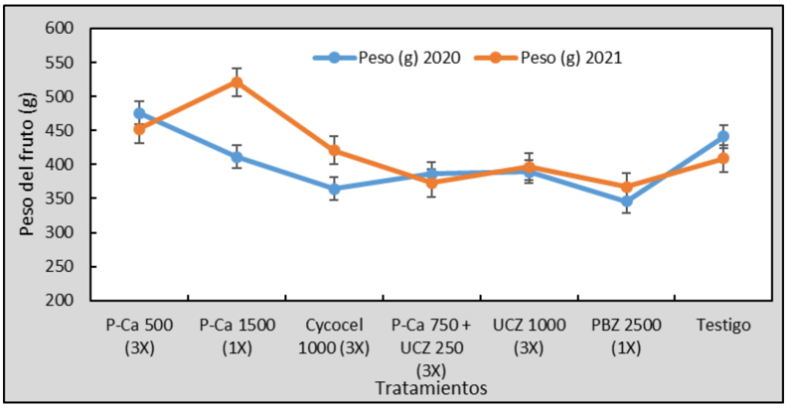

Figure 15. Average fruit weight in trees of the ´Tommy Atkins' variety due to the effect of the treatments. The bars at each point represent the average for 20 fruits per treatment ± standard deviation. Nayarit 2020-2021.

Table 15. Developmental stage of the apical bud (DSB), percentage of differentiated buds (DB) and time at which differentiation occurred (TD) due to the effect of the treatments on 'Kent' mangos. Nayarit, 2021.

Treatments	EDY	DB (%)	TD (Days)
1. P-Ca 1500, 1X[z]	4	100	122
2. Cycocel 1000, 3X	4	100	119
3. UCZ 1000, 3X	4	100	122
4. PBZ 2500, 1X	4	100	118
5. Control	4	100	138

[z] Doses in mg L^{-1}; 1X = single application and 3X = three applications.

Table 16. Percentage of flowering, time during which full flowering and earlier flowering occurred due to the effect of the treatments on 'Kent' mangos. Nayarit, 2021.

Treatments	Total Flowering (%)	Full Flowering (Days)	Acceleration (Days)[x]
P-Ca 500, 3X[z]	100 a[y]	135 c	21 a
P-Ca 1500, 1X	100 a	135 c	21 a
Cycocel 1000, 3X	100 a	137 bc	19 ab
UCZ 1000, 3X	100 a	139 b	17 b
PBZ 2500, 1X	100 a	135 c	21 a
Control	76 a	156 a	0 c

[z] Doses in mg L^{-1}; 1X = single application and 3X = three applications. and Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05. [x] Earlier flowering compared to the control

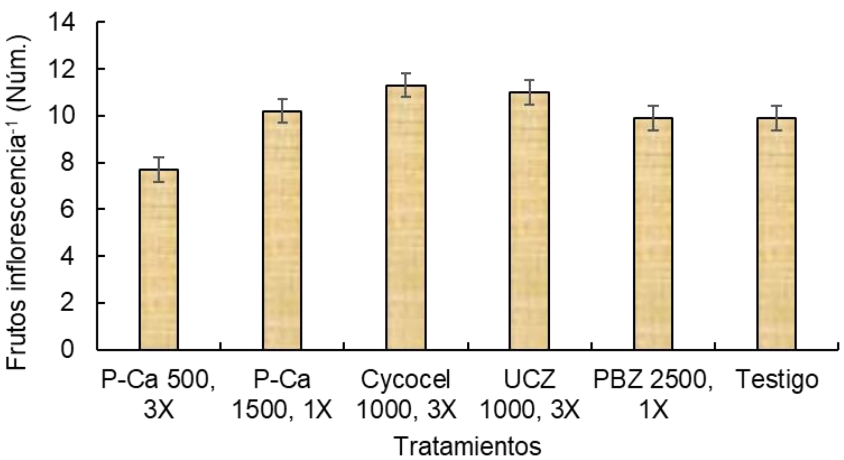

Figure 16. Effect of the treatments on initial fruit set, evaluated 45 days after full flowering in trees of the ‘Kent’ variety. The bars at each point represent the average of 20 inflorescences per treatment ± standard error. Nayarit, 2021.

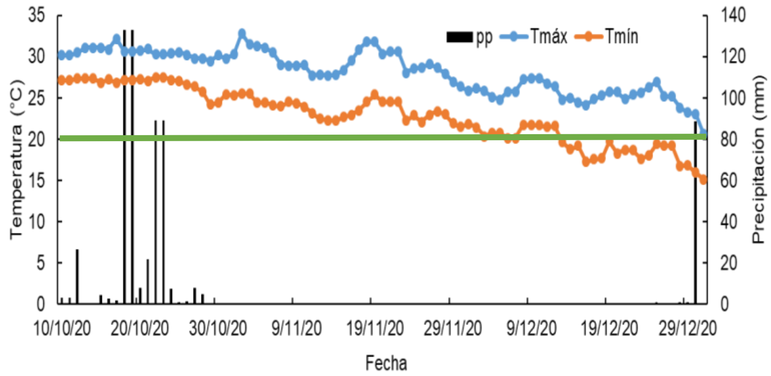

Figure 17. Maximum and minimum temperature and rainfall from October to December of 2020. Santiago Ixcuintla, Nayarit

Table 17. Number and kg of fruit per ´Kent´ mango tree due to the effect of the treatments. Nayarit, 2021.

Treatment	Yield (Kg tree^{1})	Acceleration of Flowering (Days)
P-Ca 500 (3X)^{z}	112 b	15 a
P-Ca 1500 (1X)	128 a	15 a
Cycocel 1000 (3X)	119 a	12 ab
UCZ 1000 (3X)	128 a	10 ab
PBZ 2500 (1X)	132 a	18 a
Control	113 b	0 b

^{z} Doses in mg L^{-1}; 1X = single application and 3X = three applications.
^{y} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

Table 18. Size of the fruit recorded in fresh weight, length and diameter due to the effect of the treatments on ‘Kent’ mangos. Nayarit, 2021.

Treatment	Weight (g)	Length (cm)	Diameter (cm)
P-Ca 500 (3X)^{z}	615 b^{y}	11.3 a	10.3 b
P-Ca 1500 (1X)	700 a	11.7 a	10.8 ab
Cycocel 1000 (3X)	735 a	11.7 a	11.3 a
UCZ 1000 (3X)	675 ab	11.2 a	11.2 a
PBZ 2500 (1X)	725 a	11.7 a	10.9 ab

Control	654 b	11.7 a	10.5 b

[z] Doses in mg L^{-1}; 1X = single application and 3X = three applications.
[y] Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

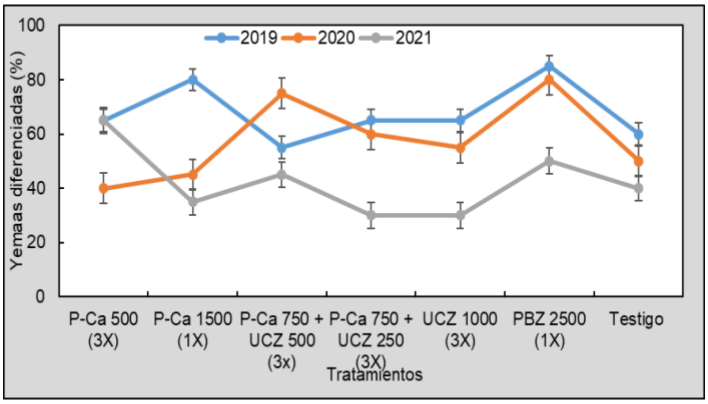

Figure 18. Percentage of differentiated buds in ‘Ataulfo’ mango trees due to the effect of the treatments. The bars at each point represent the average of 24 buds sampled per treatment ± standard error. Colima, 2019-2021.

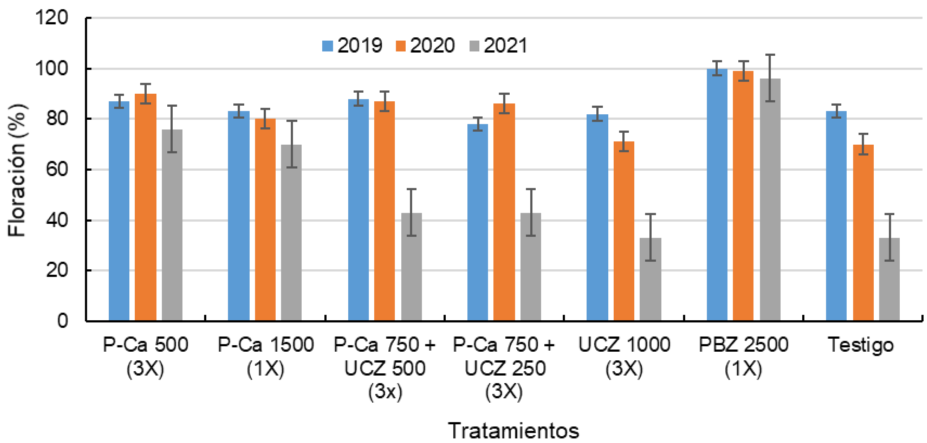

Figure 19. Percentage of flowering en ‘Ataulfo’ trees due to the effect of the treatments. The bars at each point represent the average of six trees per treatment ± standard error. Nayarit 2019-2020.

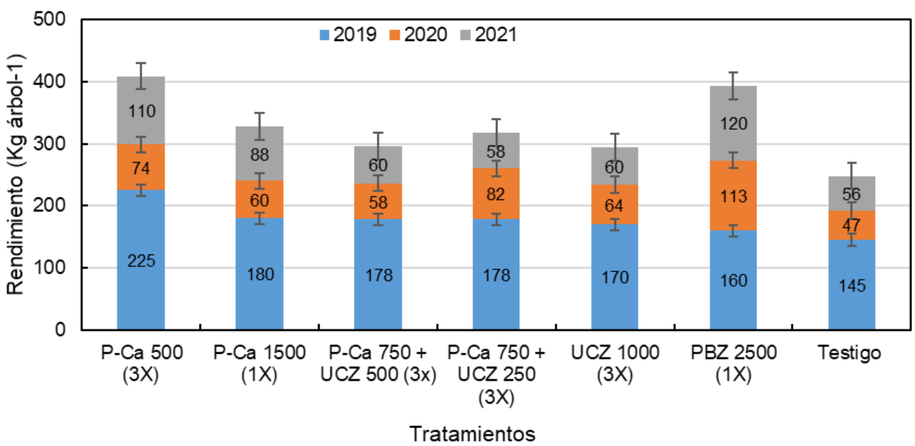

Figure 20. Yield based on Kg of fruit per tree in 'Ataulfo' mangos due to the effect of the treatment. The bars at each point represent the average of six trees per treatment ± standard error. Colima, 2019-2020.

Experiment 5) Effect of pruning and nutrition on the flowering process of different mango cultivars. Which make up the following sub experiments:

Experiment 5.1. Effect of pruning period and intensity on the flowering and production of mango Ataulfo.

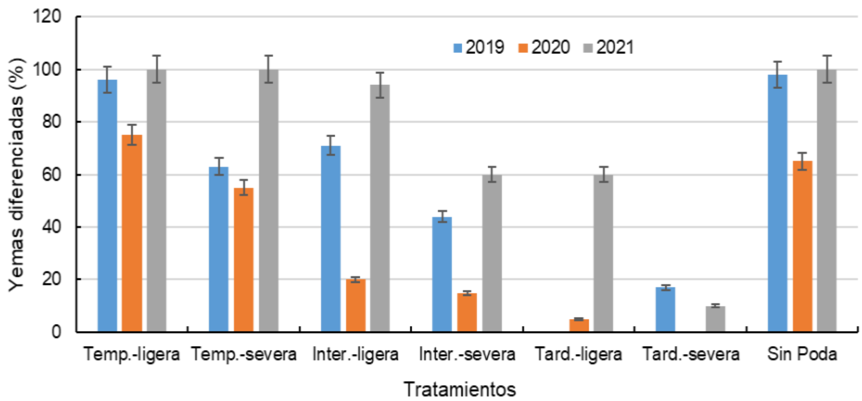

Figure 21. Percentage of differentiated buds in 'Ataulfo' mango trees due to the effect of the treatments. The bars at each point represent the average of 24 buds per treatment ± standard error. Nayarit, 2019-2021.

Table 19. Percentage of flowering and delay compared to the control, in 'Ataulfo' mango trees. Nayarit, 2019-2021.

Treatment	Total Flowering (%)			Delay (days)^z		
	2019	2020	2021	2019	2020	2021
Early-light	61 ab^y	70 a	94 a	0 c	10 c	14 b
Early-severe	28 c	60 a	91 a	10 b	13 c	18 ab
Intermediate-light	46 b	57 ab	85 a	28 a	34 b	21 a
Intermediate-severe	43 b	47 b	58 b	30 a	31 b	29 a
Late-light	70 a	29 c	59 b	0 c	52 a	29 a
Late-severe	53 b	15 c	19 c	0 c	55 a	29 a
Without Pruning	75 a	71 a	99 a	0 c	0 c	0 c

[z] Delay in flowering compared to the control
[y] Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

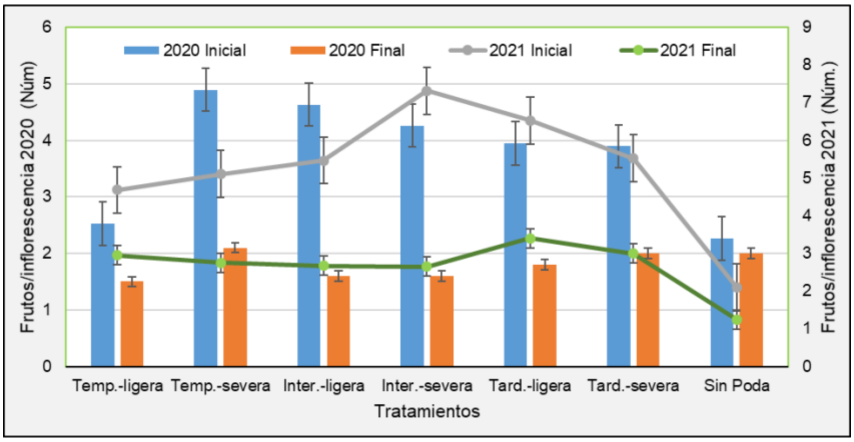

Figure 22. Fruits retained through inflorescence 45 days after full flowering (initial fruit set) and eight days before the harvest (final fruit set) in ‘Ataulfo’ mangos due to the effect of the treatments. The bars at each point represent the average of 24 inflorescences per treatment ± standard error. Nayarit 2020-2021.

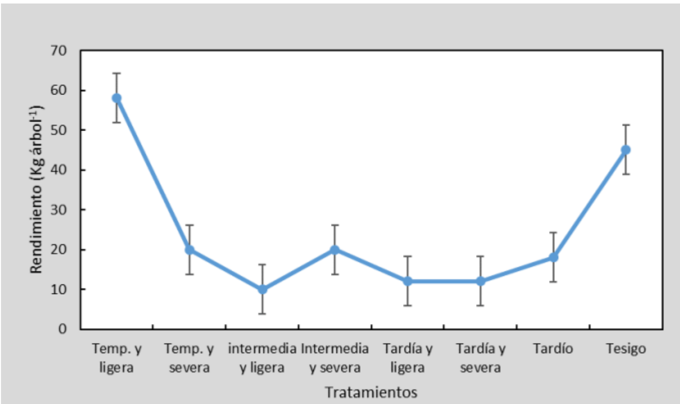

Figure 23. Yield obtained during the first year of evaluation in ‘Ataulfo’ mango trees due to the effect of the pruning period/severity interaction. Nayarit, 2019.

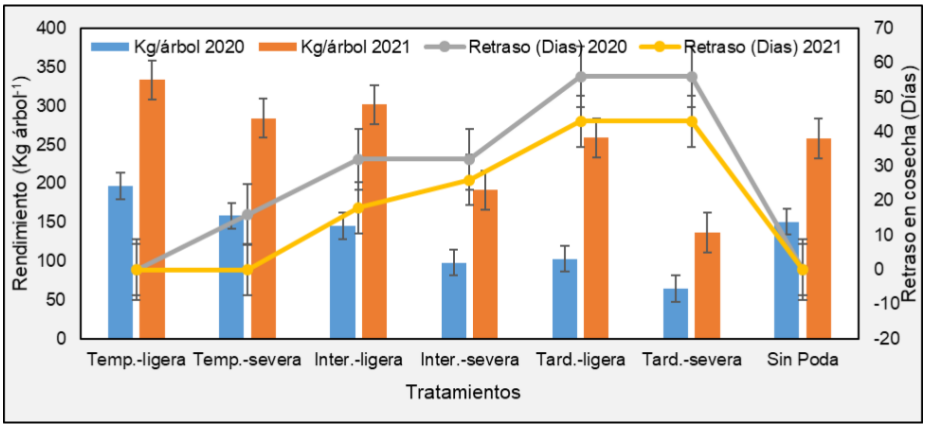

Figure 24. Yield and delay in the harvest for ‘Ataulfo’ mango trees due to the effect of the treatments. The bars at each point represent the average of six trees per treatment ± standard error. Nayarit 2020-2021.

Table 20. Harvest dates, prices per kg of fruit and profits obtained per treatment stemming from the production of fruit per tree in ‘Ataulfo’ mangos. Nayarit, 2020

Treatments	Harvest date	Price/kg ($)	Price/tree ($)
Early-light	30- May	3.2	631.5
Early-severe	15-June	3.2	508.5
Intermediate-light	30-June	5.4	780.0
Intermediate-severe	30-June	5.4	525.0
Late-light	30-July	8.9	918.8
Late-severe	30-July	8.9	575.0
Without pruning	30-May	3.2	484.7

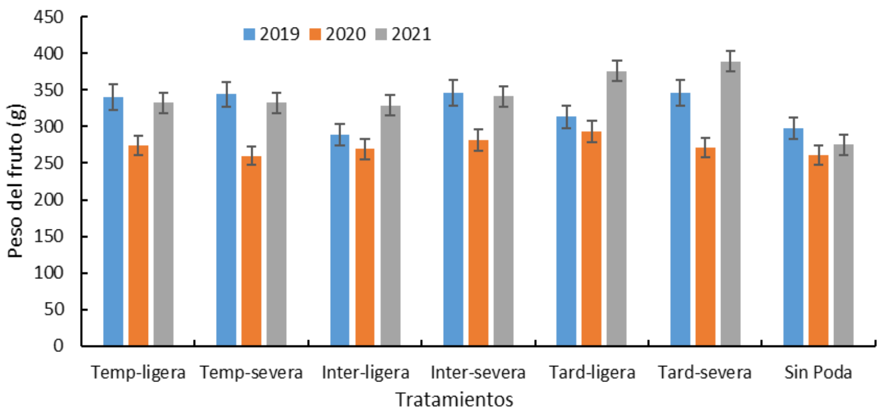

Figure 25. Average fruit weight obtained for ‘Ataulfo’ mangos due to the effect of the treatments. The bars at each point represent the average for 20 fruits per treatment ± standard deviation. Nayarit, 2020-2021

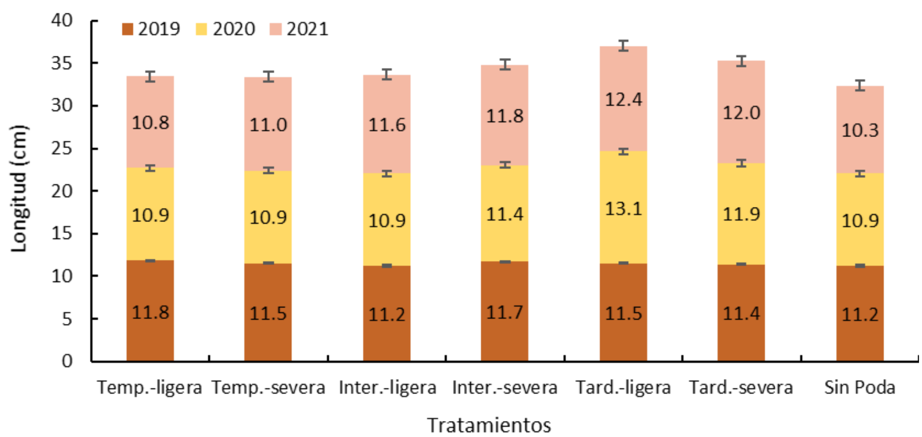

Figure 26. Length and diameter of fruit obtained due to the effect of the treatments on ‘Ataulfo’ mangos. The bars at each point represent the average for 20 fruits per treatment ± standard error. Nayarit, 2020-2021

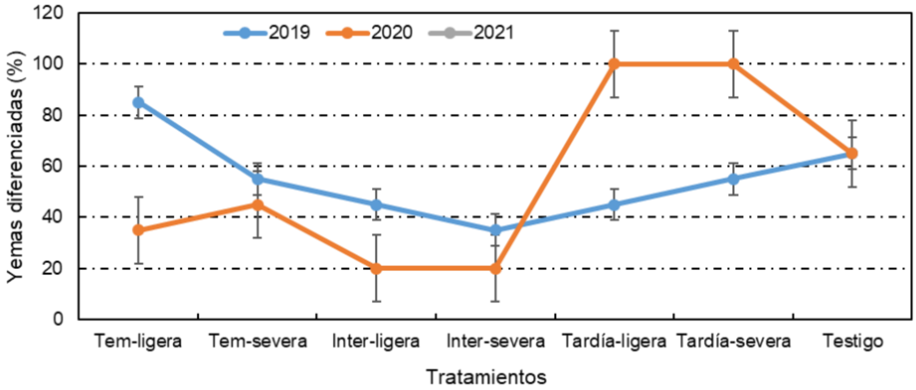

Figure 27. Percentage of differentiated buds obtained due to the effect of the treatment on ‘Ataulfo’ mango trees. Colima 2019-2021.

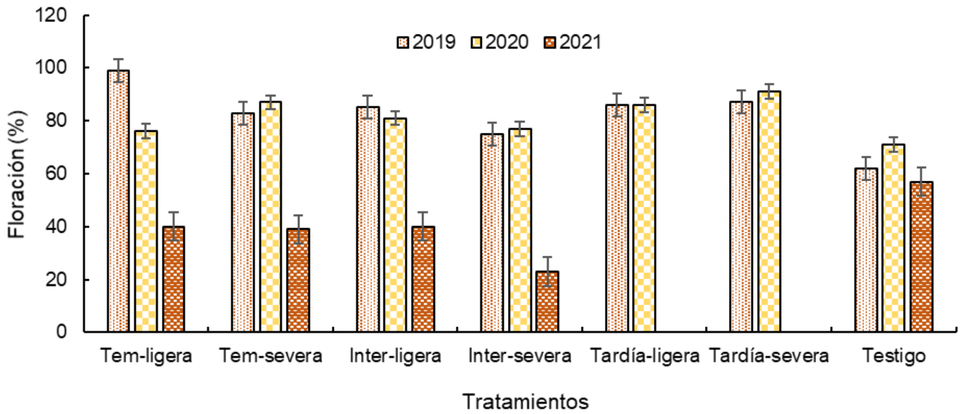

Figure 28. Percentage of flowering obtained due to the effect of the treatment on ‘Ataulfo’ mango trees. Colima 2019-2021.

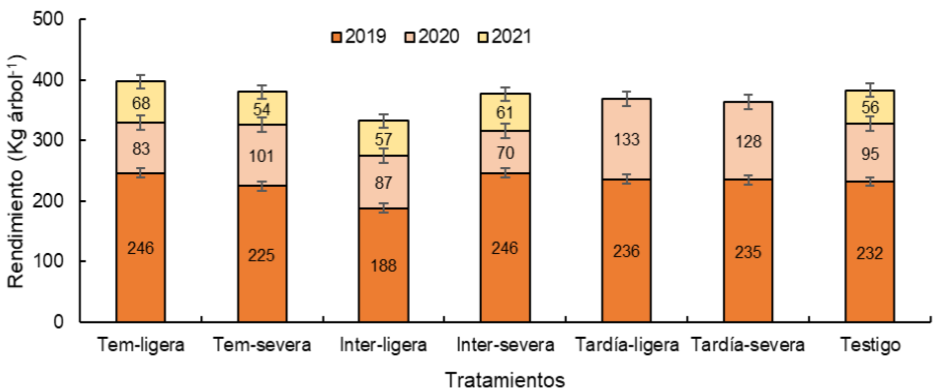

Figure 29. Yield obtained due to the effect of the treatment on ‘Ataulfo’ trees. Colima 2019-2021.

Experiment 5.2. Nutritional and sustainable integrated management strategies for floral induction and differentiation in ‘Ataulfo’ mangos.

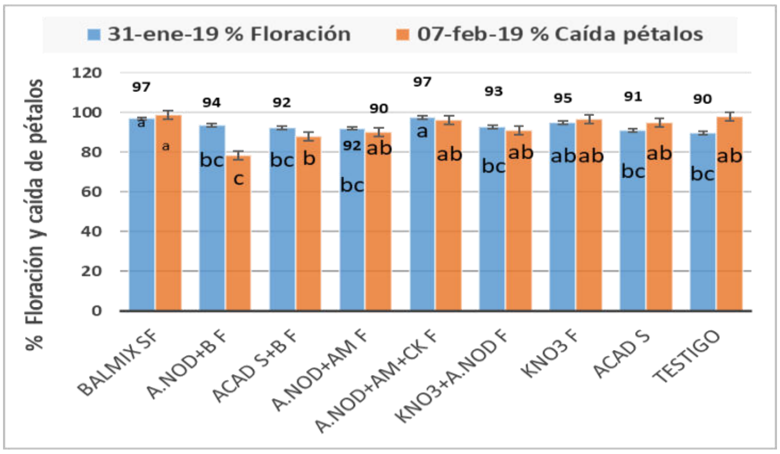

Figure 30. Percentage (%) of maximum flowering and petal fall occurring during the months of January and February of 2019, due to the effect of treatments on ‘Ataulfo’ mangos. Nayarit. 2019.

Table 21. Number and percentage (%) of fruit through inflorescence due to the effect of the treatments on ‘Ataulfo’ mangos. Nayarit, 2019

Treatments	Fruits per branch	Set fruits (No.)	%
Balmix SF	15	9.6	63 a
A. Nod + BF	21	12.5	54 ab
Acad S + BF	20	11.3	59 ab
A. Nod + Am F	22	9.7	45 b
A. Nod + AmF + Ck F	18	9.6	57 ab
KNO3 + A.nod F	21	11.2	56 b
KNO3 F	17	10.4	52 b
Acad S	18	9	53 ab
Control	18	7.6	44 b
Average	19	10	54

Table 22. Number of fruits per tree, fruit weight, and yield obtained due to the effect of the treatments on 'Ataulfo' mangos. Nayarit, 2019.

Treatments	Fruits tree^{-1} (No.)		Fruit weight (g)		Yield (T ha^{-1})	
	Mean	Stand Dev.	Mean	Stand Dev.	Mean	Est Error.
Balmix SF	584	85	370	21	20.3	1.6
A. Nod + BF	680	147	353	7	24.0	2.1
Acad S + BF	654	77	329	26	21.5	1.0
A. Nod + Am F	604	68	341	29	20.6	1.2
A. Nod + AmF + Ck F	569	34	351	26	20.0	0.6
KNO3 + A.nod F	493	34	332	12	16.4	0.5
KNO3 F	663	48	310	19	20.5	0.6
Acad S	664	96	338	21	22.3	1.2
Control	380	51	285	33	10.8	0.9
Average	588	116	335	31	19.8	1.2

Table 23. Average values of the initial flowering percentages (January), full flowering (March), and accumulated flowering due to the effect of the treatments on 'Ataulfo' mangos, Nayarit 2020.

Treatment	Jan		Feb		Mar		Accum	
Balmix F+Sue	2.10	b^{z}	22.1	c	42.6	ab	67	b
A.nodosum F+Balmix F	2.71	b	38.5	b	28.8	c	70	ab
A.nodosum +Cks+Am. F	4.34	a	48.4	a	15.2	d	68	b
A.nodosum Sue+ Balmix F	1.51	bc	10.5	d	48.9	a	61	c
Control	2.28	b	21.3	c	49.4	a	73	a

^{z} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05

Table 24. Fruits per tree and yield in tons per hectare (T ha^{-1}) due to the effect of the treatments on 'Ataulfo' mangos. Nayarit, 2020.

Treatment	Fruits tree^{-1} (No.)		Yield (T ha^{-1})	
	Mean		Mean	
Balmix F+Sue	363.3	a^{z}	11.0	bc
A.nodosum F+Balmix F	374.9	a	11.6	bc
A.nodosum +Cks+Am. F	426.1	a	14.0	a
A.nodosum Sue+ Balmix F	372.3	a	12.2	ab
Control	356.5	a	10.7	bc
p		0.216		0.01

^{z} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05

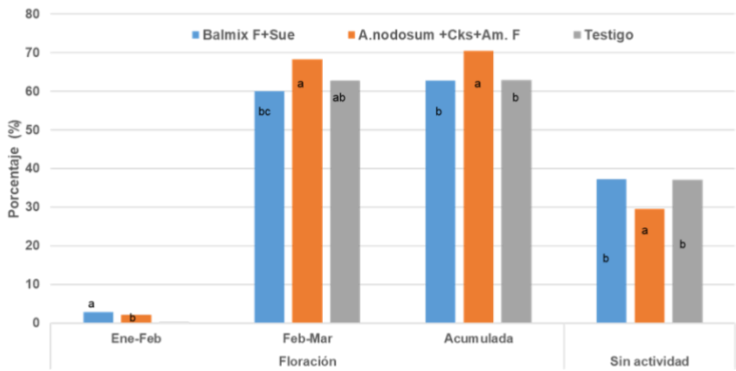

Figure 31. Percentage of initial (Jan-Feb), full (feb-mar) and accumulated flowering, and floral inactivity, per treatment on 'Ataulfo' mangos. Nayarit, 2020.

Table 25. Fruits per tree and yield in tons per hectare due to the effect of the treatments on 'Ataulfo' mangos. Nayarit, 2020.

Treatment	Fruits tree^{-1} (No.)		Yield (T ha^{-1})	
	Mean		Mean	
Balmix F+Sue	321.6	bc^{z}	12.0	b
A.nodosum +Cks+Am. F	370.8	ab	14.0	a
Control	388.7	a	12.7	b

^{z} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05

Table 26. Weight, length, diameter, and SST per treatment on 'Ataulfo' mangos. Nayarit, 2020.

Treatment	Weight (g)		Length (cm)		Diameter (mm)		SST (°Brix)	
	Mean		Mean		Mean		Mean	
Balmix F+Sue	308.2	ab^{z}	11.4	b	7.2	ab	13.5	ab
A.nodosum +Cks+Am. F	324.6	a	12.1	a	7.5	a	14.5	a
Control	296.3	bc	11.1	b	6.8	bc	12.3	bc

^{z} Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05

Table 27. Days to maximum flowering and maximum flowering percentage due to the effect of treatments to synchronize flowering on 'Ataulfo' mangos. Nayarit, 2021.

Treatment	Days to maximum flowering[z]		Maximum Flowering (%)	
Balmix+A nod+ F1	86.3	d[y]	90.2	a
Fi Gran+ A nod+ F1	85.0	bc	90.8	a
Hydro Fi+ A nod+ F1	81.2	a	92.2	a
Balmix + A nod+ F2	85.3	bc	92.4	a
Fi Gran + A nod+ F2	85.6	c	91.0	a
Hydro Fi+ Anod+ F2	83.7	bc	91.7	a
Balmix+NO_3K F2	85.0	c	93.0	a
Fi Gran+NO_3K F2	81.0	a	91.3	a
Hydro Fi+NO_3K F2	83.1	b	91.1	a
Control (2kg T17)	87.2	d	57.8	b

[z] Days from the first date of the application of bio-stimulants (F1)
[y] Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05

Table 28. Yield components for 'Ataulfo' mangos based on type of fertilizer and inductor for flowering and fruit quality. Nayarit. 2020-2021.

Type	Factor	Fruits per tree (No.)	Weight (g)		Yield (kg tree^{-1} and T ha^{-1})	
			Regular	Large	Tree	Ha
Fertilizer	Balmix	224 bc[z]	305 b	402 b	76 bc	10.2 bc
	Fi Gran	281 a	313 ab	406 b	100 a	13.4 a
	Hydro Fi	251 ab	334 a	425 a	90 ab	12.0 ab
	Test (2 kg T17)	258 ab	306 b	406 b	81 bc	10.8 bc
Inductor	A. nod. F1	291 a	323 a	414 a	102 a	13.7 a
	NO3K F2	248 b	321 a	418 a	86 bc	11.6 bc
	A. nod. F2	248 b	329 a	411 ab	89 ab	12.0 ab
	Sin	231 bc	293 b	397 b	74 c	9.9 c
Mean		252	314	411	87	11643

[z] Means with the same letter inside the columns, are not significantly different. Tukey P ≤ 0.05.

Presentations (oral and poster presentation)

1. Conferencia "Inhibidores de giberelinas y su efecto en el proceso of flowering en mango, como una alternativa al paclobutrazol: primeros avances", presentada en X Reunión Nacional de Investigación Agrícola, Chiapas, 2019. ***– Conference "Gibberellin inhibitors and their effect on the flowering process in mangos as an alternative to paclobutrazol: initial progress", presented at the X National Congress of Agricultural Research, Chiapas, 2019.***
2. Conferencia "Variabilidad de la temperatura para la región productora de mango in Colima and Nayarit", presentada en X reunión Nacional de Investigación Agrícola, Chiapas, 2019. ***– Conference "Temperature variability for the mango production regions in Colima and Nayarit", presented at the X National Congress of Agricultural Research, Chiapas, 2019.***
3. Conferencia "El ambiente como factor clave en la producción del mango". 2º. Congreso Internacional de Productores and Exportadores de Mango. EMEX. Puerto Vallarta, Jalisco, 2019. ***– Conference "The environment as a key factor in mango production". 2nd International Congress for Mango Producers and Exporters.*** **EMEX. Puerto Vallarta, Jalisco, 2019.**
4. Presentación de avances de resultados del proyecto en el evento "Día del Productor Expo-INIFAP Tecomán 2019", realizado en el Campo Experimental Tecomán el 2 and 3 de octubre de 2019, en Tecomán Colima. ***– Presentation of project preliminary results for the event "Producer Day Expo-INIFAP Tecomán 2019", held in the Tecomán Experimental Field, October 2-3, 2019, in Tecomán, Colima***
5. Presentación de resultados del proyecto "Estrategias para evitar floración irregular and modificar época de cosecha del mango mediante un manejo integrado" Décimo Noveno Congreso Internacional sobre el Mango Peruano. Piura Perú, 2020.Virtual. **–** ***Presentation of results for the project "Strategies to avoid irregular flowering and modify harvest timing for mangos through integrated management"*****. 19th International Congress for Peruvian Mangos. Piura, Peru, 2020. Virtual.**
6. Conferencia "Estrategias para prevenir the irregular flowering del mango". Seminario Virtual. AGEXPORT, Guatemala. 2020. ***– Conference "Strategies to prevent irregular flowering in mangoes." Virtual workshop. AGEXPORT, Guatemala. 2020.***
7. Conferencia "Efecto de la temperatura and reguladores de crecimiento en el proceso of flowering del mango" Ciclo de talleres de extensión agrícola para productores de mango campaña 2021-2022. APEM, Perú, 2021 - ***Conference "Effect of temperature and growth regulators on the flowering process in mangos"*****.** ***Cycle of agricultural***

***extension workshops for mango growers for the 2021-2022 season.* APEM, Peru, 2021**

8. Conferencia "Poda and manejo of the flowering en mango", Clúster de mango dominicano (PROMANGO). Jornadas Técnicas Virtuales. República Dominicana, 2021. - ***Conference "Pruning and flowering management for mangos" Cluster of Dominican Mangos (PROMANGO). Virtual technical sessions. Dominican Republic, 2021***
9. Presentación Oral "Floración y rendimiento con inhibidores de giberelinas alternativos al paclobutrazol en mango 'Tommy Atkins'" e "Intensidad and época de poda and su relación con desarrollo floral en mango 'Ataulfo'" Presentadas en el XXVIII Congreso Nacional and VIII Internacional de Fitogenética. Realizado del 20 al 24 de septiembre 2021. Virtual. - ***Oral Presentation (Flowering and yield with alternative gibberellin inhibitors to paclobutrazol in 'Tommy Atkins' mangos and "Pruning intensity and timing, and their relationship to floral development in 'Ataulfo' mangos". Presented at the XXVIII National and VIII International Congress on Phytogenetics. September 20-24, 2021. Virtual***
10. Cartel "Respuesta a la intensidad and época de poda en mango 'Ataulfo' in Colima". XXVIII Congreso Nacional y VIII Internacional de Fitogenética, realizado del 20 al 24 de septiembre de 2021. Virtual. **– Poster "*Response to pruning intensity and timing in 'Ataulfo' mangos in Colima*". *XXVIII National and VIII International Congress on Phytogenetics, September 20-24, 2021. Virtual.***
11. Cartel "Modificación de cosecha e incremento en la productividad del mango 'Ataulfo' mediante la poda" XI Reunion Nacional de Investigación Agrícola, del 10 al 12 de noviembre del presente año. ***– Poster "Modification of the harvest and increase in productivity for 'Ataulfo' mangos through pruning". XI National Congress of Agricultural Research, November 10-12 of the present year.* Virtual**

•Review articles of the same level or abstract

Scientific article under review by the *Revista Fitotecnia Mexicana*.

Title of the article: "Floración y alto rendimiento con inhibidores de giberelinas alternativos al paclobutrazol en mango 'Tommy Atkins' ***(Flowering and high yield with alternative gibberellin inhibitors to paclobutrazol in 'Tommy Atkins' mangos.)***

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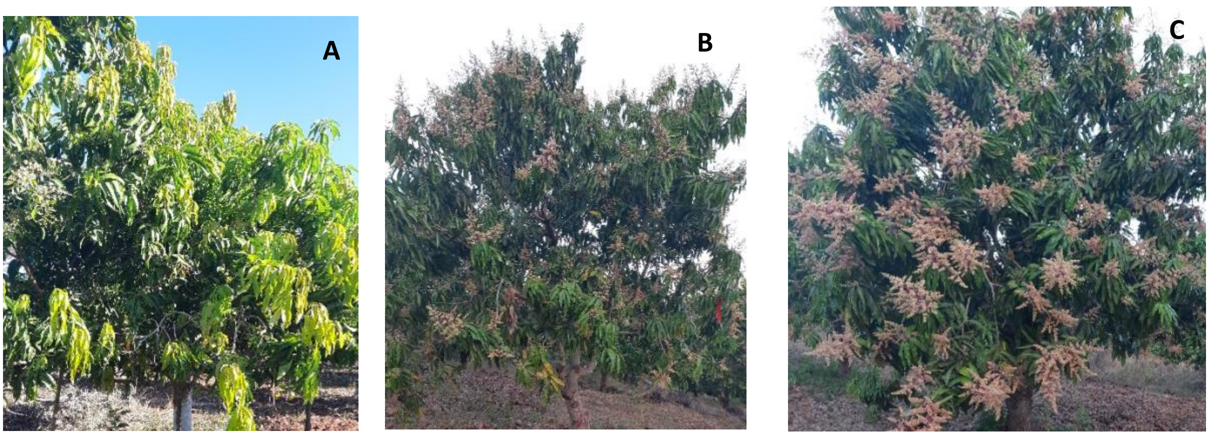
PHOTOGRAPHIC SECTION

INHIBITORS

Response to the application of calcium prohexadione P-Ca 1500 mgL-1 during the flowering and production periods for ‘Tommy Atkins’ (left) and ‘Kent’ (right) mangos.

GIBBERELLINS



Response to the application of gibberellins in Kent mangos (A), response in ‘Tommy Atkins’ mangos with a delayed flowering (B) and ‘Tommy Atkins’ control without gibberellins (C)

TIMING AND INTENSITY OF PRUNING

Pruning treatment on 'Ataulfo' Tree with pruning (left) and without pruning (right)

Response in flowering during early (A), intermediate (B) season pruning in Ataulfo mangos

Response in flowering during late pruning season (A) and flowering in late season pruned branches (B).

Response to early season harvest

Response in the production of fruit with intermediate (left) and late (right) season pruning. In both seasons, the fruit were always healthier

‘Ataulfo’ mango harvest