THE XIII INTERNATIONAL MANGO SYMPOSIUM

29 September - 3 October 2023, Malaga, Spain

Andre Botha – Subtrop

The Symposium was held at the NH Malaga Hotel in the picturesque city of Malaga in the South of Spain next to the Mediterranean Sea. At the symposium a total of 48 oral papers and 30 posters were presented over 3 days. In mainland Spain, currently around 95% of the commercially cultivated area is occupied by the cultivars Tommy Atkins, Osteen, Kent and Keitt, with Osteen the most important with over 75% of the total planted area (5000 ha). Average yields for the area are around 18 tons/ha.

Malaga city

Symposium venue, NH Malaga Hotel

The first two sessions were focused on different world markets and production in countries. A lot of interest was shown in the fresh-cut mango market which shows strong growth and great potential in the USA, UK, Netherlands, Spain, and Italy. The demand includes big (>500g) fibreless, strict quality-controlled fruit in a perfect stage of maturity, especially the cultivars Keitt and R2E2.

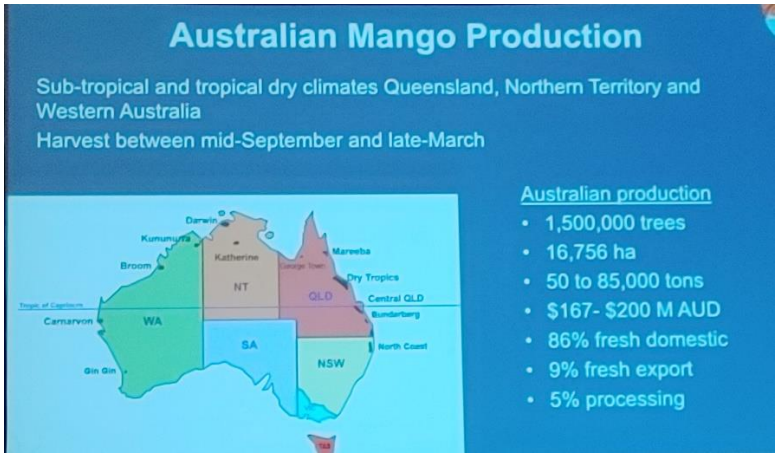
Leonardo Ortega talked about the US mango trends and the National Mango Board, an organization focused on increasing awareness and consumption of fresh mangoes in the US. Since 2005 to 2022, the per capita availability of mangoes in the U.S. has increased from 1.88 to 3.76 lb. per person (100% increase) and the overall import volume of fresh mangoes in the U.S. has also increased significantly from 260,841.9 to 574,782.7 t representing an increase of 120%. Mango retail sales have increased from $109 to $302 per store per week; and the volume-per store-per week has increased from 132 to 251 units of whole mangoes. As the average percentage of household aware of advertising and promotions has increased from 6.7 to 17.3%, market penetration (households buying in a two-week period) and market intensity (mangoes per buying occasion) have increased from 14.1 to 27.7% and from 2.83 to 3.45 whole mangoes per household in a two-week period respectively since 2013.

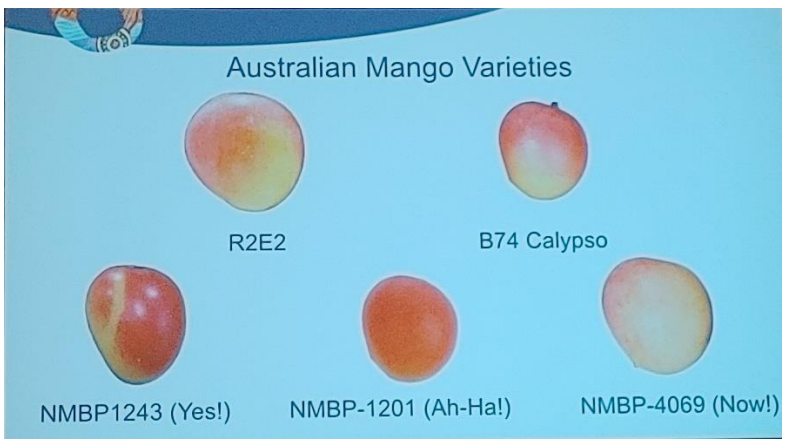
The crop management sessions included talks on high density plantings in Australia, how crop loads effect fruit mineral status and susceptibility to internal disorders as

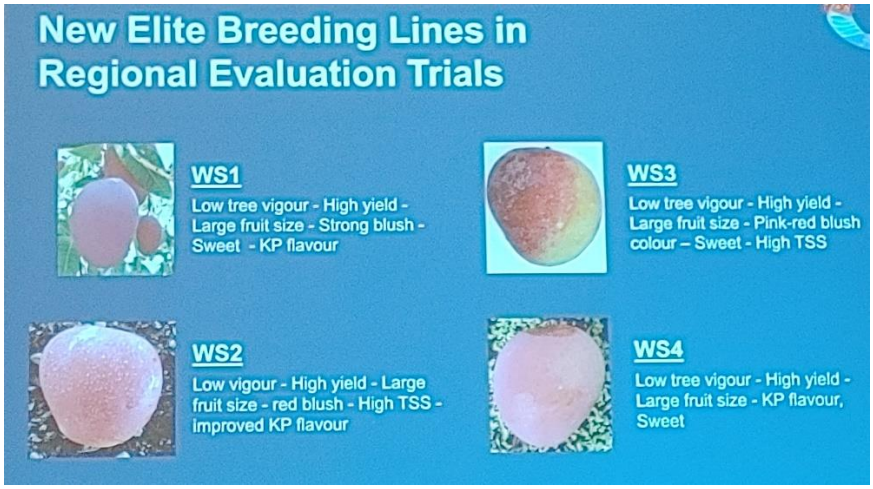
well as understanding the practical applications of vegetative growth and development of the mango tree canopy. This presentation covered key elements that underpin production in mango orchards such as crop load, tree size and vigour, canopy architecture, light interception and distribution, harvest efficiency, economics, and genetics.
Ian Bally also talked about the adoption of intensive mango practices and the use of Agri-technologies in Australia, These cutting-edge projects incorporate an integrated research, development and extension structure, with objectives to 1) Investigate and progress the knowledge and understanding of increased mango orchard intensification methods and technologies, with goals to improve orchard efficiency, productivity and profitability and 2) Communicate, demonstrate and extend these latest findings and recommendations to support mango industry stakeholders to make informed decisions which improve their management practices. This strategy known as 'Farmer Participatory Research' harnesses the farmers practical experience and expertise, to improve the value of innovative technologies and improved practices, which then facilitates greater industry adoption.

The second day started with the breeding section with the keynote speaker Dr. Yuval Cohen from Israel talking about breeding mangoes for quality traits. The ideal fruit qualities in Israel includes a red or red on yellow external color, no fiber, sweet taste, gentle aroma, regular and symmetric shape, small stone, and around 500 – 600 g. To date no new mango cultivars has been released out of Isreal.

Dr Ian Bally presented on the breeding program in Australia, and they have just released 3 new, early season cultivars namely: ‘Yes!’, ‘Ah-ha!’ and ‘Now!’.

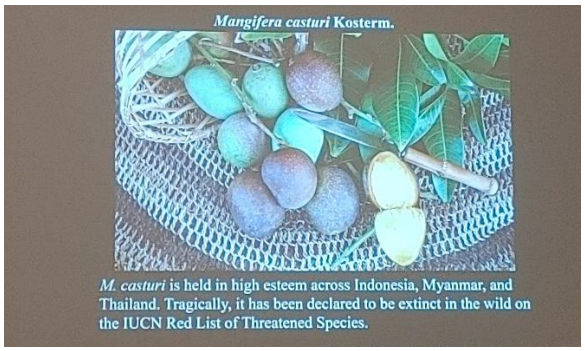


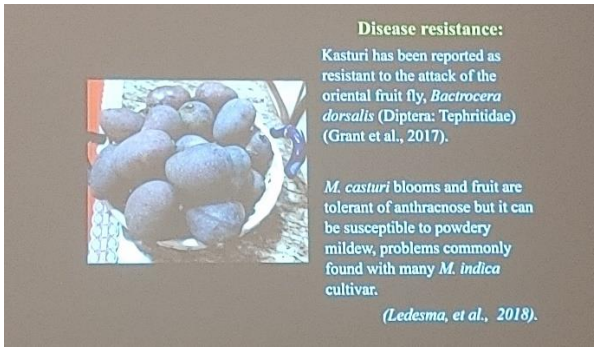


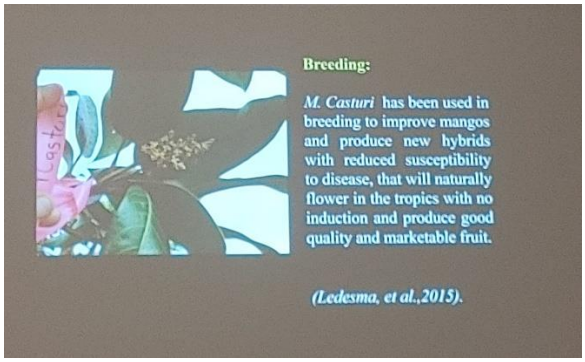


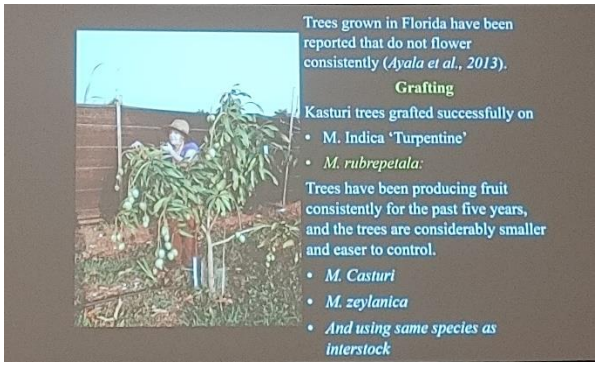
Sergio R. Marquez-Berber from Mexico talked about local mango cultivars with Ataulfo being the main cultivar planted since 2009, due to its greater acceptance in Mexico and for export because of its small size, rich flavour, and creamy texture. In 2021, it was cultivated in over 31% of the area with mango in Mexico. In recent years, there has been a growing trend towards organic and sustainable mango production in Mexico, as consumers and producers alike prioritize environmental and social responsibility.

The following sessions focused on germplasm and diversity with different *Mangifera* species being grafted and bred to hopefully develop superior cultivars with higher disease resistance as well as better colour and taste, this work was presented by Norris Ledesma.









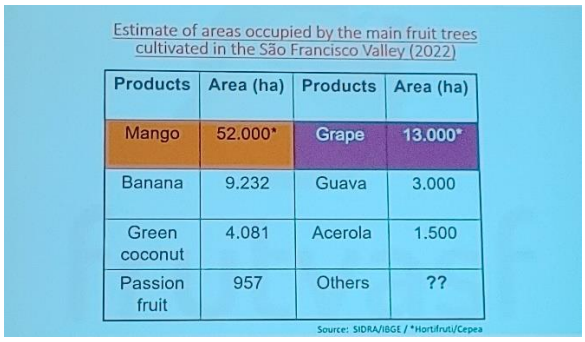
Genomics was also presented in this session focusing mainly on identifying key genes controlling certain preferred traits in mango fruit including flesh colour, sensory preferences, and the cause of polyembryony.

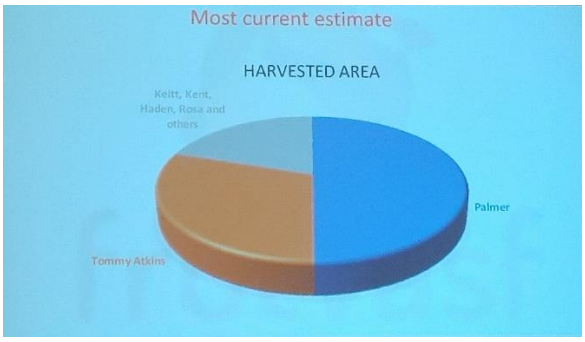
Stanley Freeman presented on mango malformation and the management of the disease. Conidia are the primary source of inoculum, dispersed from mature malformed panicles that disseminate passively in the air. Apical and lateral buds serve as the infection sites where conidia land, germinate and penetrate via host tissues. *F. Mangifera* interaction with mango tissue is mainly epiphytic. Mycelial growth occurs between protected buds and flower organs and usually does not survive in exposed organs. Specific interactions of mycelia with stamens, gynoecium and penetration into aborting carpels, allow survival of the pathogen on developing malformed panicles. Colonization and subsequent plant infection is not systemic as the pathogen was not detected within the vasculature between bud nodes, cannot infect roots or survive in soil. Due to the airborne nature of disease and local infection, a conceivable method for management suggests protection of buds from external conidia, disseminating from infected panicles. Fungicide dip-treatment of infected budwood reduced inoculum density but did not cure infected material. Timely application of selected fungicides (prochloraz) in infected orchards demonstrated that disease severity can be reduced under field conditions. Furthermore, sanitation by removal of infected panicles is paramount for reducing inoculum density.

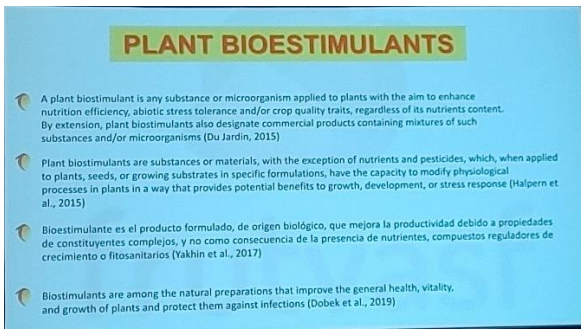
Miguel Barcelo-Anguiano presented on Anatomical differences in floral organs between diploids and autotetraploids of Kensington Pride mango. During the spring of 2021, self and cross hand pollinations were performed using mango trees belonging to diploid and autotetraploid genotypes of 'Kensington Pride'. Pollen tube growth in both ploidies was monitored *in vitro* and *in vivo* through fluorescent microscopy methods. Additionally, we evaluated the size of the vascular elements of the xylem and the phloem in the female gynoecium, comparing the style and the ovary tissues. Our results revealed that flowers from autotetraploid genotypes were generally larger than those from diploids. Pollen grains and pollen tubes from autotetraploids were also wider, and the pollen walls thicker. However, pollen tube arrival to the ovary was similar in self and cross pollinations between ploidies. The vascular elements of the xylem and the phloem were also larger in tetraploids, and both ploidies showed larger vascular elements in the pistil compared with the ovary, with much shorter elements. The general size increase related with ploidy is consistent in autotetraploid genotypes of mango. This gigas size effect was maintained in the pollen tubes, which putatively contain haploid and diploid sperm cells in pollen from diploids and tetraploids, respectively. The pistil of mango does not discriminate between genotypes that only differ in chromosome numbers, allowing the arrival of pollen tubes to the ovule and therefore hybridization between ploidies.

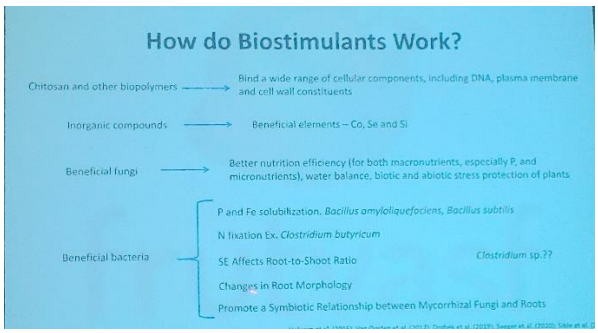
The last session included talks on harvesting, postharvest and stress, some interesting talks were given on the role of bio stimulants in fertilization of mangoes as well as advances in orchard irrigation technology and theory and its application in mango orchards.

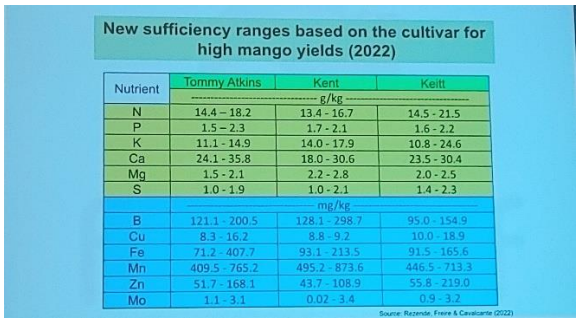
Italo Herbert Lucena Cavalcante presented on the role of bioestimulants in fertilization of mangoes. The presentation was in Spanish but here is a couple of slides from his presentation.

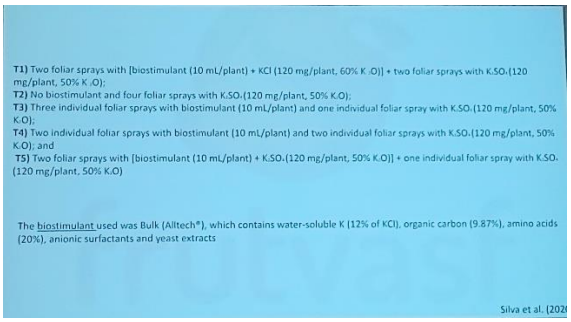


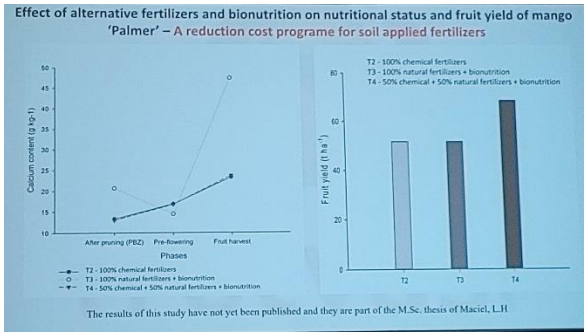












Poster session: The following posters were presented at the symposium.

Institute of Olive Tree, Subtropical Crops and Viticulture

ELGO - DEMETER
HELLENIC AGRICULTURAL ORGANIZATION- DEMETER

Can exogenous application of Zn, B, Ca and NAA on mango trees obstruct fruitlets' abscission?

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Introduction

Mango (*Mangifera indica* L.) is one of the most important fruit crops in the tropics and subtropics. Fruit drop is a yield-limiting factor for mango (Singh et al., 2005) and accounts for over 90 % loss of fruitlets (Wahdan and Melouk, 2004).

Many studies indicate foliar nutrient application of NAA (Roemer et al., 2011), Zn, Ca and B to be efficacious on fruit set, fruit drop, fruit retention and yield attributes (Tzatzani et al., 2022; Muengkaew et al., 2018; Patil et al., 2018; Dar, 2017; Karemera et al., 2013). Therefore, the study aims to evaluate the effectiveness of foliar application of calcium, zinc, boron and auxin on mango production.

Materials and methods

Kent, Tommy Atkins, Palmer and Irwin varieties were cultivated in a greenhouse in Western Crete. Solutions with 16 amino acids, in addition with Zn 0.2 %, B 0.125 %, Ca 0.4 % and NAA 0.005 % were applied through three treatments (Control, AMINO16-Zn-B, AMINO16-Zn-B-Ca-NAA). The solutions were sprayed onto trees at two stages, 1st just before flowering and the 2nd at the beginning of fruit setting.

Results

Mango flowering of trees cultivated in greenhouse in the North - Western Crete (Chania), begun in April and the first fruits were harvested ready-to-eat, at the end of July.

In Kent and Tommy Atkins varieties no statistical differences were observed in any of the parameters measured (Table 1 and 2, Figure 1). In Palmer variety, fruit weight was higher in AMINO16-Zn-B treatment (471.7 g), in comparison to the other two treatments (Figure 1). The other parameters did not differ statistically (Table 3). Irwin variety had a higher Initial fruit number per inflorescence in Control (9.3), than in AMINO solution treatments (Table 4). In addition, Fruit weight was higher than the Control when AMINO16-Zn-B was sprayed onto Irwin trees (563.3 g) (Figure 1). The rest of the parameters were not statistically different (Table 4,). At harvest, 35.6% (mean value of the three treatments) of fruits retained on Palmer mango trees, 34.65% on Kent, 27.8% on Tommy Atkins and 12.6% on Irwin. However, no significant differences were recorded among the treatments.

Discussion

Although there are reports that the foliar spray of NAA on mango trees produced significantly higher fruit yield per tree, our results indicated NAA application did not affect fruit number retained on trees. Only in Palmer variety, fruit weight was higher in AMINO16-Zn-B treatment, in comparison to the Control and the AMINO16-Zn-B-Ca-NAA treatments. In our experiment, fruit weight of Palmer and Irwin varieties increased when sprayed with AMINO16-Zn-B. Concerning leaf mineral content, several researchers included more than two spraying materials in combination, for better results. Consequently, additional research should be done to investigate whether higher quantities of macro- and micro-nutrient are more effective to obstruct fruitlets' abscission on Kent, Tommy Atkins, Palmer and Irwin mango trees.

Table 1. Kent mango variety results

Treatment	Initial fruit no./ inflorescence	Initial fruit no./ tree	Fruit retained %/ tree			Final fruit no./inflorescence	Final fruit retained %/tree
			15 days	30 days	45 days		
Control	3.6 a	11.7 a	59.9 a	39.9 a	30.0 a	1.0 a	29.9 a
AMINO16-Zn-B	2.9 a	8.0 a	38.5 a	25.0 a	25.0 a	1.0 a	25.0 a
AMINO16-Zn-B-Ca-NAA	3.4 a	10.8 a	44.8 a	38.5 a	21.1 a	1.3 a	21.1 a

Table 2. Tommy Atkins mango variety results

Treatment	Initial fruit no./ inflorescence	Initial fruit no./tree	Fruit retained %/ tree			Final fruit no./ inflorescence	Final fruit retained %/tree
			15 days	30 days	45 days		
Control	6.0 a	30.5 a	54.7 a	25.1 a	36.9 a	1.7 a	28.3 a
AMINO16-Zn-B	5.1 a	21.5 a	49.8 a	21.1 a	19.9 a	1.3 a	10.0 a
AMINO16-Zn-B-Ca-NAA	5.3 a	15.8 a	46.2 a	29.4 a	24.2 a	1.3 a	24.2 a

Table 3. Palmer mango variety results

Treatment	Initial fruit no./ inflorescence	Initial fruit no./tree	Fruit retained %/ tree			Final fruit no./ inflorescence	Final fruit retained %/tree
			15 days	30 days	45 days		
Control	4.9 a	22.6 a	40.1 a	36.8 a	34.9 a	1.6 a	34.9 a
AMINO16-Zn-B	5.9 a	22.9 a	74.0 a	59.6 a	57.5 a	1.7 a	57.5 a
AMINO16-Zn-B-Ca-NAA	3.6 a	23.2 a	43.1 a	32.7 a	32.7 a	1.3 a	32.7 a

Table 4. Irwin mango variety results

Treatment	Initial fruit no./ inflorescence	Initial fruit no./tree	Fruit retained %/ tree			Final fruit no./inflorescence	Final fruit retained %/tree
			15 days	30 days	45 days		
Control	9.3 a	27.8 a	31.2 a	17.3 a	16.6 a	1.5 a	16.4 a
AMINO16-Zn-B	**7.9 b**	13.3 a	72.4 a	29.1 a	29.1 a	1.3 a	29.1 a
AMINO16-Zn-B-Ca-NAA	6.6 b	17.9 a	30.6 a	11.4 a	11.4 a	1.5 a	11.4 a

(a) Mean values for each measured parameter; they are not significantly different in the case of the same letter (P < 0.05; Duncan test); se: standard error.
(b) GLM model. Values of F: * P < 0.05; ** P < 0.01; *** P < 0.001; NS: no significant differences

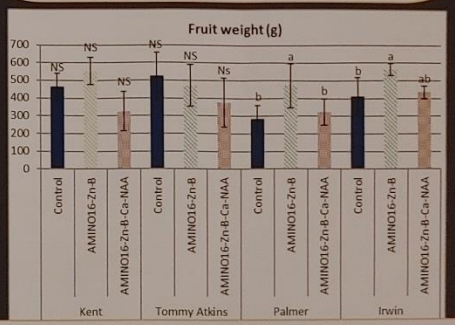

Figure 1. Effect of amino acids, Zn, B, Ca and NAA on mango Fruit weight, at harvest. Three treatments (Control, AMINO16-Zn-B and AMINO16-Zn-B-Ca-NAA) were applied on Kent, Tommy Atkins, Palmer and Irwin mango varieties.
(a) Mean values of the three treatments having the same letter in each variety, are not significantly different (P < 0.05; Duncan test); se: standard error.
(b) GLM model. Values of F: * P < 0.05; ** P < 0.01; *** P < 0.001; NS: no significant differences.

Flowering and Yield with Alternative Gibberellin Inhibitors to Paclobutrazol in `Tommy Atkins` mango

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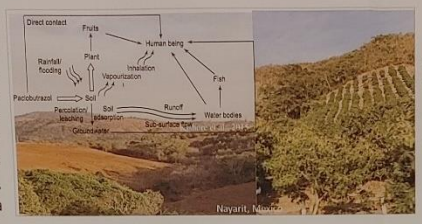
Introducción

`Tommy Atkins` es el segundo cultivar mas importante en Nayarit, pero tiene floración irregular en otoños cálidos y húmedos que afectan su rendimiento hasta en un 50% (1,3). PBZ se ha usado para mitigar este problema, sin embargo, el continuo uso de este producto podría tener un riesgo potencial para la salud humana (2)



Nuestro objetivo fue evaluar otros inhibidores de giberelinas diferentes a PBZ, sin afectar sin afectar floración y rendimiento,

Materiales y Métodos

Huerto comercial `Tommy Atkins`/criollo regional

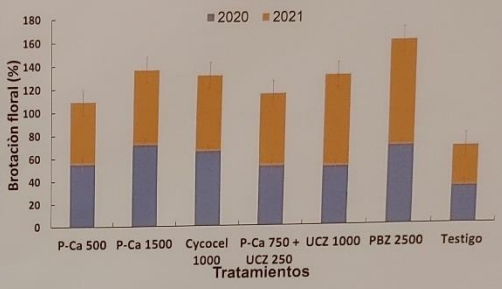
Tratamientos
-P-Ca 500 3X
-P-Ca 1500 1X
-Cycocel 1000, 3X
-UCZ 1000, 3X
-P-Ca 750+UCZ 250, 3X
-PBZ 2500, 1X
-Testigo
Dosis en mg L-1
P-CA proexdadiona de calcio
UCZ: uniconzasol
PBZ: paclobutrazol

Ciclos
2019-2020 (Año 1)
2021-2022 (Año 2)

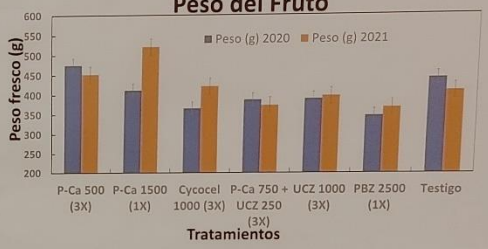
Variables
-Estado de diferenciaciòn (EDY)
-% de yemas diferenciadas(YD)
-% de brotaciòn floral
-Peso fresco del fruto
-Rendimiento

Diseño Experimental
Completamente al azar
6 repeticiones
1 árbol unidad experimental

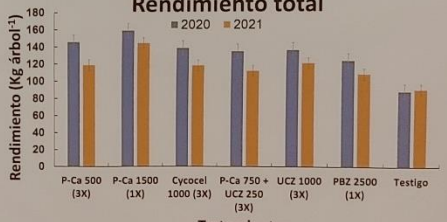
Brotaciòn Floral



Peso del Fruto

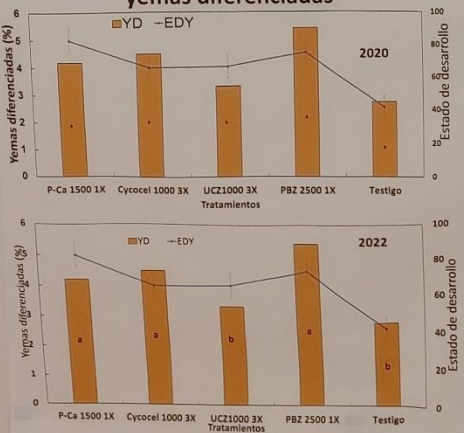


Rendimiento total



Resultados

Estado de diferenciación de la yemas y yemas diferenciadas



El procentaje de yemas diferenciadas difirió entre años, pero el porcentaje de brotaciòn floral en todos los tratamientos con inhibidores de GAs fue mayor comparado con el testigo.

El peso fresco del fruto fue mayor en los tratamientos con P-Ca y se observò un aumento en el rendimiento final.

Conclusiones

Los resultados indican que P-Ca podría ser un substituto de PBZ

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Agradecimientos

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Flowering and harvest modification with intensity and time pruning on mango 'Ataulfo' in Nayarit, México

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INTRODUCTION

'Ataulfo' is the most important in Mexico 63,000 ha.

Irregular flowering or harvest concentration, low prices.

Pruning can affect flowering and yield depending on time and severity (Davenport, 2006).

Tool for flowering modification, with nitrates or PBZ, advance and increase in flowering and production (Srilatha y Reddy, 2015).

To evaluate the effect of time and intensity pruning on flowering, harvest, yield and fruit size.

MATERIALS AND METHODS

Comercial 'Ataulfo' orchard
- Nayarit, Mexico: 2019-2020 and 2020-2021
- Treatments
- Three seasons and two pruning intensities

Early, medium and late.
- Light (50 cm) severe (75 cm)
- Control
- Design Completely random
- Factorial 3x2

Seven treatments
Six repetitions
One tree = experimental unit.
Variables
%, flowering and harvest time.
Yield and fruit weight.

RESULTS AND DISCUSSION

In the first year, early-light, severe and no pruning excels in flowering. Similar results were obtained in the second year. Late pruning in its two intensities reduced the flowering percentage in both years and in delayed it.

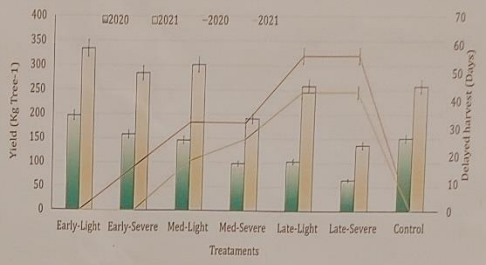
Effect in percentage and flowering time

Treatment	Flowering (%)		Delay (days)[z]	
	2020	2021	2020	2021
Early-light	70 a	94 a	10 c	14 b
Early-severe	60 a	91 a	13 c	18 ab
Medium-light	57 ab	85 a	34 b	21 a
Medium-severe	47 b	58 b	31 b	29 a
Late-light	29 c	59 b	52 a	29 a
Late-severe	15 c	19 c	55 a	29 a
No pruning	71 a	99 a	0 c	0 c

[z] Flowering delay compared to control.[y] Averages with the same letter are not significatively different. Tukey P ≤ 0.05.

Yield fluctuated between 64 and 196 kg tree-1 in the first year, treatments with early pruning with its two intensities and medium-light pruning stand out. Second year varied between 137 and 333 kg, highlighting the same treatments. Lower yield was observed with medium and late pruning at severe intensity.

The later and more severe the pruning there is lower yield and a harvest delay of 30 to 50 days. These leads to a higher productivity and better price on the product.

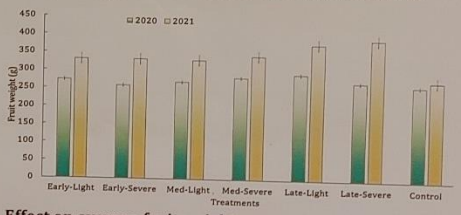


Effect on yield and harvest time

Harvest time, product price and profitability

Treatments	Harvest time	Price kg^{-1} ($)	Price tree^{-1} ($)
Early-light	May 30th	3.2	631.5
Early-severe	June 15th	3.2	508.5
Medium-light	June 30th	5.4	780.0
Medium-severe	June 30th	5.4	525.0
Late-light	July 30th	8.9	918.8
Late-severe	July 30th	8.9	575.0
No pruning	May 30th	3.2	484.7

Late pruning produced heavier and healthier fruits.



Effect on average fruit weight

CONCLUSIONS

Early pruning does not affect flowering or production, but medium-light and late-light pruning make the crop more profitable.

ACKNOWLEDGMENTS

The authors thank the National Mango Board for funding the project 'Irregular flowering and gibberellin inhibitors in mango' of which these results are part.

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Srilatha, V., Y.T.N. Reddy. 2015. Pruning and Paclobutrazol Induced Flowering and Changes in Phenols and Flavonoids of Mango (Mangifera indica L.) cv. Raspuri. Journal of Engineering Computers & Applied Sciences 4: 43-47

Production increase of pollinated fruits with boron and calcium application on mango 'Ataulfo' in Nayarit, México

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INTRODUCTION

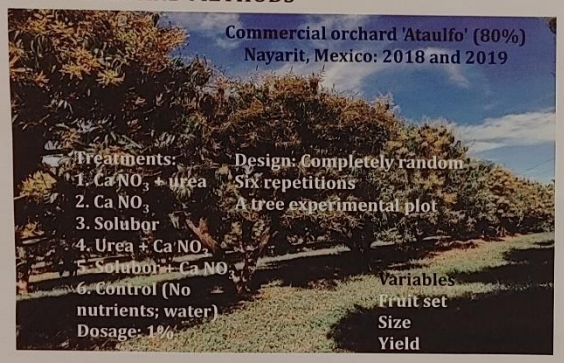
'Ataulfo' mango, most important in Mexico 63,000 ha. Seedless fruits (15 – 80%), small size and less nutrients.

Lack of seed: extreme temperatures (<15% and >33°C), embryo abortion or low pollination (Pérez et al., 2019; Patel-Gaurang et al., 2015).

Nutrition has not been investigated, calcium and boron improved flower quality) (Dar, 2017).

Production increase of fruits with seed in 'Ataulfo' cultivar, improving pollination and fertilization.

MATERIALS AND METHODS



RESULTS AND DISCUSSION

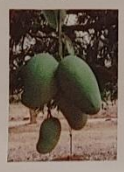
In the first year, the initial set was increased up to 47% with nitrogen + boron or with boron + calcium. In the second one, an increase of 32% was observed with boron + calcium.

Effect on number of fruits with seed per inflorescence (FS) and stenopermocarpic (ST) at 45 DPA

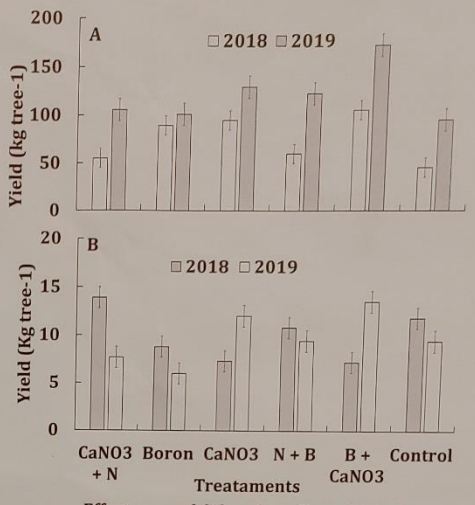
Treatment[z]	2018		2019	
	FS	ST	FS	ST
Calcium + Nitrogen	2.2 ab[y]	4.7 ab	4.5 a	5.3 ab
Boron	1.9 ab	3.6 b	4.0 a	4.5 b
Calcium	2.2 ab	5.1 a	3.8 ab	7.5 ab
Nitrogen + Boron	2.5 a	5.0 a	2.7 b	8.2 a
Boron + Calcium	2.4 a	5.7 a	5.3 a	6.6 a b
Control	1.7 b	3.1 b	4.0 a	6.0 a b
MSD[x]	0.7	1.39	2.7	3.9

[z]Nutrient dosage 1% each. [y]Averages with the same letters are not statistically different. (Tukey, 0.05). [x]MSD: Minimum significative difference.

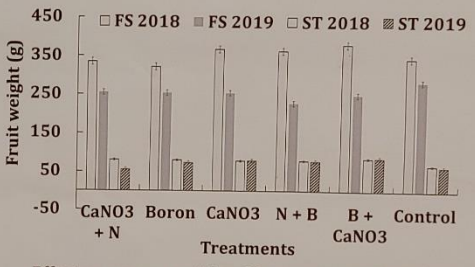
It was possible to increase the fruits with seed production (kg tree-1) with most treatments, but with boron + calcium the increase was of 83-133% in 2019 and 2018, respectively.



With boron or boron + calcium, the average fruit weight was increased surpassing control. Initial and final set of fruits with seed increased the number of fruits and the yield per tree. Boron + calcium was the best treatment.



Effect on seed (A) and seedless (B) fruit production.



Effect on average weight of fruit with seed (FS) and stenospermocarpy (ST)

CONCLUSIONS

Boron + calcium increase yield and size of fruit with seed and contribute to improve economic benefit of the producer by marketing fruits of grater commercial value.

ACKNOWLEDGMENTS

The authors thank the National Mango Board for funding the project 'Parthenocarpy in 'Ataulfo' mango of which these results are part.

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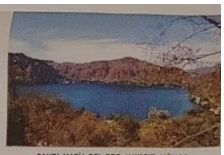

SANTA MARÍA DEL ORO, NAYARIT, MÉXICO

Non-destructive techniques to determine optimal harvesting time in mango fruit

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RESUMEN

El objetivo fue construir y validar un modelo para predecir de manera no destructiva la madurez óptima de cosecha de las principales variedades de mango para exportación. El modelo se construyó usando la aplicación artificial neural network y se validó durante 2020 y 2021 en huertos comerciales. El modelo fue promisorio ya que presentó una R^2 = 0.8487 y un RMSE = 0.9059. Los resultados de validación indicaron que el modelo fue aceptable y confirmaron que el F-751® es una herramienta viable para determinar el contenido de materia seca de cualquiera de las variedades, aunque se detectaron diferencias varietales. 'Ataulfo' mostró el mejor ajuste del modelo de predicción, en tanto que 'Keitt' tuvo el peor.

INTRODUCTION

The quality at consumption of mango fruit depends mainly on the ripeness at harvest. The development of pulp color is a good indicator of fruit maturity, however, the percentage DM has recently been used as a more precise indicator (Saranwong et al., 2004), since it is highly correlated with the final concentration of total soluble solids reached by a fruit ready for consumption. Moreover, the DM content can be determined quickly by microwave oven (Brecht et al., 2020) or by a non-destructive NIR method using a spectrometer (Walsh and Subedi, 2016). Thus, the objectives of this work were to build and validate a model to predict the DM content of main mango exporting varieties in Mexico.

MATERIALS AND METHODS

Building the model

During 2019, five groups of 40 fruit each (from unripe green to ripe and color break) were harvested from 'Tommy Atkins', 'Ataulfo', 'Kent' and 'Keitt' varieties. The 200 fruit were scanned in both cheeks (sides) with an F-750® spectrometer to obtain the DM values. The reference values were attained by a forced air oven at 60 °C for 72 h. The model was built by means of the artificial neural network application using the second derivative of calculated absorbance from diffuse reflectance in the NIR spectra from 684 to 990 nm.

Figure 1. Harvest maturity categories for 'Tommy Atkins' and fruit scanning.

Model validation

Validation was performed during 2020 and 2021 in two commercial orchards of each variety, located in Nayarit and Sinaloa states, Mexico. In each orchard, six trees were chosen, tagging 40 panicles/tree at full blooming. After 50 days, when fruit were ~5 cm length, they were individually tagged for DM determination before harvest and at two ripening stages at harvest: a) green ripe and b) fully ripe. DM was measured non-destructively using an F-751® spectrometer. For destructive samples at harvest, DM was measured with a forced air oven by drying the samples at 60 °C for 72 h. Fruit were harvested when reached 1600 Accumulated Heat Units (AHU) [green ripe] and 1750 AHU (fully ripe) for 'Ataulfo' and 'Tommy Atkins'; 1800 and 1950 AHU for 'Kent' and 2200 and 2400 for 'Keitt' (Osuna-García, 2020). DM values obtained non-destructively with the F-751® were compared against those got by the oven. Correlations between both values were run.

RESULTS AND DISCUSSION

Building the model

The performance of the model was promising since it presented an R^2 = 0.9097 and RMSE = 0.8389 for Brix (Figure 2), as well as, an R^2 = 0.8487 and RMSE = 0.9059 for DM (Figure 3). Even though the initial parameters were better for total soluble solids, the predictability of DM was higher and more consistent. So, it was decided to use only the DM content as a criterion for predicting ripening stage at harvest of the main four exporting mango varieties in Mexico.

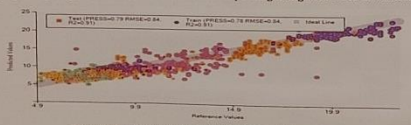


Figure 2. Performance for total soluble solids model.

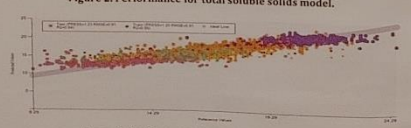
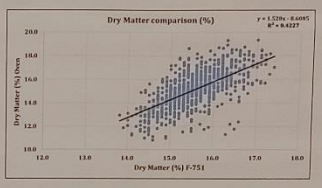


Figure 3. Performance for the dry matter model.

Model validation

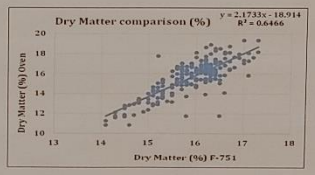
The comparison of DM content measured nondestructively with the F-751® versus the conventional oven showed that, in the general model, considering the four varieties and the two ripening degrees, a very acceptable DM average value of 15.6% was found for the spectrometer, while that obtained through traditional waving was 15.2% with an R^2 = 0.4227 (Figure 4). These results indicated the adjustments made to the model were acceptable and confirmed that the F-751® is a viable tool to determine nondestructively fruit DM content of any of the four varieties using the model generated by the artificial neural networks methodology.



Dry Matter (%)	F-751	Oven
Max	17.4	19.3
Min	13.8	10.8
Average	15.6	15.2
StanDev	0.7	1.6

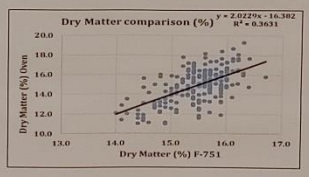
Figure 4. Prediction for the full Model considering the four varieties at both harvesting stages.

Varietal effects were detected. 'Ataulfo' showed the best fit of the prediction model with average values for the F-751® of 15.9% while for the oven were 15.6% with an R^2 = 0.6466 (Figure 5), while 'Keitt' had the worst with an average DM value of 15.5% for the F-751® and 14.9% for the oven with an R^2 = 0.3631 (Figure 6). In summary, the adjustments made to the model and spectrometer were effective, since they were able to predict acceptably the fruit DM content for all varieties with only 0.3 to 0.6 percentage points difference compared to the traditional microwave oven method.



Dry Matter (%)	F-751	Oven
Max	17.3	19.3
Min	14.1	10.8
Average	15.9	15.6
StanDev	0.6	1.8

Figure 5. Prediction of the Model for 'Ataulfo' at both harvesting stages.



Dry Matter (%)	F-751	Oven
Max	16.7	19.3
Min	14.0	11.0
Average	15.5	14.9
StanDev	0.5	1.7

Figure 6. Prediction of the Model for 'Keitt' at both harvesting stages.

CONCLUSIONS

The model to predict DM content of main export mango varieties in Mexico was successfully built and validated. Results indicated the feasibility of the F-751® to determine non-destructively the DM content of any of the mango varieties; although differences were detected among them. 'Ataulfo' showed the best fit of the prediction model, while 'Keitt' had the worst.

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FELIX APPLIED FOOD SCIENCE

A field trip was organised on the last day of the symposium. Firstly, Trops was visited. Trops is a producers organisation specialising in the production and marketing of mangoes and avocados, currently comprising more than 3000 associated farmers, representing 55% of the mango sector in Spain.

Trops packhouse and offices

The delegates also visited the IHSM: Subtropical and Mediterranean Hortofruticulture Institute ‘’La Mayora’’ where the first mango trees in Spain were planted in 1978. At present the outdoor mango variety plot contains the varieties Irwin, Keitt, Kent, Sensation, and Ataulfo all grafted onto the rootstock Gomera. Unfortunately, only ‘Keitt’ fruit was still on the trees due to the severe heat wave in Europe in their summer causing their season to be as much as 4-5 weeks earlier than usual.

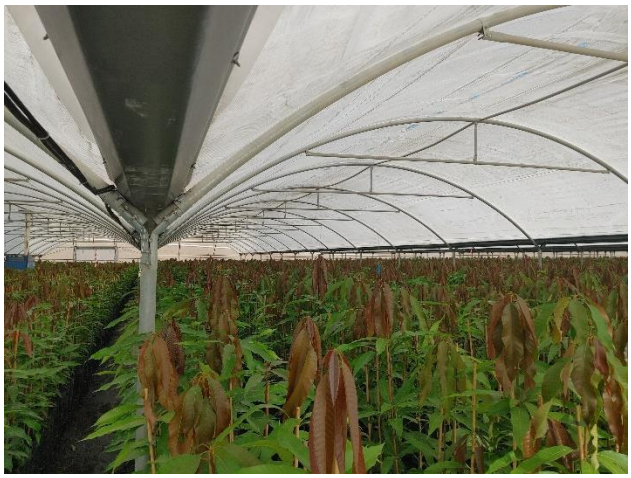
‘Keitt’ orchard

Ripe ‘Keitt’ fruit on the tree

In the surrounding areas (farms) mangoes are mostly planted on the severe slopes making use of terraces with the flatter better soils being utilized for avocado production.

Mangoes planted on terraces.

Mango and Avocado Nursery – Southern Spain



Mangoes planted on trellises with a roof closed in winter months.

Fairwell Dinner – Larios Malaga

I would like to thank the organisers in Spain for hosting a very enjoyable and professional international symposium, and to SAMGA for giving me the opportunity to attend and build up valuable contacts with people involved in mango production and research all over the world. The next international symposium will be hosted by Mexico in 2025.