



XXX. INTERNATIONAL HORTICULTURAL CONGRESS

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**VII International Symposium on Tropical
and Subtropical Fruits**

**II International Symposium on Jackfruit
and other Moraceae**

I International Symposium on Avocado

II International Symposium on Date Palm

ABSTRACTS

Conveners – Editors:

Prof. Dr. Sisir Kumar Mitra

Prof. Dr. Mustafa Akbulut

Dr. Hannah Jaenicke

Dr. Yuval Cohen

Dr. Hatice İkten



ORAL PRESENTATIONS

II International Symposium on Jackfruit and other Moraceae

Number	Title	Authors
1	Genetic resources of jackfruit in the world (Keynote 1)	Prof. Sisir Kumar Mitra
2	Metabolite profiling of <i>Artocarpus nankadak</i> using GC-MS and LC-MS	Dr. Deden Derajat Matra
3	Influence of pre-treatments and packaging on quality and shelf life fresh cut jack fruit bulbs	Dr. K.R. Vasudeva

VII international Symposium on Tropical and Subtropical Fruits

Number	Title	Authors
4	Challenges in Growing Citrus, Mango, Litchi, Avocado or Macadamia at Ultra High Density (Keynote 1)	Dr. Steven A. Oosthuysen
5	Tropical fruit genomes and postharvest technologies (Keynote 2)	Prof. Robert E. Paull
6	Effect of nutritional deficiencies and excesses of some nutrients on the physiological behavior of avocado plants (<i>Persea americana</i> , cv Hass)	Prof. Diego Miranda Lasprilla
7	Integrated effects of organic and inorganic fertilizer on growth and yield of papaya (<i>Carica papaya</i> L)	Dr. Sunday O. Solomon Akinyemi
8	Development of an organic small-scale pineapple production system in Chapada Diamantina, Bahia, Brazil. 2. From post-planting to harvest	Dr. Domingo Haroldo Reinhardt
9	A systematic approach for identifying promising leads to contribute to a solution for citrus greening	Dr. Jean Broadbent
10	Effect of Winter Lowest Temperature on Vine Growth, Flowering, Fruit Growth and Chlorophyll Fluorescence of Passion Fruit (<i>Passiflora edulis</i> Sims var. <i>edulis</i>)	Dr. Chan Kyu Lim
11	Superiority of root-sucker over hedge as stock plant in cutting propagation of persimmon (<i>Diospyros kaki</i>)	Prof. Takuya Tetsumura
12	Evaluation of morphological diversity of tamarind (<i>Tamarindus indica</i>) accessions from Eastern parts of Kenya	Ms. Mercy Kidaha
13	Unravelling the genomics of sucrose-associated sweetness in papaya	Ms. Usana Nantawan
14	RNA sequencing reveals Identification of differentially expressed genes in gamboge disorder of mangosteen	Dr. Deden Derajat Matra
15	Seed set in crosses between tetraploid and diploid plantain-banana hybrids	Dr. Josephine Udunma Agogbua
16	Mango in India: Technological Development	Prof. Dr. Sisir Kumar Mitra
17	Ambient temperature affects bud emergence and development in white pitaya (<i>Hylocereus undatus</i>) under inductive long-day photoperiod conditions	Ms. Yu-Chun Chu
18	Exploring the state of annona (<i>Annona</i> sp.) cultivation in Lebanon through surveys targeting local nurseries and farmers	Fatima Yassine
19	Evaluation of the functional potential of a microencapsulation of asai (<i>Euterpe precatoria</i>) and copoazú (<i>Theobroma grandiflorum</i>) in healthy volunteers	Prof. Maria Soledad Hernandez
20	Effects of cytokinin on female flower formation in litchi	Mr. Yutaro Osako
21	Periodic pruning in guava (<i>Psidium guajava</i> L.) and consequential impact assessment on phenological phases using modified BBCH scale	Dr. Karan Bir Singh Gill
23	Effect of different pre-harvest treatments on postharvest storage quality of 'Kutdiken' lemons	Prof. Okan Özkaya
24	The physiological disorder of purple spot in loquat fruit: a molecular and physiological approach	Prof. George Manganaris
25	Breeding, research and development of purple-fruited pitanga (<i>Eugenia uniflora</i> L.) as a commercial crop in Hawaii USA, 2007 to 2017	Dr. John L Griffis
26	Response of 'Pink solo' papaya to organic fertilizer in southwest Nigeria	Prof. Isaac Ore Aiyelaagbe
27	Understanding causes of Resin Canal Disorder in Australian mango	Mr. Umar Muhammad



	industry	
28	Bayer forward farming	Mr. Albert Schirring
29	How pre-harvest applications of Nitrogen fertiliser affect branching and flowering in mango (<i>Mangifera indica</i>)	Dr. Ian Bally
30	Impact of temperature on axillary bud development in mango cv. 'Honey Gold' and 'Calypso (B74)' in subtropical climate	Dr. Ali Sarkhosh
31	Growth and development of Moriche fruit in Guaviare- Colombia	Mr. Jaime Barrera
32	Detection and distribution of Banana bunchy top virus (BBTV) in banana-producing regions of South Africa	Ms. Sinethemba Ximba
33	Physiological responses of nine mango cultivars seedlings inoculated with <i>Ceratocystis fimbriata</i>	Dr. Rashid Al-Yahyai
34	Effect of mulches on soil moisture, temperature, weed suppression and estimation of cost benefit ratio of grape (<i>Vitis vinifera</i> L.) Cv. Kishmish rozavis white in northern dry zone of Karnataka	Prof. Dilipraj R Patil
35	Superfruits and human health	Prof. Julian Heyes
36	The Avocado: Guatemalan food	Dr. Noris Ledesma
37	Berries and Human Health	Prof. Sisir Kumar Mitra
38	Pruning mistakes and suggestions in tea orchards in Turkey	Prof. Mustafa Akbulut
39	A trial to enhance cold tolerance of passion fruit (<i>Passiflora edulis</i>) crop in Lebanon through foliar application of the natural osmoprotectant Glycine betaine	Layal Khalil
40	Comparison between growth and production of self-grafted and cross-grafted annona species in coastal region of South Lebanon	Fatima el Omar
41	Creasing in sweet orange: Role of cobalt sulfate	Dr. Zahoor Hussain
42	Study of Erythromycin and Copper Sulfate effects in controlling Witches' Broom Disease of Lime (WBDL)	Dr. Shadab Famarazi



I International Symposium on Avocado

Number	Title	Authors
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2	Avocado Ripening: "What not to do, what to do and what if?" (Keynote 2)	Dr. Mary Lu Arpaia (Invited Lecture)
3	Understanding pollination processes in avocado (<i>Persea americana</i>) orchards (Keynote 3)	Dr. David Pattemore (Invited Lecture)
4	The introduction of West Indian Avocados to South Florida, USA	Dr. Noris Ledesma
5	Applying non-host criteria and fruit fly population models to obtain market Access for West Australian avocados	Dr. Francis De Lima
6	Distribution, detection and management strategies for Avocado Sunblotch Disease (ASBV) in South Africa	Dr. Elize Jooste
7	Polyphagous shotholeborer-Fusarium dieback, a new pest-disease complex threatening avocado and urban forest in California	Dr. Akif Eskalen
8	Thyme oil low-density polyethylene impregnated pellets in polylacticacidsachets improves postharvest quality of ready-to-eat avocado	Prof. Dharini Sivakumar
9	Comparison of physico-chemical quality of avocado fruit (<i>Persea americana</i> mill) cv. Hass produced in Colombia with international quality standards	Jorge L. Sandoval
10	A conundrum of Avocado 'Hass' fruit skin color change: The South African perspective	Dr. Nhlanhla Mathaba
11	Transcriptomics of adventitious rooting potential in avocado propagation	Ms. Madeleine Gleeson
12	Effect of paclobutrazol or potassium nitrate sprayed during the period of inflorescence development and shortly thereafter on fruit retention, size and yield in Maluma Hass avocado	Dr. Steven A. Oosthuysen
13	Breaking the glass ceiling of avocado yields: accounting for the periodic demand for water and nutrients	Dr. Ayner Silber
14	Micropropagation; efficient alternative for clonal propagation of avocado (<i>Persea americana</i> Mill.)	Ms. Jayeni Hiti Bandaralage
15	Adventitious rooting in avocado - unravelling the bottle neck to propagation	Ms. Madeleine Gleeson
16	Avocado innovation in Mexico's Central Highlands	Prof. Sergio Marquez-Berber

II International Symposium on Date Palm

Number	Title	Authors
1	Fertilization and fruit setting in date palms	Dr. Yuval Cohen
2	Irrigation water management in date palm (<i>Phoenix dactylifera</i> L) under arid environment	Dr. Narayana Bhat
3	Effect of potassium application on Deglet Noor date palm production and quality	Prof. Mehdi Ben Mimoun
4	Prediction of quality parameters non-destructively for Barhi dates at different stages of maturity utilizing near-infrared (NIR)	Dr. Abdullah Alhamdan
5	Tetraploid date palm	Prof. Stefaan Werbruggen
6	Development of molecular markers for application in sex determination of <i>Phoenix dactylifera</i> L	Mr. Nopparat Intha



7	Genetic characterization of date palm (<i>Phoenix dactylifera</i> L.) germplasm cultivated in Algeria	Dr. Aziz Akkak
8	Characterization and sensory analysis of some Tunisian date cultivars consumed at early maturity stage	Ms. Sarra Cherif
9	Recent Achievements on Date palm Micropropagation	Dr. Sudharsan Chellan
10	First field results with Sivanto Prime to control Date Palm Weevil	Mr. Mohamed Elsherif

POSTER PRESENTATIONS

Number	Title	Authors
1	Sustainable approach to Asian citrus Psyllid control using Movento and Sivanto insecticides	Mr. Rolf Christian Becker Mr. Albert Schirring
2	Fruit yield of 'Pera' sweet orange grafted onto citrandarins in Central region of São Paulo State, Brazil	Dr. André Luiz Fadel Dr. Mariângela Cristofani-Yaly Mr. Rafael Kupper Moretto Dr. Marcos Antonio Machado Ms. Maria Amélia R. Pereira Cardoso
3	Research on the effects of foliar urea applications on fruit set and yield in 'washington navel' oranges	Dr. Banu DAL Prof. Dr. Hamide GUBBUK
4	Research on Adaptation of Different Tropical Fruit Species to Antalya Conditions	Dr. Beyza Biner Prof. Dr. Hamide Gubbuk Dr. Banu Dal Dr. Isilay Yildirim
5	A robust set of standardised productivity and fruit quality trait measures for the Australian papaya industry	Dr. Chutchamas Kanchana-Udomkan Ms. Usana Nantawan Prof. Rod Drew Assoc. Prof. Rebecca Ford
6	Rujak Base; an multi-omics database for enhancing research on Indonesian fruits	Dr. Deden Derajat Matra Dr. Arya Widura Ritonga Dr. Winarso Drajad Widodo Prof. Sobir Ridwani Prof. Roedhy Poerwanto
7	Development of an organic small-scale pineapple production system in Chapada Diamantina, Bahia, Brazil. 1. From soil preparation to planting	Dr. Domingo Haroldo Reinhardt Dr. Túllio Pádua Dr. Aristoteles Matos Dr. Raul Rosa Dr. Zilton Cordeiro
8	Membrane phospholipids composition during softening process of 'Manila' mango (<i>Mangifera indica</i> L.)	Prof. Dulce M. Rivera Pastrana Dr. Dalia Vazquez-Celestino Prof. Miguel David Duffo-Hurtado Prof. Luis E. González de la Vara Prof. Ma Estela Vázquez-Barrios Prof. Edmundo Mercado-Silva
9	Carpeloidy in Pitaya Fruit	Tsu-Hsien Li Assist. Prof. Yi-Lu Jiang Assist. Prof. Pai-Tsang Chang
10	Biochemical Composition Of Some Pomegranate Cultivars and Genotypes Grown From Harran Region	Dr. Gökhan Akkus Assoc. Prof. Ferhad Muradoglu Ms. Sibel Akkus Binici
11	Investigation of Fatty Acid Compositions and Some Pomological Characteristics of Different Olive Cultivars during Maturation in Cool Subtropical Condition of Turkey	Mr. Mehmet Ali Gundogdu Prof. Dr. Kenan Kaynas
12	Physiological and biochemical characteristics of Diospyros kaki Thunb. under various culture conditions	Dr. Natalya Ivanova Dr. Oksana Grebennikova Dr. Anfisa Paliy



		Valentina Brailko Dr. Sergey Khokhlov Prof. Dr. Irina Mitrofanova
13	Growth and development of Asai (<i>Euterpe precatoria</i>) in Guaviare-Colombia. II. Chemical changes during ripening stages	Jaime Barrera Ms. Marcela Carrillo Ms. Juliana Cardona Ms. Luisa Peña Ms. Nubia Orjuela Ms. Lorena Garcia Ms. Sandra Castro Prof. Dr. Orlando Castro Ms. Bernardo Giraldo Prof. Dr. Maria Soledad Hernandez Gomez

14	Growth and development of Asai fruits in Guaviare, Colombia. I Morphological changes during maturity	Jaime Barrera Ms. Luisa Peña Ms. Nubia Orjuela Ms. Lorena Garcia Ms. Sandra Castro Prof. Dr. Orlando Martinez Mr. Bernardo Giraldo Prof. Dr. Maria Soledad Hernandez Gomez
15	Physical and chemical attributes of feijoa fruit in Veracruz, Mexico	Dr. Juan Guillermo Cruz-Castillo Diana Guerra-Ramirez
16	Winter Pineapple Can Be Cultivated and Harvested in One Year	Pei-Chin Sun Assist. Prof. Yi-Lu Jiang Assist. Prof. Pai-Tsang Chang
17	Morphological differences in vegetative and fruit characters among eight pepino (<i>Solanum muricatum</i> Ait.) cultivars in Japan	Assoc. Prof. Ken Takahata Hiroki Mizumura Prof. Dr. Hirosuke Shinohara Assist. Prof. Ok-Kyung Kim Assoc. Prof. Tadashi Ishikawa Assoc. Prof. Katsumasa Niwa Assoc. Prof. Hiroyuki Fujisawa Prof. Dr. Kotaro Tada Assist. Prof. Tomohiro Irisawa Assoc. Prof. Yuki Mitsui Youichi Kawaguchi Yoshinori Kiri Saori Kawabata Prof. Dr. Tadashi Baba
18	Comparison of Growth and Functional Components of Cacao (<i>Theobroma cacao</i>) in Jeju Island, Korea	Ms. Youngbin Jung Prof. Dr. Chan Kyu Lim Prof. Dr. Seong Cheol Kim Prof. Dr. Seung Yeob Song Prof. Dr. Chun Hwan Kim
19	Growth Characteristics Evaluation of Some Papaya Lines for production of green papaya in Korea	Dr. Seong Cheol Kim Mr. Chun Hwan Kim Ms. Yung-Bin Jung Dr. Chan-Kyu Lim Dr. Hyun Joo An Dr. Seung-Yeob Song
20	Comparison of Fruit and Growth characteristics of Mango cultivars cultivated under greenhouse conditions in Korea	Hyun Joo An Dr. Chan Kyu Lim Dr. Seong Cheol Kim Ms. Young Bin Jung
21	Effect of calcium treatment in improvement of freeze tolerance in 'Miyagawa' Satsuma mandarin (<i>Citrus unshiu</i> Marc. cv. Miyagawa)	Hye Jin Lee Cheol Woo Choi Hee Duk Oh Dr. Duk Jun Yu Jun Hyeong Park Dr. Young Eel Moon Dr. Young Hun Choi



		Prof. Dr. Hee Jae Lee
22	Overview of Subtropical Fruits in The Last Quarter Century in Turkey	Prof. Dr. Mustafa Akbulut Assist. Prof. Keziban Yazici Ms. Nalan BAKOGLU Ms. Burcu GOKSU
23	Reaction of sour-passion fruit genotypes to bacteriose under field conditions in Federal District, Brazil	Mara Cecília Ms. de Mattos Grisi Marina Ms. Silveira da Silva Mr. Yasser de Carvalho Libaino Mr. Gabriel Soares Miranda Prof. Dr. Michelle Souza Vilela Prof. Dr. Márcio de Carvalho Pires Prof. Dr. José Ricardo Peixoto

24	Reaction of sour-passion fruit genotypes to septoriose under field conditions in Federal District, Brazil	Ms. Mara Cecília de Mattos Grisi Ms. Marina Silveira da Silva Mr. Yasser de Carvalho Libaino Mr. Gabriel Soares Miranda Prof. Dr. Michelle Souza Vilela Prof. Dr. Márcio de Carvalho Pires Prof. Dr. José Ricardo Peixoto
25	Effect of foliar spray of NAA and paclobutrazol on vegetative growth of rambutan	Dr. Naoko Kozai Ms. Orwintinee Chusri Dr. Atsushi Shimada Mr. Tatsushi Ogata
26	Italy's contribution to kiwi fruit production: 47 years of experience in the Latina province	Dr. Ottavio Cacioppo
27	Investigation the Flowering Behavior of Citrus depressa Hayata in Taiwan	Chen-Hsi Wu Shu-Yen Lin
28	Effects of Ethrel on Flowering in 'Hey-Yeh' Litchi	Ms. Ting Wei Chiu Assist. Prof. Su Yen Lin Dr. Po An Chen
29	Effect of Coating Material on Quality of 'Manee-Esan' Pummelo Fruits During Storage	Dr. Rumpai Nampila
30	Investigation of bioactive molecules and antioxidant capacity of Iranian ornamental pomegranate cultivars (<i>Punica granatum</i> var. <i>pleniflora</i>)	Dr. Ali Sarkhosh Mr. Alimohammad Yavari
31	Optimising foliar nitrogen uptake of mango: Effect of adjuvant, leaf position and time of potassium nitrate spray	Dr. Constancio Asis Ms. Teagan Alexander Dr. Ali Sarkhosh Mr. Muhammad Umar Dr. Cameron McConchie
32	Determination of growth performance in fig cultivars applied gamma radiation in different dosages	Mr. Mesut Ozen Mr. Aytekin Belge Mr. Selim ARPACI Assoc. Prof. Ferit COBANOGLU
33	The effect of salinity on leaf chlorophyll content of satsuma mandarin onto Troyer citrange rootstock	Prof. Dr. Serra Hepaksoy
34	Influence of inorganic fertilizer on the early growth and nutrient concentration of Bush Mango (<i>Irvingia gabonensis</i>)	Dr. Sunday O. Solomon Akinyemi Dr. Adejare Adesope Mr. Joshua Matthew Mr. Goodness Adebo
35	Effect of moringa based edible coatings to enhance quality and shelflife of Papaya (<i>Carica papaya</i> L.)	Dr. Samson Tesfay Mr. SSL Mthembu Dr. Asanda Mditshwa Dr. Lembe Magwaza
36	Investigating the effect of moringa leaf extracts incorporation in edible coating on maintaining 'Marsh' grapefruit (<i>Citrus paradise</i> MacFad) quality and prolonging shelflife	Dr. Samson Tesfay Mr. Maphumulo MM Dr. Asanda Mditshwa Dr. Lembe Magwaza
37	The effects of mineral elements on the naringin production in citrus	Dr. Juan Xu Mr. Ziyu Yuan



		Mr. Jiajing Chen Mr. Yaoqiang Shi
38	Evaluation of Some Mango (<i>Mangifera indica</i> L.) Cultivars under Jordan Condition	Dr. Raid Lutfi Qusi Kaseb Ms. Majieda Thniebat Mr. Abed Almonim Jabari
39	Determining Pomological and Biocemical Futures of Some Pecan Nuts Varieties Which is Grown in Gap Region	Ms. Sibel Akkus Binici
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I International Symposium on Avocado

Number	Title	Authors
1	Native Pollinators of California Avocado as Affected by Introduced Pollinator Gardens	Ben Faber Gordon Frankie Rollin Coville Robbin Thorp Jaime Pawalek
2	In-situ assessment of harvest maturity of 'Hass' avocado (<i>Persea americana</i>) using portable Vis-NIR spectrometer	Dr. Lembe Samukelo Magwaza Mr. Khayelihle Ncama Dr. Samson Tesfay Dr. Asanda Mditshwa Dr. Nokwazi Mbili
3	De novo transcriptome of <i>Persea americana</i> cv. Hass provides insights on genes related to fatty acids during fruit development	Dr. Bruno Defilippi Bruzzone Cristian Vergadra-Pulgar Dr. Reinaldo Campos-Vargas Dr. Mauricio González-Agüero Dr. Claudio Meneses
4	Potential use of moringa leaf extract with edible coating to reduce the prochloraz application rate in postharvest avocado (<i>Persea americana</i> Mill.) fruit	Dr. Samson Tesfay Mr. Sbulelo Mwelase Mwelase Dr. Asanda Mditshwa Dr. Lembe Magwaza
5	The use of instant controlled pressure drop (DIC) method improves the extraction of bioactive compounds from 'Hass' avocado seed	Dr. Miguel David Dufoo-Hurtado Adriana E. Ms. Ibarra-Buenavista Dr. Edmundo M. Mercado-Silva Dr. Dalia Vázquez Celestino Dr. Ma. Estela Vázquez Barrios Dr. Dulce M. Rivera Pastrana
6	Preliminary assessment of maturity and picking dates of avocado under Lebanese growing conditions	Prof. Dr. Lamis Chalak Mr. Joe Merheb Ms. Georgette Lahoud Dr. Sandra Fahd Mr. Hussein Abou Yehia Mr. Issam Bou Rached Mr. Joseph Kahwaji Ms. Celine Berbari Ms. Ayat Ayoub Dr. Milad El Riachy Dr. Frank Obrien



7	Girdling as a tool to unravel the `Hass´ avocado skin color problem	Dr. Nhlanhla Mathaba Mr. Sakhile Mathe Dr. Samson Tesfay
8	Quantifying fruit shape in avocado: a better way forward	Mr. Eric Focht Dr. Rodrigo Iturrieta Mary Lu Arpaia
9	The effect of volatiles and edible coatings on postharvest Avocado (Persea americana Mill.) fruit quality	Dr. Samson Tesfay Dr. Lembe Magwaza Dr. Asanda Mditshwa Dr. Nokwazi Mbili Mbili Mr. Sabelo Shezi

II International Symposium on Date Palm

Number	Title	Authors
1	Biodiversity of medicinal and aromatic plants in modern and traditional date palm farms in Northern and Central Oman	Dr. Rashid Al-Yahyai Khalid Al-Hashmi
2	Isolation and Identification of Expressed Sequence Tags Related To Drought Tolerance In Date Palm	Dr. Mohammed Refdan Alhajhoj Al-Qahtani





30th International Horticultural Congress

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ORAL PRESENTATIONS





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II International Symposium on Jackfruit and other Moraceae

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II International Symposium on Jackfruit and other Moraceae

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KEYNOTE 1

GENETIC RESOURCES OF JACKFRUIT IN THE WORLD

Prof. Dr. Sisir Kumar Mitra

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Jackfruit (*Artocarpus heterophyllus* Lam.) trees are cross pollinated and are mostly propagated by seed. This caused a considerable range of variation in morpho-agronomic characters. A considerable variation between trees has been observed for traits such as growth habit, canopy structure, leaf size, fruit shape, size, colour, fruit bearing (age and seasonality) and maturity. Attempts were made to understand the extent of genetic diversity for morphological characters and select superior clones of jackfruit. Jackfruit germplasms of India, Malaysia, Sri Lanka, Thailand, Bangladesh, Indonesia, the Philippines, USA (Florida) and Vietnam were evaluated. During the last decade significant progress has been made in selection of superior clones or developing varieties in different jackfruit producing countries.

In India, the varieties/clones developed are PLR-1, PP1, Swarna, Konkan Prolific, Janagara, NSP, Byrachandra, Kachahalli, Kantanukuntae, PLR (J)-2, Muttam Varikka, Gum less Jack, Palur-1, Pechiparai-1, Singapore Jack, Velipala, Barlian-1, Sindoor, CHESHJF 1, CHESHJF 2, CHESHJF 3 etc. In Sri Lanka, the varieties developed are Father Long, Kothmale, Maharagama, Hirosa, Mandoor, AV Dias, Matara, Thelippalei, Champerdine, Kuruwita etc. The Malaysia jackfruit researchers developed J29, Mastura (J35), Mantin (J32), NS1 (J31) etc. The varieties Mit Nghe, Mit Dua, Mit To Nu and Mit Malai were developed at Vietnam. Jackfruit is the National fruit of Bangladesh. Several clones have been selected such as BAU Jackfruit1, Florida etc. In Myanmar varieties Talaing and Kala were reported to grow. Several named varieties like Golden Nugget, Black Gold, Honey Gold, Lemon Gold, Cheena, Chompa Gob, Galaxy, Nahen Kapa etc. were reported from Australia. The Philippines have varieties named J-01, J-02, TVC and Torres. Most of the Australian and Malaysian varieties are available in Florida. This paper reviewed the genetic resources of jackfruit available in the World.

Keywords: variety, clone, diversity, conservation



METABOLITE PROFILING OF ARTOCARPUS NANGKADAK USING GC-MS AND LC-MS

Mr. Hafidz Ramadhan Halim, Dr. Ahmad Junaedi, Dr. Arya Widura Ritonga, Dr. Aziz Natawijaya, Prof. Roedhy Poerwanto, Prof. - Sobir, Dr. Winarso Drajad Widodo, **Dr. Deden Derajat Matra**

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Artocarpus nangkadak is a species cross-hybridization between *Artocarpus heterophyllus* x *Artocarpus integer*. The nangkadak derivate from nangka dan cempedak, an Indonesia names for their progenitor. At the first time, nangkadak developed by G. Hambali, a researcher form Mekarsari Fruit Garden, Bogor, Indonesia. Now, some variants have been developed from self-crossing hybridization (F2). In this study, we examined three of nangkadak variants from their fleshy aril using gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-mass spectrometry (LCMS). The metabolic differences of fleshy aril of three Nangkadak variants were assessed. In this work, Crude extracts from fleshy aril were extracted with ethyl acetate at room temperature for 72 h. The concentrated extract was subjected to GC-MS and LC-MS. Using a combination of GC/LC-MS, at least 20 major components have been identified. Their compound includes ester and aliphatic alcohol groups as well as carotenoids as provitamin A detected. The identification of secondary metabolites warrants the utilization of GC/LC-MS for confirmation of their presence that could be used as taxonomic markers for these species. Therefore, the characterization of the secondary metabolites is one of the critical aspects of basic research and plant breeding.

Keywords: Carotenoid, Chromatography, Metabolomics, Secondary Metabolites, Tropical Fruit



EFFECT OF PRETREATMENT AND PACKAGING ON POSTHARVEST QUALITY AND SHELF LIFE OF MINIMALLY PROCESSED JACKFRUIT (*Artocarpus heterophyllus* L.) BULBS

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The effect of pre-treatment and different packaging to enhance the postharvest shelf-life of minimally processed jackfruit (*Artocarpus heterophyllus* L.) bulbs under refrigerated storage was investigated. The packages studied include low density polyethylene (LDPE) and high density polyethylene (HDPE) of 100 gauge, cling film, vacuum packaging, stand on pouches and shrink film. Jackfruit bulbs after separation from fruit were imposed a pre-treatment with CaCl₂ (1%) along with combination of ascorbic acid (0.25%) and packed in different packages. The physico-chemical and sensory attributes revealed that, pre-treatment and packaging was found to be most effective in maintaining ascorbic acid content and minimizing deteriorative changes in sensory attributes and minimum moisture loss. Based on sensory evaluation it was inferred that pretreated and vacuum packing of bulbs resulted in maximum shelf life (33 days) whereas, lowest shelf life was observed in bulbs packed with shrink film (17.67 days).

Keywords: Jackfruit, modified atmosphere packaging, bulb quality, shelf life





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ORAL PRESENTATIONS



IHC2018-Symposium 5

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ORAL PRESENTATIONS

KEYNOTE 1

CHALLENGES IN GROWING CITRUS, MANGO, LITCHI, AVOCADO OR MACADAMIA AT ULTRA HIGH DENSITY

S.A. Oosthuysen

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Trees spaced at (between row - in row) 4 x 1.5 m, 5 x 1.5 m and 6 x 2 m, may be as considered high density spacings. The spacing of 3 x 1 m or closer are regarded to ultra high density spacings. Tree filling their allotted space at such spacings, are “small,” being such that canopy manipulations, fruit treatments and harvest can be carried with ease and without the use of elevation equipment, such as ladders. Procedures such as canopy size containment or selective branch pruning can be carried out accurately and quickly. Fruit protection measures, such as bagging, are economically feasible, this not being so for trees whose canopies are not in easy reach by workers. Increased efficiency of spraying and of carrying out tasks ensuring enterprise success can be achieved. Tree productivity during the early years is elevated, this reducing economic risk and the investment payback period. Difficulty of maintaining sustained “high” productivity of ultra high density orchards has been proclaimed, however.

Success in maintaining the productively level attained of citrus, mango, macadamia, avocado, or litchi trees planting at ultra high density relates directly to maintaining a high intensity of flowering once canopy containment pruning is initiated. There is the requirement of adhering to specific pruning measures as specific times during the phenological cycle, and in some instances application of growth regulators at specific times and rates. Truly dwarfing rootstocks are not generally available or are absent. The current paper elicits the basis for succeeding in growing the crops in question at ultra high density. Root system size, growing conditions, farmer capability, and reproductive habit are deliberated.

Keywords: Canopy size maintenance, root size maintenance, flowering intensity, growth retardant, flowering structures, flower induction, inflorescence development



KEYNOTE 2

TROPICAL FRUIT GENOMES AND POSTHARVEST TECHNOLOGIES

Robert E. Paull, Nancy J. Chen

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The number of fruits that have had their genomes sequenced stands at least at 12, with Durian genome being published in 2017. The cost of sequencing has decreased dramatically in the last ten years though the quality of the genome assemblies in absence of linkage maps is a limitation. Following from the gene predictions made from these assembled genomes has been gene expression profiles (transcriptomes) from some fruit development stages and ripening. Network analysis can be done on the expression profiles to determine control points in regulations of various ripening processes. This focus has been on gene expression with more data suggesting that small RNAs also play a role in the regulation of these developmental processes.

An underlying assumption is that fruit ripening processes are similar across species. However, fruit ripening seemingly evolved independently in different plant groups opening up the possibility that the gene controls, plant growth regulator involvement and gene modules used to arrive at the fully ripe fruit might be different between different species. The difference in ripening patterns between the two broad categories of climacteric and non-climacteric fruit might reflect difference within these categories. We have known for many years that ethylene responses and fruit ripening varies with the stage of different fruit development and ethylene concentration. Hence, we cannot assume that because a specific gene or small RNA play a significant role in a particular species “A” that in species “B” the same gene or allele is as critical to the process. Expression studies then allow the correlation of some predicted genes expression pattern to biochemical or physiological functions. The most difficult step is to test and confirm that the gene function hypothesis about cause-and-effect does directly connect the gene to phenotype.

Knowledge of the genes involved in various aspects of fruit development and ripening opens various possibilities for modification. For postharvest technology and its focus on offering the consumer high quality safe product that meets their needs and wants, via traditional breeding with marker selection to genetic modification. Examples of application would be new varieties with more controlled flowering giving more concentrated harvesting thus reducing costs, different more convenient shapes and sizes giving less wastage, improved flavour and aroma, and added vitamin and mineral availability, improved storage life with less chilling susceptibility and reduced water loss, less discoloration following cutting and minimal processing and greater disease resistance. In some of these areas, success has already been achieved examples include pineapple flowering control and chilling related internal browning, and virus resistance in papaya.

Keywords: genomes, phenomes, phenotype fruit development, fruit ripening, gene expression



EFFECT OF NUTRITIONAL DEFICIENCIES AND EXCESSES OF SOME NUTRIENTS ON THE PHYSIOLOGICAL BEHAVIOR OF AVOCADO PLANTS (*Persea americana*, cv Hass)

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In order to observe the effects of nutrients: potassium (K), boron (B) and phosphorus (P), on physiological and growth variables in avocado var. Hass, seven treatments and four repetitions with three dose levels were evaluated: 1) deficiency of the respective element: 50% or half of the complete fertilization, 2) complete or control treatment: 100%, 3) excess of the respective element 150% above the complete fertilization, arranged in a completely random design. The plants were transplanted in plastic bags, with soil from El Rosal-Cundinamarca town, weekly fertilization and irrigation was carried out. Some of the evaluated variables were: foliar area (AF), leaf number (LN), chlorophyll content (CC), potential maximum efficiency of photosystem II (F_v / F_m) and transpiration (E), and the symptomatology was described in leaves. It was found that the values of AF, LN and CC were lower compared to the control. Similarly, F_v/F_m and E were lower compared to the control suggesting probable stress caused by the treatments; being presented in greater proportion for P, followed by K and B. The visual signs of nutritional stress were observed more clearly in plants subjected to deficiency than in those subjected to excess, being consistent with what was reported for this variety.

Keywords: nutrients, leaf area, chlorophyll fluorescence, transpiration, deficiency and excess symptoms



INTEGRATED EFFECTS OF ORGANIC AND INORGANIC FERTILIZER ON GROWTH AND YIELD OF PAPAYA (*Carica papaya* L)

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A study was conducted at the experimental field of National Horticultural Research Institute, (NIHORT), Ibadan, Nigeria. The objective of this study were: (i) to determine the response of pawpaw to varying rates (in sole and combination) of organic and inorganic fertilizer and (ii) to evaluate the effect of these fertilizers on soil properties. The experimental design was a randomized complete block design (RCBD) with four replications. The treatments were: (1) No fertilizer (NOF), (2) Sole organic fertilizer (OF), (3) Half organic + Half inorganic fertilizer (HOF + HIF), (4) Half organic fertilizer + Inorganic fertilizer (HOF + IF), (5) Inorganic fertilizer (IF). The results revealed that application of inorganic fertilizer gave higher stem height than other treatments. This was only significant when compared with control. Other morphological parameters (stem girth, leaf area, and days to 50% flowering) were better in treatments with organic fertilizer. Highest pawpaw fruit yield of 83.5t/ha/yr obtained in OF was 16 and 34% higher than HIF and NF respectively. The results further revealed that while some soil properties like potassium remain unchanged, element like Nitrogen and organic matter slightly increased with increase in organic but not with inorganic fertilizer. The use of organic fertilizer has potential of being a good material for production of pawpaw and improvement of soil properties in a long run. It may also serve as a better alternative to inorganic fertilizer especially where the latter is costly and scarce.

Keywords: Pawpaw, Manure, NPK fertilizer



DEVELOPMENT OF AN ORGANIC SMALL-SCALE PINEAPPLE PRODUCTION SYSTEM IN CHAPADA DIAMANTINA, BAHIA, BRAZIL. 2. FROM POST-PLANTING TO HARVEST

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The national market in Brazil presents a wide demand for organic fruits. There is no supply of organic pineapple. Pineapple is produced from the North to the South by tens of thousands of small to intermediate-sized producers, but in a conventional system, with intensive use of mineral fertilizers and other synthetic chemical inputs, mainly for the control of fusariosis (*Fusarium guttiforme*) and other pests. Aware of this research demand, Embrapa established a technical partnership with the company Bioenergia Orgânicos, aiming to develop the organic cultivation of pineapple, in the environmental conditions of the region of Lençóis, Chapada Diamantina, State of Bahia, Brazil. Using several experimental designs, the technical team conducted over five years studies on aspects of pineapple cultivation, from the production of planting material to fruit harvesting. In this second part of the work will be addressed studies on post-planting crop management of both cultivars, the traditional 'Pérola' and the 'Imperial', the new one with resistance to fusariosis. The results obtained allowed the establishment of technical recommendations for the control of weeds, pests and organic fertilization. The organic production of pineapples proved to be technically feasible, but studies continue to improve the cultural management initially adopted.

Keywords: *Ananas comosus comosus*, cultural system, cv. Pérola, cv. Imperial



A SYSTEMATIC APPROACH FOR IDENTIFYING PROMISING LEADS TO CONTRIBUTE TO A SOLUTION FOR CITRUS GREENING

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Huanglongbing (HLB), citrus greening disease, is a severe problem in Florida citrus production. This devastating disease, caused by phloem associated *Candidatus liberibacter asiaticus* (CLAs), is transmitted by a sucking insect, the Asian Citrus Psyllid *Diaphorina citri*. HLB impacts quality and quantity of fruit and ultimately kills the citrus trees. No tools or agronomic practices currently available can stop the progression of the disease.

Bayer is partnering with the Citrus Research and Development Foundation (CRDF) in discovery of new agents to control HLB via a systematic research approach involving 1) microorganisms to target CLAs and 2) compounds to boost the immunity of citrus trees to minimize bacterial infection. Bayer has expertise with both approaches for different crops and diseases. Discovery relies on screening large numbers of compounds or microbes to identify candidates, which can then be developed into products. However, because HLB is an obligate pathogen with slow progression of the disease in trees, the regular discovery screens used by the industry are not directly applicable. Thus, adapted, multi-tiered screening cascades using surrogate models for initial discovery followed rapidly by in planta testing on HLB infected citrus plants will be developed.

Direct inhibition of the pathogen by microbes from the Bayer Biologics platform as well as the induction of plant defenses, via synthetic compounds from the Bayer chemical library will serve as inputs to the screening cascade. The different screening cascades, status on their implementation and first results will be presented.

Keywords: Citrus, Huanglongbing (HLB), Biologics, Plant Defense Modulators



SUPERIORITY OF ROOT-SUCKER OVER HEDGE AS STOCK PLANT IN CUTTING PROPAGATION OF PERSIMMON (*Diospyros kaki*)

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Last few years, some dwarfing rootstocks for persimmon were registered as cultivars in Japan, and the methods of clonal propagation have been investigated. We showed that the softwood cuttings collected from root-suckers, not from hedges, was one of key success factors. However, we recently found that cuttings from hedge of 'MKR1', a dwarfing rootstock, rooted as well as those from root-sucker, although the rooting speed was slower. Hence, the objective of this study was to confirm abilities of cuttings from root-suckers to root and survive, compared with those from hedges. 'MKR1', 'Maekawajiro', Rootstock-a and Rootstock-c were used in this study. All 'MKR1' cuttings from root-suckers rooted, and two thirds of cuttings from 'MKR1' hedges rooted. Overwintering survival rates of the rooted cuttings from 'MKR1' root-suckers and hedges were 89% and 50%, respectively. As a result, one year after cutting, 89% cuttings from the root-suckers survived, whereas 33% from hedges did. The rooting percentages of Rootstock-a cuttings from root-suckers and hedges were 96% and 82%, respectively. However, overwintering survival rates of the rooted cuttings were 80% and 28%, respectively. Cuttings from hedges of Rootstock-c and 'Maekawajiro' did not root at all, although those from root-suckers rooted to some extent. Hence, we recommend to use root-sucker rather than hedge for mother stock of persimmon cuttings, because the rootstocks can be efficiently obtained by using cuttings from root-suckers.

Keywords: Dwarfing rootstock, 'MKR1', Softwood cutting



EVALUATION OF MORPHOLOGICAL DIVERSITY OF TAMARIND (*Tamarindus indica*) ACCESSIONS FROM EASTERN PARTS OF KENYA

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Tamarind is native to tropical parts of Africa and Asia. It has been used as a fruit and source of raw material in food industry and in pharmaceuticals, as well as timber and for ornamental purposes. Despite the vast importance of tamarind, the morphological diversity of the plants from Eastern parts of Kenya has not been evaluated. The objective of this study was to determine morphological diversity of tamarind accessions from Eastern parts of Kenya. Morphological descriptors of stems, branches, seeds and pods were used. Data collected was analyzed using principal component analysis (PCA) and Darwin software for clustering. Primary branches ranged from 1-2 while secondary from 2-12. Terminal shoot length varied from 480-2400m, trunk diameter at the ground varied from 70-500m, trunk diameter at the neck varied from 60-590m and height to the first branch varied from 280- 420m. Growth habit was either orthotropic or plagiotropic. Seed shape was quadrant, irregular, ovate and D shape. Seed color was light brown, brown, dark brown, dark brown/brown and black. Pulp color observed was either light brown or dark brown. Pod color was cinnamon brown or greyish brown. Pod shape varied from curved through semi curved to straight. PCA analysis for qualitative descriptors revealed two principal components (PCs). In PC1 and PC2 seed brightness had a positive contribution in them. Quantitative PCA revealed 5 PCs. Descriptors that contributed positively to PC1, PC2, PC3, PC4 and PC5, respectively, were trunk diameter at the ground, pod weight, number of seeds per pod, pod width and number of seeds per pod. Darwins cluster analysis revealed 3 major clusters with cluster 2 having 5 sub clusters. Morphological results revealed diversity among the accessions studied. Morphological diversity can be used for germplasm conservation and to initiate new breeding programmes in tamarind for improved fruit and tree crop.

Keywords: Tamarind, morphology, diversity, accessions, principle component



UNRAVELLING THE GENOMICS OF SUCROSE-ASSOCIATED SWEETNESS IN PAPAYA

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Along with flavour, an important papaya fruit quality trait to preserve at point of sale is sweetness, and in particular sweetness that is derived from sucrose. This is directly regulated by a suite of genes involved in sucrose synthesis (ss) and it is unknown how the expression of these genes is affected during fruit maturation, presumably leading to differences in sweetness of the harvested fruit. Therefore, the aims of this study were to assess the differential expression of nine key genes known to be involved in governing the production of sucrose through a time course of fruit maturity and examining transcription profiles for association with sucrose accumulation. This included assessing three sucrose phosphate synthase (*cpSPS*), four invertase (*cpAVIN*, *cpCWINV*) and two sucrose synthase (*cpSUS*) genes in two papaya genotypes 'RB2' and 'Sunrise Solo'. The fruit of each cultivar were harvested at five maturity stages; mature green, three colour break stages (25%, 50%, 75%) and fully ripe. Accordingly, similar patterns in sucrose accumulation were observed among the genotypes over the maturity stages, accounting for 40-60% of the total sugar detected. The majority of ss genes were expressed in higher levels in 'Sunrise Solo' than in 'RB2', ranging from 0.3 to 12.5 fold higher with *cpSPS2* most changed in mature fruit. In all harvest stages 'Sunrise Solo' showed greater expression of *cpSPS2* than 'RB2' and ranged from 1.5 to 6 fold. Other differentially expressed genes were *cpCWINV1* and *cpAVIN2*, which were highly expressed in genotype 'Sunrise Solo' during ripening stages. The genomic locations of the differentially expressed genes were identified using an F2 to generate a physical map of 'RB2' x 'Sunrise Solo' using GBS. The proximity of unique SNPs within these target genes to major QTL for sweetness was determined as further evidence for their direct role in the sweetness trait and potential for validation as candidate sweetness markers in future selective breeding strategies.

Keywords: Papaya breeding, GBS, qPCR analysis, fruit quality traits, differential expression analysis, QTL



RNA SEQUENCING REVEALS IDENTIFICATION OF DIFFERENTIALLY EXPRESSED GENES IN GAMBOGE DISORDER OF MANGOSTEEN

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Gamboge disorder (GD) is one of the physiological disorders occurs in mangosteen due to the breakdown of yellow latex duct in the fruit rind (pericarp) during fruit development. Lack of genomic information in mangosteen is challenging to elucidate gene control mechanisms involved physiological processes in the occurrences of GD symptoms. Our study performed RNA sequencing based on Ion Proton™ systems to determine differentially expressed genes (DEGs) in GD disorders from the GD-affected rind and normal rind. High quality and clean reads were performed, and then the de novo assembly was performed by Trinity. The DEGs were analyzed by pairwise comparisons of the normal and GD-affected rind. A result of 13 384 transcripts was obtained using TMM normalization on R Packages EdgeR. The transcripts detected with at least two-fold differences in the two type of tissues compared disorder tissue to normal tissue. Some genes were up- and down-regulated in occurrences of gamboge disorders-affected fruits in mangosteen. Based on functional annotation of KEGG pathway and gene ontology analyses, epithelium development, mineral nutrient-related transporter genes, cell wall-related genes were identified. The related-genes subjected to epithelium development (GO:0060429) such as 3-ketoacyl-CoA synthase 10, Serine/threonine-protein kinase Nek5, TRANSPARENT TESTA GLABRA 1 and 3, Ethylene-insensitive protein 2, Zinc finger protein JACKDAW, ARF guanine-nucleotide exchange factor, and WRKY transcription factor 44. These genes need confirmation by RTqPCR analysis. This study has valuable information for better understanding the gene regulation and molecular mechanisms of GD-like physiological disorders in mangosteen.

Keywords: Gamboge, Secretory Duct, RNA, Mangosteen



SEED SET IN CROSSES BETWEEN TETRAPLOID AND DIPLOID PLANTAIN-BANANA HYBRIDS

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Plantain breeding at the International Institute of Tropical Agriculture (IITA) involves crossing disease-susceptible triploid (AAB) cultivars with disease-resistant diploid (AA) wild accessions or cultivars to generate tetraploid hybrids (AAAB). These tetraploids ($2n = 4x = 44$), exhibiting male and female fertility are further used by crossing them with improved diploid germplasm ($2n = 2x = 22$), to produce secondary triploids ($2n = 3x = 33$), thereby restoring sterility in the improved genome. Seed set in *Musa* germplasm is genotype and season-dependent. Seed set pattern, average seed per bunch and pollination success was evaluated in nine tetraploid hybrids (PITA 2, PITA 4, PITA 5, PITA 6, PITA 7, PITA 8, PITA 12, PITA 14 and PITA 17) derived from two French plantain landraces: 'Bobby Tannap' and 'Obino L'Ewai'. These tetraploids were crossed with nine male-fertile diploid accessions over a period of 10 years (1994–2005). All the tetraploids exhibited high female fertility. Average seed set ranged from 0.5 seed per bunch to 1,304 seeds per bunch in PITA 2 x 1448-1 and PITA 4 x 8084-2 crosses respectively, which is extremely high for a parthenocarpic genotype. A significant monthly variation was observed for total number of seeds produced, pollination success and average seed set per bunch. The monthly average seed set was 19 per bunch in dry, hot and sunny February, while it was 213 seeds during wet and cloudy August respectively. The percentage pollination success peaked in August and September (96%) and declined to a very low level in February (41%).

Keywords: diploid, plantain and banana, seed set, tetraploid.



MANGO IN INDIA: TECHNOLOGICAL DEVELOPMENT

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Mango is the most important fruit crop of India contributing about 40% of total mango production in the world. In India the total area under mango cultivation is 2125 thousand hectares with an annual production of 19004 thousand tons. Enormous genetic diversity of mango exists in India as primary and secondary centres of domestication of *Mangifera indica*. More than a thousand monoembryonic varieties occur in India. Although varietal wealth is quite rich, only about 30 varieties are now being commercially grown in different agro-ecologies. Nearly 40 mango hybrids have also been developed using donor sources of regular bearing, high quality, resistant to certain diseases and disorders. Mango is available for nine months (February-October) in India due to dynamics of weather and technological development. A number of research institutes and universities have developed the production and post-harvest management technologies for major commercial cultivars growing in different states. Technology for high-density planting, canopy management, flower regulation by use of paclobutrazol, nutrient and irrigation management, rejuvenation of old and unproductive orchards etc. have been standardized. We export quality fresh mangoes and varied value-added mango products to many countries. The country has projected a production target of 36920 thousand tons in 2030 from 15055 thousand tons produced in 2010. This paper will discuss the status of technological development in mango production in India.

Keywords: production, export, cultivars, production technology



AMBIENT TEMPERATURE AFFECTS BUD EMERGENCE AND DEVELOPMENT IN WHITE PITAYA (*Hylocereus undatus*) UNDER INDUCTIVE LONG-DAY PHOTOPERIOD CONDITIONS

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Night-breaking (NB) is generally used for the off-season production of pitaya (*Hylocereus* spp.) but may be less successful in higher-latitude subtropical regions with cold winter. Therefore, this study documented the effect of ambient temperature on bud emergence and development in white pitaya (*Hylocereus undatus*) under an inductive photoperiod. Two-year-old field-grown potted plants with 8-11 shoots were transferred to a phytotron with day/night temperature of 32/22°C(CK) and 23/13°C (LT) under a prolonged 14-h photoperiod on March 25, 2016. For LT, the temperature was increased 2°C every 4 weeks once reproductive bud (RB) emergence in CK until RB formation. RB and vegetative bud (VB) emergence and development (stages 0-3) were recorded each week. VBs first emerged at 3 weeks in both the CK and LT treatments and stopping at 10 and 16 weeks, respectively, indicating that VB emergence was not affected by ambient temperature but more VBs were produced under LT. RBs first emerged at 3 weeks in the CK treatment, which was 1 week earlier than in the field-grown potted plants, and continued to emerge each 1-2 weeks. Warm temperature also accelerated bud development, with 59% of bud reaching the stage 3 by 19 weeks in the CK treatment. By contrast, temperatures of 23/13°C-27/17°C did not induce RB development under long-day conditions and almost retard bud development, with the first RB emerging 3 weeks after the temperature was increased to 29/19°C and most buds remaining at stage 2 until the end of the experiment in the LT treatment. Our findings suggest that RB formation in pitaya is induced by long-day photoperiod but RB emergence depends on a warm ambient temperature, with 29/19°C being critical for RB emergence, and 32/22°C being optimal for both RB emergence and bud development.

Keywords: dragon fruit, off-season production, night-breaking



EXPLORING THE STATE OF ANNONA (*Annona* sp.) CULTIVATION IN LEBANON THROUGH A SURVEY TARGETING LOCAL NURSERIES AND FARMERS

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Annona cultivation is gaining momentum in Lebanon because of the increased local and international demand for this produce, and also for the high revenues underlying such business. In order to explore the state of annona in Lebanon, 2 surveys were conducted in 2016 targeting 69 nurseries producing annona plants and 96 farmers cultivating annona.

Results showed that in Lebanon, annona cultivation started in the year 1989, it increased in 1997 and peaked in 2 distinct periods: 2004 and 2012. The majority of farmers cultivating annona (94%) had an age higher than 40 years. Nowadays, the total cultivated area is of 133.21 Ha with the cultivar (sugar apple scion grafted on cherimoya rootstock) covering 88.6%. This cultivar was the most adapted to local climatic and soil conditions, it could be found at different ages (2-3 years) it is self-pollinated and produces high quantity and quality yields. It was mainly found in sandy-loam (51%) and sandy-clay-loamy (29%) soils. Annona orchards were mainly located in South-Lebanon (60%) and less in Chouf (15%) and Byblos (11%), 71% of those orchards had an area less than 60 dunoms. Annona farmers brought their plants in majority (61%) from local nurseries, a minor part (26%) imported them and only few farmers (13%) brought plants from both sources. Nurseries started to import annona plants 5 years ago. The short shelf-life of the fruit, difficult post-harvest management and decreasing selling price of annona have pushed a group of farmers towards other crops such as avocado, however half of respondents declared their willingness to expand the area of annona cultivation in the coming years. In conclusion, despite some constraints facing this type of cultivation it is a promising one with a promising future potential.

Keywords: Lebanon, annona sector, survey, growing areas, production volumes



EVALUATION OF THE FUNCTIONAL POTENTIAL OF A MICROENCAPSULATION OF ASAI (*Euterpe precatoria*) AND COPOAZU (*Theobroma grandiflorum*) IN HEALTHY VOLUNTEERS

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The global increase of morbidity from chronic noncommunicable diseases attributable to diet has made consumers pay more attention to what they eat, with the intent to consume more fruits and vegetables with high phytochemical compound contents of high functional value. Asaí and copoazú are two Amazonian fruits that are considered "superfruits", with a high content of phytochemicals with an antioxidant capacity, that, when combined in juices, provide a pleasant flavor. Microencapsulation is a suitable technique for the preservation of compounds of interest in powdered products. The objective of the present study was to evaluate the functional potential of an asaí and copoazú microencapsulation (MAC) supplied to healthy volunteers. Healthy volunteers were evaluated nutritionally with a food consumption survey and a 24-hour reminder to establish their average diet and avoid interference with the supplied microencapsulation. Anthropometric measurements, weight and height, were taken. The biochemical parameters evaluated in each subject were: cholesterol, triglycerides, high density cholesterol (HDL-C), low density cholesterol (LDL-C), very low cholesterol (VDL-C), uric acid, creatinine, blood glucose, fasting insulin, insulinic sensitivity, estimated using the Homeostasis Model, HOMA-IR, and indicator of oxidative stress: 8-Isoprostane and nitric oxide like endothelial marker dysfunction. The evaluations were performed at baseline (before receiving the drink) and at endpoint (31 days). The results did not show significant variations ($P = .05$) in the anthropometric measurements. The LDL-C and NO showed significant differences from the beginning and the end of the assay. The 8-iso-PGF2 α show positive correlations with NO at the endpoint of the study. The consumption of MAC by the healthy volunteers proved to be a promising functional drink for combating oxidative stress.

Keywords: intervention study, antioxidative capacity, stress biomarkers, oxidative stress



INVESTIGATION OF ENDOGENOUS PHYTOHORMONE CONTENTS IN MALE AND FEMALE LITCHI FLOWERS

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Litchi (*Litchi chinensis* Sonn.) bears the following three types of flowers: male, functionally hermaphroditic male, and functionally hermaphroditic female flowers. Endogenous and exogenous phytohormones considerably affect the sexual expression of flowers in other monoecious and dioecious species. However, little information is available regarding the relationship between phytohormones and sex differentiation in litchi. Therefore, we analyzed the phytohormone contents of the male and female flowers of several litchi cultivars using a method involving a solid-phase extraction and high-performance liquid chromatography–electrospray ionization tandem mass spectrometry. In all tested cultivars, auxin and abscisic acid contents were lower in female flowers than in male flowers. In contrast, the abundance of cytokinins (e.g., isopentenyl adenine and *trans*-zeatin) was higher in female flowers than in male flowers. We also tested the effects of cytokinins on litchi flower formation by applying a synthetic cytokinin, forchlorfenuron (CPPU), on ‘Hei-ye’ litchi trees growing in a commercial orchard in Hsinchu City, Taiwan. Inflorescences on trees were treated with 50 ppm CPPU in 0.5% ethanol or 0.5% ethanol alone (control). The results of this preliminary testing suggested a CPPU treatment during the floret anthesis stage may induce abnormal feminization and female flower abscission. The data presented herein may be relevant for future research on the regulation of sex differentiation by exogenous phytohormones.

Keywords: *Litchi chinensis*, CPPU, cytokinin, phytohormone



PERIODIC PRUNING IN GUAVA (*Psidium guajava* L.) AND CONSEQUENTIAL IMPACT ASSESSMENT ON PHONOLOGICAL PHASES USING MODIFIED BBCH SCALE

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The guava (*Psidium guajava* L.) fruits bears on current season's growth and phonological events are quite amenable to the pruning of plants. The different phenological phases of bud development, vegetative growth, floral development up to fruit maturity in coded form can be record by using BBCH (Biologische Bundesantalt Bundessortenamt and Chemische Industrie) scale. In the fruit plans, which bears fruits on current season growth, the pruning is an important strategy to alter the phenological stages hence; the manipulation of availability and maturity of crop. However, the normal BBCH scale may not be valid to induced phonological alterations. To study the extent of deviations from the normal phonological events of a crop at particular place, the present investigations were carried out in the guava cv. L-49. The traditional nomenclature described by Fleckinger (1945) was used for recording of phenological events and the BBCH general scale was used to relate the periodically pruned and unpruned plants. The observations revealed the significant alterations in the phenological phases owing to periodic pruning from January to December. The respective vegetative and floral bud appearance started after 11 to 15 and 23-41 days in case of plants pruned between March to September. The peak flowering and fruit setting in March to September pruned trees ranged from 39 to 51 days and 52 to 61 days, respectively. The fruit got ripened in 109 and 164 days in plants pruned during these respective months. However, in case of plants pruned in October to February, the vegetative as well as reproductive developments fail to take place till next spring season. The normal BBCH scale proved to be invalid in trees subjected to different months of pruning.

Keywords: guava, periodic pruning, flowering, fruit set. yield



EFFECT OF DIFFERENT PRE-HARVEST TREATMENTS ON POSTHARVEST STORAGE QUALITY OF 'KUTDIKEN' LEMONS

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Imazalil, Imazalil+Scholar and Imazalil+Scholar+Propiconazole drencher treatments, Imazalil+light storage wax treatment as well as two different modified atmosphere packaging applications were compared during 6 months of storage at 10°C and 85-90 % Relative Humidity. Fruit quality parameters; weight loss (%), total soluble solids (%), titratable acidity (%), total juice amount (%), vitamin C (ascorbic acid mg/100 g), fruit peel color (h°), fruit peel thickness (mm), and total decay rate (%) were measured monthly. Imazalil, Imazalil + Scholar and Imazalil + Scholar + Propiconazole applications were maintained the overall fruit quality at the end of 6 months storage. Two different modified atmosphere packaging bag were also found to have a potential for lemon storage.

Keywords: Lemon, kutdiken, fungicide combination, modified atmosphere storage



THE PHYSIOLOGICAL DISORDER OF PURPLE SPOT IN LOQUAT FRUIT: A MOLECULAR AND PHYSIOLOGICAL APPROACH

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Loquat (*Eriobotrya japonica* Lindl) market potential is severely affected by purple spot, a pre-harvest physiological disorder evident as skin discoloration with depressed purple surface that renders the fruit non-marketable. Despite its economic impact, only few studies have dealt with aspects controlling the incidence and severity of such symptoms. The aim of the current study was to investigate key physiological and molecular mechanisms underlying purple spot symptomology. Initially, the intensity and severity of purple spot in three cultivars ('Morphitiki', 'Karantoki' and 'Obusa') with differential response to this disorder during successive on-tree developmental stages was registered. At commercial maturity stage, harvested fruits per cultivar were separated into five distinct groups based on the intensity of symptoms and severity index was calculated. Phenotypic data indicated that 'Obusa' fruits were characterized by severe symptoms with ca. 60% of the harvested fruit showing purple spot symptoms. On the contrary, 'Morphitiki' fruit was not affected by purple spot, while 'Karantoki' fruit showed an intermediate sensitivity. Subsequently, peel of selected 'Karantoki' and 'Obusa' fruits with intense purple spot symptoms during on-tree ripening (covering 30-50% of total surface) was excised from both symptomatic and asymptomatic tissue (of the same fruit), as well as from asymptomatic tissue of 'Morphitiki' fruits. Total soluble sugars, sucrose, glucose and fructose content were determined in order to dissect the role of sugar metabolism. Furthermore, transcript levels of key genes implicated in the sucrose biosynthetic pathway [such as cell-wall, cytoplasmic and vacuolar invertases, sucrose synthase and sucrose phosphate synthase] and in the chlorogenic pathway and oxidation process (such as polyphenol oxidase, phenylalanine ammonia lyase, p-coumarate 3-hydroxylase) were determined.

Keywords: *Eriobotrya japonica*, purple spot, pre-harvest disorder, gene expression, sucrose, glucose, fructose, chlorogenic pathway



BREEDING, RESEARCH AND DEVELOPMENT OF PURPLE-FRUITED PITANGA (*Eugenia uniflora* L.) AS A COMMERCIAL CROP IN HAWAII, USA – 2007 TO 2017

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In 2003, purple-fruited pitanga was one of only twelve tropical fruit crops selected from more than 200 prospective crops for development in Hawai‘i by tropical fruit growers, processors and chefs. The most desirable seedlings were selected for further research, plants of these were propagated by grafting and one established, named cultivar, ‘Zill Dark’, was selected as the parent for a breeding project to look for variation within the crop. A planting of 135 seedlings from a self-cross of ‘Zill Dark’ was installed in a field at the Kona Experiment Station in Kealahou, Hawai‘i in February 2007. While evaluating the seedling plants for various traits, they were also used in a trial to evaluate the effects of fertilizer rates on growth and development of the crop. In summer 2008, 20 grafted plants of ‘Zill Dark’ were added to the field for comparison with the seedlings. Seedling plants may begin to produce fruits only two years after planting in the field, but full production takes several years of growth and maintenance. Grafted plants often produce some fruit within a year of grafting. The fertilizer trial continued for several years and fruits were harvested and evaluated for traits such as color, size and taste. Fruits were successfully marketed at local farmers’ markets and to local chefs. After five years in the field, fruit production data was collected for all of the purple-fruited seedlings and the ‘Zill Dark’ grafted plants from 2013 to 2015. Surprisingly, plants were not all synchronized to produce fruits at the same time, so the potential to find new varieties from among the seedlings that could alter the growing season for producers in Hawai‘i was noted. Substantial variations in fruit yield and length of fruiting period were also discovered. In 2017, during further evaluation of fruits in the field, three seedlings in the plot were discovered bearing large numbers of ripe, seedless fruits, something not previously known to exist for this crop. These plants have been propagated by veneer graft for further evaluation. Experiments to measure brix in relation to exact fruit color of ripening fruits (measured with a Nix Pro Color Sensor) have also been initiated to determine if fruits might be harvested and marketable sooner in the crop cycle so that fewer fruits are lost when very soft, fully ripe fruits abscise and drop from the plants.

Keywords: new crop development, pitanga, seedless



RESPONSE OF 'PINK SOLO' PAPAYA TO ORGANIC FERTILIZER IN SOUTHWEST NIGERIA

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There is an increased demand for organic fruits such as papaya (*Carica papaya* L) by health-conscious consumers in Nigeria. Papaya features in low input production systems thus, it is currently undersupplied. To redress the shortage, productivity of papaya orchards needs to be intensified through fertilizer application. Consequently, a greenhouse experiment was conducted between June and September 2015 and repeated March and July 2016 at the Department of Agronomy, University of Ibadan, Nigeria to investigate the response of 'Pink Solo' papaya seedlings to 'Gateway' organic fertilizer (GOF). In both trials GOF was applied pre-plant in a single dose following a completely randomized design with four replicates at rates equivalent to 5, 10, 20t/ha in the first trial and 10, 20 and 40t/ha in the second. Control plants received no fertilizer (0t/ha). Data was collected fortnightly on plant height, canopy diameter, leaf area and number of nodes. Total dry matter accumulation and foliar nutrient concentration were determined at the end of the study. In 2015, compared with control, organic fertilizer at 5-20t GOF/ha did not significantly ($P>0.05$) influence vegetative growth except plant height and total dry matter accumulation where 20t GOF elicited significantly higher values than control, 5 or 10t GOF/ha. In 2016, 40t GOF/ha significantly increased canopy diameter and leaf area compared with control, 10 or 20 t GOF/ha, but its effects did not differ significantly from these rates with regards to plant height, number of nodes and total dry matter accumulation. Foliar nutrient concentration increased with rate of GOF application but its relationship with dry matter accumulation were non-linear. Since dry matter accumulation is a strong index of plant growth, application of 20t/ha of GOF is recommended for optimum growth of 'Pink solo' papaya.

Keywords: Pink Solo', organic fertilizer, organic fruits, southwestern Nigeria



UNDERSTANDING CAUSES OF RESIN CANAL DISORDER IN AUSTRALIAN MANGO INDUSTRY

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Resin canal disorder (RCD) is a fruit quality defect found in Australian mangoes. It occurs sporadically showing up as red-brown resin canals that form networks through the flesh and irregular brown mottling across the skin. This defect is most frequent in 'Kensington Pride' mangoes. Other than the visual appearance it does not affect the eating quality and only becomes evident when fruit are fully ripe. In some cases, RCD symptoms may only become visible after purchase. The cause or causes is still unknown and it is sometimes confused with other skin browning disorders. The current study firstly sought to quantify the impact of RCD on consumer's behaviour to understand whether it negatively impacts on the consumer's willingness to buy mangoes. Consumer awareness of and willingness to buy the RCD affected fruit was measured by intercept questionnaires at three supermarkets in Sydney. The results showed that RCD significantly affects consumer's purchasing behaviour. The research then sought to determine whether there is a consistent association of bacterial colonisation and type with RCD symptoms. Isolation and identification of the bacteria was performed from the infected fruit, peduncle, leaves and stem. Finally, options to develop pre and postharvest interventions for its management have been tested. Non-destructive techniques (NIR) and modified atmospheric storage (MAP) bags were used to investigate the relationship RCD incidence under different storage conditions in mature fruit. The development of management strategies to address the issue of RCD in mango fruit will be discussed.

Keywords: Kensington Pride , Mango, resin canal disorder, NIR.



BAYER FORWARD FARMING

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Huanglongbing (HLB), citrus greening disease, is a severe problem in Florida citrus production. This devastating disease, caused by phloem associated *Candidatus liberibacter asiaticus* (CLAs), is transmitted by a sucking insect, the Asian Citrus Psyllid *Diaphorina citri*. HLB impacts quality and quantity of fruit and ultimately kills the citrus trees. No tools or agronomic practices currently available can stop the progression of the disease. Bayer is partnering with the Citrus Research and Development Foundation (CRDF) in discovery of new agents to control HLB via a systematic research approach involving 1) microorganisms to target CLAs and 2) compounds to boost the immunity of citrus trees to minimize bacterial infection. Bayer has expertise with both approaches for different crops and diseases. Discovery relies on screening large numbers of compounds or microbes to identify candidates, which can then be developed into products. However, because HLB is an obligate pathogen with slow progression of the disease in trees, the regular discovery screens used by the industry are not directly applicable. Thus, adapted, multi-tiered screening cascades using surrogate models for initial discovery followed rapidly by in planta testing on HLB infected citrus plants will be developed. Direct inhibition of the pathogen by microbes from the Bayer Biologics platform as well as the induction of plant defenses, via synthetic compounds from the Bayer chemical library will serve as inputs to the screening cascade. The different screening cascades, status on their implementation and first results will be presented.

Keywords: Citrus, Huanglongbing (HLB), Biologics, Plant Defense Modulators



HOW PRE-HARVEST APPLICATIONS OF NITROGEN FERTILISER AFFECT BRANCHING AND FLOWERING IN MANGO (*Mangifera indica*)

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The effect of pre-harvest applications of nitrogen (N) fertiliser to mango trees during late fruit maturation stage was investigated over 3 years to determine the effects on branch growth and morphology, flowering and tree yield in 8 year-old Kensington Pride (KP) mango trees growing in Far North Queensland.

The experiment consisted of five treatments where 156 g N were applied per tree as 340 grams of urea at three different times and in four proportions. The treatments were applied as 1) 100% post-harvest (control), 2) 50% 2 weeks pre-harvest plus 50% post-harvest, 3) 35% 2 weeks pre-harvest plus 65% post-harvest, 4) 35% 4 weeks pre-harvest plus 65% post-harvest, and 5) 65% 4 weeks pre-harvest plus 35% post-harvest.

Yield characteristics were not significantly affected by the timing or proportion of nitrogen applications. However, at the tree level, vegetative growth including the mean annual length of branches and the mean length of growth units was greater with the 50 % and 65 % of N applied at 2 and 4 weeks pre-harvest. At the growth unit (GU) level, GU morphology (leaf area, GU diameter, leaf weight, leaf length) was dependent on its position on the branch (apical or auxiliary, terminal or non-terminal). Floral development was earlier with pre-harvest applications of N depending on the sampling time and canopy position (canopy level and quarter) and fruit number was significantly related to leaf area at the branch scale more-so than the growth unit scale. Physiological reasons for these variations are discussed.

Keywords: marker-assisted selection, anthracnose, *Colletotrichum gloeosporioides*, post-harvest disease, QTL



IMPACT OF TEMPERATURE ON AXILLARY BUD DEVELOPMENT IN MANGO CV. 'HONEY GOLD' AND 'CALYPSO (B74)' IN SUBTROPICAL CLIMATE

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Axillary bud development can be triggered by tip-pruning of branches in mango. Cool conditions in mango are detected in mature hard green leaves and transmitted to growing shoots where flower development occurs. This project takes advantage of the progressively cooler weather in Katherine regions that occurs from April to July to investigate the effects of night temperatures on developing mango buds. The experiment was conducted using six-year-old commercial mango cultivars "Honey Gold" and "Calypso" (B74) grown on separate properties. Pruning treatment was applied to 3 replicate trees at fortnightly intervals for five months. All stems around the canopy were pruned ~10cm above the last internode for each branch on each tree. The length of new flush growth for 20 randomly selected pruned branches on each tree was recorded on a weekly basis. Variables including; pruning time, re-flushing time, anthesis time, max and min daily temperatures and RH% was measured for each treatment. Climate data were analyzed to describe the relationship between bud growth and floral initiation and any effects on vegetative bud growth. First-year data revealed that the pruned trees produced more fruits than the unpruned controls. Data indicated that tip pruning at the right time could be used as an agro-technical tool to advance or delay flowering time for both cultivars. Results on the effects on floral initiation will be presented and discussed.

Keywords: Calypso (B74), dry matter, Honey Gold, maturity, near-infrared spectroscopy, tip-pruning



GROWTH AND DEVELOPMENT OF MORICHE FRUITS (*Mauritia flexuosa*) IN GUAVIARE-COLOMBIA

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Moriche, aguaje or canangucha (*Mauritia flexuosa*) is a dioecious palm that reaches 40 m in height, with male and female individuals flower synchronously. A methodology focused on the characterization of the maturation phase and changes in chemical composition during this stage was proposed to determine the collection rates for the different uses of moriche pulp. This procedure evaluated the physiological characteristics and chemical composition of clusters in different stages of maturity during a single period of maturation in the field. The moriche fruits exhibited a simple sigmoidal growth, in which the increase in dry weight was the variable that best explained the increase in fruit size. The carotenoids increased in a single evaluation cycle under the conditions of San José del Guaviare; however, the contents can fully satisfy the intake requirements of Provitamin A.

Keywords: neotropic, phytoterapeutic, carotenoids, Vitamin A



DISTRIBUTION AND DIVERSITY STUDIES OF *Banana bunchy top virus* (BBTV) IN BANANA-PRODUCING REGIONS OF SOUTH AFRICA

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Banana viruses are limiting factors for banana production in many countries where bananas are grown. The most devastating viral-caused disease of bananas worldwide is Banana bunchy top disease (BBTD) caused by *Banana bunchy top virus* (BBTV). BBTD was first reported from Africa in 1901. BBTV is a quarantine virus that is included in the South African Phytosanitary Services list of pathogens which must be absent in imported *Musaceae* propagation material. The disease is spread by the banana aphid *Pentalonia nigronervosa* Coquerel (Hemiptera: Aphididae) and through infected propagation material. In 2015, the virus was detected in an isolated area in the South Coast region of KwaZulu-Natal (KZN), South Africa. The aim of the study was to conduct delimiting surveys across banana-producing regions in South Africa, focusing on regions where the BBTD outbreak was reported. Additionally, the distribution of the virus in the KZN region and the molecular diversity in the plant samples, were determined. Over 400 plant- and aphid samples were collected from 15 commercial farms and 60 rural households in the region. A BBTV-specific Polymerase Chain Reaction was carried out using the primer pair BBTV-1 and BBTV-2 which amplifies a fragment of the putative replicase gene. The BBTV-amplicons, that yielded an expected band size of 349 bp, were sequenced using Sanger sequencing. Comparative phylogenetic analyses of replicase gene sequences showed that the South African BBTV isolates clustered with the South Pacific genomic group that included accessions from India and other regions in Africa with a sequence identity of 99%. To date, the virus has been identified in another commercial farm 42 km from the initial outbreak site. Intense management strategies, including removal of infected plants and spraying for aphids, have been implemented in areas where positive samples were identified to minimize the spread of the virus to neighbouring plantations.

Keywords: Banana, Banana bunchy top virus, BBTV



PHYSIOLOGICAL RESPONSES OF NINE MANGO CULTIVARS SEEDLINGS INOCULATED WITH *Ceratocystis fimbriata*

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Mango (*Mangifera indica* L.) is facing increased biotic and abiotic stresses that lead to reduced number of trees and total fruit production in many producing countries, including Oman. Mango Sudden Wilt (MSW), caused by *Ceratocystis fimbriata* (syn. *C. manginecans*), is a major fungal disease that spread over the past decades causing loss of up to 60% of mango trees in Oman. The aim of this study was to determine the physiological responses of nine mango cultivars commercially grown in Oman that included Zafaran, Batikah, Disheheri, Ishbiah, Baramasi, Banishan, Piri, Rose and Langra inoculated by *C. fimbriata*. Measured parameters included (net carbon assimilation rate (A), transpiration rate (E), stomatal conductance to water vapour (gs), water use efficiency (WUE), sub-stomatal cavity (internal) CO₂ concentration (Ci) and chlorophyll content (SPAD) and florescence (Fv/Fm). Physiological responses of the inoculated and non-inoculated cultivars varied significantly among cultivars and their interaction with the inoculum. This indicated that under controlled (glasshouse) and non-stressful conditions, physiological processes of different cultivars did not equally respond to fungal infection as compared to non-inoculated seedlings. However, correlation among various conductance (gs) was considered as the independent variable. All cultivars showed a strong correlation between stomatal conductance (gs) and transpiration (E) ($r^2 \sim 0.99$) but this value varied with the gs relationship with assimilation (A). The correlation between A and gs was highest for Zafaran, Batikah, Disheheri and Baramasi while the other cultivars showed moderate to low correlation like Banishan, Piri, Rose and Langra. Nonetheless, the correlation between stomatal conductance (gs) and other physiological parameters affected by stomatal aperture (primarily A & E) indicated the sensitivity of various cultivars to infection by *C. fimbriata*. However, inference about cultivar sensitivity to the disease can be obtained from the relationship of assimilation and transpiration with stomatal conductance.

Keywords: Mango Sudden-Dieback Disease Photosynthesis *Mangifera-indica* Oman



EFFECT OF MULCHES ON SOIL MOISTURE, TEMPERATURE, WEED SUPPRESSION AND ESTIMATION OF COST BENEFIT RATIO OF GRAPE (*Vitis vinifera* L.) CV. KISHMISH ROZAVIS WHITE IN NORTHERN DRY ZONE OF KARNATAKA

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A study was conducted during September 2015 to February 2016 to assess the effect of different types of mulching materials on soil moisture, soil temperature, weed suppression and estimation of cost benefit ratio of grapes (*Vitisvinifera* L.) cv. Kishmish Rozavis White” at Department of Fruit Science, University of Horticultural Sciences, Bagalkot. Among different types of mulches used both organic and inorganic mulches suppressed weeds to maximum extent (0.00/m²) and only in control treated vines weeds were seen at 30, 60, 90, 120 and 150 days after treatment imposition. Higher percentage of soil moisture at 0-15 cm (18.76%) and 15-30 cm depth (19.54%) was recorded in vines mulched with black polythene at different stages. Different mulching material showed different effect on soil temperature, higher mean soil temperature was recorded in vines mulched with black polythene (24.96 °C) and highest cost benefit ratio was obtained in vines mulched with sugarcane trash (3.48).

Keywords: Grape, mulch, weed suppression, soil moisture, soil temperature and cost benefit ratio



'SUPERFRUIT' AND HUMAN HEALTH

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The term 'Superfruit' is commonly used in marketing but has little scientific basis. Our colleagues who work in nutrition and health remind us that single food items will not magically change our overall health. It is our whole diet, combined with our lifestyle choices (e.g. exercise, alcohol consumption, smoking) that leads to better health. Nevertheless we should all promote 'a diet rich in fruit and vegetables' and there is value in knowing what different fresh products contain so we can aim to diversify our intake of phytochemicals and maximise our chances of receiving health benefits. Consumers have been led to believe that 'high in antioxidants' is an important attribute but this is simply not the case. Although most phytochemicals are antioxidants that is not their role in the body. In particular, bioactivity of an extract in some specific bioassay frequently does not correlate with total antioxidant activity. Vitamins, minerals and fibre have 'recommended daily intakes' and most countries require a product to deliver 10% of the RDI in a single serving before it can claim to be a 'source' of that material. Despite this, marketing claims often say a product 'contains...' something; without acknowledging it is not technically a 'source' for that constituent. Phytochemicals are more problematic as we are still a long way short of knowing what concentration of each phytochemical would be a beneficial 'dose', nor do we know at what frequency it should be consumed. My advice would be to focus our efforts on increasing the consumption of all fruit and vegetables (at least 5 servings of vegetables, 2 of fruit per day); to restrict marketing claims only to products that are a 'source' of vitamins, minerals or fibre; and to beware the calorie content of fruit and juices. Finally, I would encourage the consumption of a wide botanical diversity of fruit to increase the range of phytochemicals consumed. In this workshop I will focus on modes of action of phytochemicals and the importance of fruit biodiversity.

Keywords: phytochemical, antioxidant, vitamin, mineral, fibre, diet



THE AVOCADOS: GUATEMALAN FOOD

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West Indian, Guatemalan and Mexican race avocados have been cultivated for thousands of years. A favorite of the Mayan people, they are native to Central and North America and have long been a staple crop of the people. This review includes recognition of the Mayan gardens present day from the expeditions in 2004 and available literature. Over half of the modern Guatemalan citizens are descendants of indigenous Mayan people, and today's Guatemalan kitchen gardens contain avocados. Guatemalan kitchen gardens are typically small cultivated areas where avocados grow with corn, cassava, banana and other short-term crops. A wide diversity of avocado seedlings are produced for home consumption and for sale fruit along roadsides. These include West Indian race avocados grown from sea level to 500 m altitude, and Guatemalan and Mexican race avocados in the higher altitudes. The West Indian germplasm from the warm, humid lowlands come in different sizes, skin color and shapes with mild flavor and lower oil contents than Guatemalan and Mexican race fruit. The avocado played an important part in the life and is used by them as food. A wide diversity of seedling avocados is combined with corn and beans as a foundation of their diet. The avocados are good source of potassium and vitamin D, fatty acids, vitamins, carotenoids and other phytochemicals. This valuable genetic resource should be conserved and used in breeding for the creation of new fruit and markets.

Keywords: West Indian avocados, Guatemalan avocado race, Guatemalan crops, Superfood, Nutrition



BERRIES AND HUMAN HEALTH

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Berries are the best dietary sources of bioactive compounds. They have low energy and fats, but high dietary fiber (cellulose, hemicelluloses, pectin), organic acids (citric, malic, tartaric, oxalic and fumaric), and certain minerals in trace amounts. Berries invariably rank high due to their powerful antioxidant content. However, the total antioxidant capacity results from several classes of compounds, such as vitamin C and polyphenols, which have different impact on human health. About half of the antioxidant activity of raspberry is due to ellagitannins, a class of phenolic compounds predominantly found in the fruits of Roseaceaea family. Berry extracts, rich in polyphenols, have a range of biological effects that can have beneficial outcomes of human health.

A debate is raging in nutrition circle around the term “Superfruit”. “Superfruit” is a marketing term, not a scientific term. Nevertheless, the term and concept is loosely based on scientific data, and strength of the marketing is the potential health value of the consumers. This workshop is aimed to discuss the latest research findings to determine whether there were nutritional and agronomical evidence to support the claim of a fruit (species and varieties) being a “Superfruit” which have been used successfully particularly by the producers of blueberries and cranberries.

Keywords: Superfruits, bioactive compounds, polyphenols, marketing



PRUNING MISTAKES AND SUGGESTIONS IN TEA ORCHARDS IN TURKEY

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The tea plant (*Camelia sinensis* L.) is a perennial shrub in the form of a tree, with a lifespan of up to 100 years, with the ability to regenerate itself very rapidly in suitable climatic conditions, with constant shoot growth. Pruning is the most important cultural measures after the harvest. Tea leaves left to grow freely produce flowers and fruit while they shoot for tea production in very small quantities. Countries producing tea in the world, different pruning levels (light, medium, heavy pruning) are applied. When these different pruning methods are determined, climatic conditions (precipitation, altitude, soil structure, etc.) and cultural applications are taken as basis. Especially at high altitudes where vegetation period is short and in arid climates, pruning period is kept longer and appropriate pruning and flapping methods are applied. There are many problems with pruning in Tea Orchards and if you specify them in headings; 1. Pruning interval in Tea Gardens is long (10 years); 2. Misuse of equipment (pruning tools are maintenance-free and damage the plant); 3. Pruning workers do not have enough technical and practical knowledge about pruning. In this study, Pruning mistakes and suggestions in Tea Gardens in Turkey were examined in detail.

Keywords: Tea, Pruning, Mistakes, Suggestions, Turkey



A TRIAL TO ENHANCE COLD TOLERANCE OF PASSION FRUIT (*PASSIFLORA EDULIS*) CROP IN LEBANON THROUGH FOLIAR APPLICATION OF THE NATURAL OSMOPROTECTANT GLYCINE BETAINE

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Passion fruit (*Passiflora edulis*) cultivation is gaining growing interest by Lebanese farmers who are trying to diversify their income from agriculture. However, production volumes are low facing the high local demand due mainly to the plant preferences for tropical climate conditions which restricted the spread of this cultivation and limited it to coastal zones. The experiment aimed to expand passion fruit cultivation into new areas by enhancing its cold stress. It was carried out on seedlings of 2 purple varieties: Black Knight (BK) and Perfecta (PR) that were grown in 3 Lebanese regions: Louaize (LO), Ajaltoun (AJ) and Hrajel (HJ) with increasingly cold weather conditions. The goal was to investigate the effect of foliar application of the natural osmoprotectant Glycine betaine (GB) on cold tolerance of plants. Thus, plant performance was evaluated among plants treated by 2 different concentrations of GB (GB1:20mM and GB2:40mM) and compared to control (GB0:0mM). Separated and combined effects of the factors: Variety, GB concentration and Location was studied on various parameters (plant height, number of shoots, leaf number, internodal length, stem diameter and leaf area). Results of Repeated Measures ANOVA showed that average plant height and leaf number were mainly affected by the factor Location recording the highest values in LO compared to AJ and HJ especially regarding the treatment GB2. On the other hand, the combined effect of the factors Location and GB concentration was significant on average stem diameter, leaf area and number of shoots; At LO, the treatment GB2 has increased leaf area and internodal length of PR variety and the number of shoots of BK variety. GB applied with a concentration 40mM improved plant growth mainly in LO and had a non-significant effect in colder conditions (AJ and HJ) showing no significant effect on cold tolerance of passion fruit plants.

Keywords: *Passiflora edulis*, cold tolerance, Glycine betaine, foliar application, growth



COMPARISON BETWEEN GROWTH AND PRODUCTION OF SELF-GRAFTED AND CROSS-GRAFTED ANNONA SPECIES IN COASTAL REGION OF SOUTH LEBANON

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Annona fruit is grown as an alternative to local fruits in the coastal zone of South Lebanon. This cultivation has been expanding due to increasing local demand. The study investigated the growth and production of 3 annona cultivars formed by self- or cross- grafting combinations of sugar apple (*Annona squamosa* L.) (Sq) and cherimoya (*Annona cherimola* Mill.) (Ch): Sq/Sq, Ch/Ch and Sq/Ch.

Results showed that cross-grafting allowed superiority in all measured parameters with the exception of root ramification and internodal length. In general, it enhanced root growth by increasing the number of primary roots by 7.3% and 20.7% compared to Ch/Ch and Sq/Sq respectively. The diameter of the main root was the highest in Sq/Ch (5.92 cm) compared to Ch/Ch (5.14 cm) and Sq/Sq (3.23 cm). Cross-grafted cultivar showed also an improvement in plant height by 5.19% and 30%, in number of lateral shoots by 7.1% and 33.3%, in leaf number by 20.2% and 25%, in leaf area by 34.1% and 46%, in trunk diameter by 28.1% and 46%, in flower number by 75.3% and 37% and in fruit yield by 96.6% and 60.4% compared to Ch/Ch and Sq/Sq respectively for all parameters. Moreover, dry matter accumulation in plant leaves, shoots and roots was the best in Sq/Ch. Not only cross-grafting has enhanced the vegetative growth but it did also affect positively fruit quality by increasing pulp percentage. Therefore, combining sugar apple scion and cherimoya rootstock allowed a better adaptation to soil and climate conditions of South Lebanon inducing amelioration in productivity and an increase in farmers' returns from this type of cultivation.

Keywords: South Lebanon, annona, self-grafting, cross-grafting, growth, production



CREASING IN SWEET ORANGE: ROLE OF COBALT SULFATE

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Creasing is physiological disorder which is detectable at maturity or at colour break stage. The cobalt sulphate (CoSO_4) with different concentration of 0, 125, 250 and 500 mg.L^{-1} was applied at the fruit set, the golf ball or the colour break stage to control creasing and to improve rheological properties of sweet oranges cv. Washington Navel and Lane Late fruit during the 2011 and 2012. Thirty five ripe fruit per replication were harvested randomly to determine the incidence of creasing, rheological properties of fruit and rind. Creasing incidence considerably reduced, when CoSO_4 (500 mg.L^{-1}) was applied at golf ball stage (29.29 and 34.29 %) compared to control (51.34 and 57.14 %) in cv. Washington Navel during 2011 and 2012, whilst, similar trend was observed in cv. Lane Late during the year 2011 and 2012. The treatment of CoSO_4 (500 mg.L^{-1}) was more effective when applied at fruit set stage to improve the rind tensile strength (47.72 and 64.05 N in both cultivars, respectively). However, the rind hardness (25.75 N), rind thickness (5.13 mm) was higher at colour break stage in cv. Lane Late. In conclusion, the exogenous applications of CoSO_4 substantially reduces the creasing incidence, improves rheological properties of fruit and rind in Washington Navel and Lane Late sweet orange fruit.

Keywords: Ethylene, Senescence, creasing, sweet orange, cobalt sulfate



STUDY OF ERYTHROMYCIN AND COPPER SULFATE EFFECTS IN CONTROLLING WITCHES' BROOM DISEASE OF LIME (WBDL)

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Mexican lime (*Citrus aurantifolia*) is cultivated in tropics and warm subtropical regions. Many Mexican lime orchards in Iran are affected by witches broom disease (WBDL), which is caused by *Candidatus Phytoplasma aurantifolia*. This plant pathogen is prokaryote (pseudo-bacterial), and affects on chlorophyll synthesis and results in narrowing leaves, shorter internodes and eventually leaves and branches turn yellow. This study was conducted to investigate the effect of chloramphenicol and copper sulfate in controlling of disease. A factorial experiment was carried out based on randomized complete block design (RCBD). The treatments were applied in 2 levels. Morphological symptoms including size of leaf, internode length, chlorophyll content, total carotenoids and total phenolic compounds were measured in control and treated plants .

Keywords: Mexican Lime, *Phytoplasma*, GA, IBA, *Citrus aurantifolia*





30th International Horticultural Congress

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I International Symposium on Avocado

ORAL PRESENTATIONS



IHC2018-Symposium 6

II International Symposium on Avacado

ORAL PRESENTATIONS

KEYNOTE 1

WORLD ACOCADO PRODUCTION, WHAT HAVE WE CREATED?

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Avocado demand is booming. Avocado consumption is increasing world-wide and plantings have increased in light of this demand and high prices. American consumption has increased from 1 Kg per capita to over 3 in the last 15 years and countries like China are embracing it for the first time. Mexico already consumes over 10 Kg per capita. Much of this demand is for the 'Hass' variety which is limited in the climatic range in which it will grow. On the supply side, weather and other factors have disrupted the steady growth needed to meet demand and prices have soared. The increasing demand has led to increased plantings in environments that are not compatible with the 'Hass' variety. This expansion of a single world-wide variety is not only inappropriate for many areas where growers want to plant, it is not good from a crop health standpoint where a disease or pest might destroy that one variety. There are already clear examples of how this has happened in certain crops, such as *Zea mays* and *Cochliobolus heterostrophus* and *Persea americana* and *Phytophthora cinnamomi*, fungal pathogens which have caused significant losses to single varieties of those crops. Within *Persea americana* there is significant variation of tolerance for such stresses as disease, pest, salinity, heat, frost and soil moisture. These attributes should be retained in the commercial varieties to ensure not only a tolerance in the crop, but also the availability of a range of fruit eating qualities.

Keywords: *Persea americana*, 'Hass', disease, pest



KEYNOTE 2

AVOCADO RIPENING: "WHAT NOT TO DO, WHAT TO DO AND WHAT IF?"

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Avocado is a climacteric fruit and is responsive to postharvest ethylene treatment to trigger ripening. Ethylene treatment of avocado is a widely utilized commercial practice which was initiated by the California industry in the 1980's. We will review the history of the commercial use of ethylene to ripen 'Hass' avocado and highlight the proper guidelines that need to be adhered for successful ripening. Topics to be covered will be fruit maturity, time after harvest and ripening temperature. We will also cover preliminary research on volatile active compounds and what role they play in the perception of avocado flavor as influenced by fruit maturity, ripening temperature and time after harvest.

Keywords: avocado, ripening, ethylene, temperature, maturity



KEYNOTE 3

UNDERSTANDING POLLINATION PROCESSES IN AVOCADO (*PERSEA AMERICANA*) ORCHARDS

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Avocado (*Persea americana*) is an important tree crop globally, and the fruit have high nutritional value. However, while production area increased 1.8-fold from 1994 to 2014, yield only increased 1.3-fold over the same time period. Pollination – the placement of viable pollen on a receptive stigma – is a key biological process required for ovule fertilisation and fruit production for most crops, so it is important to manage crop systems to ensure that pollination is not limiting production. Fruit-set rates in avocado are typically less than 0.3%, while hand-pollination often achieves about 5% fruit set, suggesting that fruit set could be partly limited to insufficient pollination. We investigated whether pollination was limiting avocado production in New Zealand, to develop guidelines for growers to optimise fruit set. While receptive female flowers were visited multiple times by potential pollinating insects, few insects carried more than 100 pollen grains (e.g. 6% of flower-visiting honey bees, *Apis mellifera*), and we recorded no pollen deposited on more than 80% of all female flowers. Honey bees, bumble bees (*Bombus* spp) and flies exhibit different patterns in the amount of pollen carried and deposited from polleniser male flowers to female ‘Hass’ flowers, suggesting that differences in behaviour affect the rate of pollen movement. Improving the rate of pollen movement and deposition in avocado orchards is critical to ensure pollination does not limit fruit production. Our research demonstrates the importance of understanding key metrics of pollination and provides a template for monitoring and managing pollination in avocado orchards globally.

Keywords: pollinators, floral biology, honey bees, bumble bees, cross-pollination, self-pollination, orchard design



THE INTRODUCTION OF WEST INDIAN AVOCADOS TO SOUTH FLORIDA, USA

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The avocado (*Persea americana* Miller) is a traditional American native. Three major types were eaten by pre-Columbian peoples from Southern Mexico to northern South America; namely the Mexican (*P.americana* var. *drymifolia*), Guatemalan (*P.americana* var. *guatemalensis*) and West Indian (*P. americana* var. *americana*) races. In the lowlands of Tropical America, local selections of West Indian avocados dominate regional markets. The expedition was focus in local West Indian avocado selections of superior fruit quality and adaptation to the climatic and edaphic conditions of the area. Working with local collaborators we concentrated our collection efforts on superior selections within home gardens, public areas and small orchards of each region. More than 200 different selections of West Indian avocado were collected during 4 years of Costa Rica, the Dominican Republic, Nicaragua, El Salvador, Guatemala, Panama and Puerto Rico. As a genetic resource, these selections hold promise for the improvement of disease resistance (phytophthora root rot), fruit quality and productivity of avocado throughout Tropical America and the world. Evaluation of fruit and tree characteristics began in 2005 and we have now identified several green- and red-skinned cultivars with promise for commercial and landscape use in Florida and in Tropical America, Africa and Asia.

Keywords: *Persea Americana*, West indian avocado, phytophthora.



APPLYING NON-HOST CRITERIA AND FRUIT FLY POPULATION MODELS TO OBTAIN MARKET ACCESS FOR WEST AUSTRALIAN AVOCADOS

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Avocados are a valuable export crop from the south-west of Western Australia where the Mediterranean fruit fly is present. Eradication methods being such as sterile insect techniques require many years for success. Meanwhile, market access must be retained, and new markets gained. The non-host status of avocado fruits was assessed for Hass, Sharwil, Fuerte and Reed cultivars. Adult fruit fly populations were monitored in orchards for 5 years and fruits were sampled for infestation of immature stages. Data was obtained of host fruit GDD (growing day degrees) and pest IDD (insect day degrees). This shows that avocados are not hosts of Mediterranean fruit fly. The work also showed that Western Australian avocados are grown in areas of low pest prevalence. This enabled the avocado industry to gain market access within Australia.

Keywords: Mediterranean fruit fly, quarantine security, host status, area of low pest prevalence, area wide management



DISTRIBUTION, DETECTION AND MANAGEMENT STRATEGIES FOR AVOCADO SUNBLOTCH DISEASE (ASBV) IN SOUTH AFRICA

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Avocado sunblotch disease (ASBV) is an infectious viroid disease of economic importance that is caused by Avocado sunblotch viroid (ASBVd). The disease has a very narrow host range and is limited to the family Lauracea, only infecting avocado. ASBVd infects all known commercial avocado cultivars with infected trees producing lower yields and fruits with poor marketability due to poor quality. Typical symptoms are found on leaves, fruit and bark of the tree. The objectives of the study were to investigate ASBVd distribution, optimal detection methods and factors affecting management strategies of ASBV in South Africa. To study the distribution of ASBVd, random sampling for ASBV was done in two provinces, Limpopo and Mpumalanga, in South Africa. A total of 30 commercial farms and 4 nurseries were visited and 310 trees were randomly collected and tested with the optimised method. In this survey, 11.1% of the trees tested positive for ASBVd. The distribution of ASBVd within a single plant was studied and an uneven distribution of ASBVd between branches and in the fruits were detected. This finding has huge implications for optimising detection methods and sampling strategies for indexing of avocado trees. A tree displaying no symptoms on the leaves or on the fruit tested positive in all branches and in all symptomless fruit. These symptomless carriers is currently the main concern for the avocado industry and precise sampling strategies and detection systems need to be in place to reduce the spread of ASBVd.

Keywords: Avocado sunblotch viroid (ASBVd), ASBV, symptomless carriers



POLYPHAGOUS SHOT HOLE BORER-FUSARIUM DIEBACK, A NEW PEST-DISEASE COMPLEX THREATENING AVOCADO AND URBAN FOREST IN CALIFORNIA

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Polyphagous shot hole borer (*Euwallacea nr. fornicatus*) (PSHB) an invasive ambrosia beetle that forms symbioses with multiple fungal species, *Fusarium euwallaceae*, *Graphium euwallaceae*, and *Paracremonium pembeum* which together cause a disease called Fusarium Dieback (FD) on avocado and urban forests in California and Israel. Females are black colored and about (1.8 – 2.5) mm long; males are brown colored and about 1.5 mm long. In California, PSHB was first reported on black locust in 2003 but there were no records of fungal damage until 2012 when the *F.euwallaceae* was recovered from the several backyard avocado trees infested with PSHB in Los Angeles County. The aim of this study was to determine the plant host range of the beetle-fungus in two heavily infested botanical gardens in Los Angeles County. Of the 335 tree species observed, 207 (62%), representing 62 plant families, showed signs and symptoms consistent with the attack by PSHB. The *F.euwallaceae* was recovered from 54% of the plant species attacked by PSHB, indicated by the presence of the *F.euwallaceae* at least at the site of the entry hole. Trees attacked by PSHB included 11 species of California natives, 13 agriculturally important species and many common street trees. Survey results also revealed 19 tree species that function as reproductive hosts for PSHB. Since 2012, the number of reproductive hosts for PSHB has increased from 19 to 60 and includes 19 species that are native to California. The infestation has spread from a single county in 2012 to seven counties in 2017 in California and recently in Tijuana, Mexico. Furthermore, the infestation was originally limited to the urban forest, but it has recently spread into native forests in southern California.

Keywords: ambrosia beetle, *Euwallaceae* sp. polyphagous shot hole borer, *Fusarium* dieback



THYME OIL LOW-DENSITY POLYETHYLENE IMPREGNATED PELLETS IN POLYLACTIC ACID SACHETS IMPROVES POSTHARVEST QUALITY OF READY-TO-EAT AVOCADO

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Due to the promising results for the control of anthracnose in avocado fruit by thyme vapours, this study was conducted to test the efficacy of the efficacy of the thyme oil vapours in commercial use in tray packs on the improvement of postharvest quality especially on the control of anthracnose and retention of dietary phytochemicals, fatty acid composition, D-mannoheptulose sugar and fruit quality in ready to eat avocado fruit. The 10% TO-LDPE-P significantly reduced the incidence severity of anthracnose and enabled the retention of dietary phytochemicals (p-coumaric, ferulic and caffeic acid, catechin and epicatechin), fatty acids, mannoheptulose, fruit firmness and taste compared to the currently used prochloraz® fungicide treatment. The results of this study strongly suggest the incorporation of 10% TO-LDPE-P in PLA sachets in commercial avocado tray packs as a natural option to improve fruit health, dietary phytochemicals, fatty acid composition and consumer satisfaction.

Keywords: *Persea americana*, *Colletotrichum gloeosporioides*, volatile vapours, hydroxybenzoic acid derivatives, hydroxyl cinnamic acid derivatives, omega-9 fatty acid, D-mannoheptulose.



COMPARISON OF PHYSICO-CHEMICAL QUALITY OF AVOCADO FRUIT (PERSEA AMERICANA MILL) CV. HASS PRODUCED IN COLOMBIA WITH INTERNATIONAL QUALITY STANDARDS

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Hass avocado is one of the most consumed fruits around the world. Colombia has started to export this fruit under fresh conditions. Since fruits quality is an important factor for exporting and consumer acceptance, it is quite important to establish physicochemical quality parameters of avocado in harvest maturity (HM) and commercial maturity (CM) for reducing losses and heterogeneity during postharvest. The aim of this study was to evaluate physicochemical properties of Hass avocado harvested in four different zones in Colombia and compare them with international standards. Fruits were collected during the first production season in Colombia and they were selected based on exportation standards. Initial weight and equatorial diameter avocado were determined. Dry matter, oil content, flesh firmness and pH were characterized at harvest or commercial maturity after 15 days of storage at 20°C and 90% of relative humidity. Results showed that avocado fruits weigh between 170 and 210 g which correspond to a median size compared with international standards. Avocado maturity index in HM and CM presented a high variability, differing from international quality standards. HM firmness results showed high values, up to 80 N and for CM less than 15 N, pH also showed difference to quality international standards. Physicochemical characteristics of fruits produced in Colombia were generally different from the international standard requirements, therefore specific quality parameters are required to catalogue Colombian production.

Keywords: harvest time, commercial quality, maturity index, weight, dry matter, oil content.



A CONUNDRUM OF AVOCADO ‘HASS’ FRUIT SKIN COLOUR CHANGE: THE SOUTH AFRICAN PERSPECTIVE

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In the last 5 years, countries importing South African ‘Hass’ avocado fruit have been complaining about poor skin colour change during ripening. ‘Hass’ avocado fruit are supposed to change skin colour from emerald green to purple to black during ripening as an indication of ripeness. A deviation from this important consumer deciding quality parameter affects promised quality, thereby, compromising market competitiveness. In response, the South African Avocado Growers’ Association (SAAGA) commissioned the Agricultural Research Council – Tropical and Subtropical Crops (ARC-TSC) to investigate both pre- and postharvest factors causing such a conundrum. Therefore, the aim of this study was to investigate several pre – and postharvest factors which could explain poor ‘Hass’ avocado skin colour development during ripening. To date, we have separately investigated the effect of harvest time, minerals, orchard topography (upper and lower slopes), production regions, and canopy position (inside and outside canopy fruit), branch girdling, tree load adjustment and ripening temperature. The results confirmed that ‘Hass’ avocado poor skin colour change is predominantly an early to mid-season occurrence. The effect of skin minerals, orchard topography, production region and canopy position had a minimal role in improving ‘Hass’ avocado skin colour change during ripening, especially for early to mid-season fruit. Tree girdling significantly reduced ‘Hass’ avocado fruit skin quality (colour change) by increasing external chilling damage. Higher ripening temperatures (21 and 25°C) could only improve skin colour change for late season fruit when compared with lower temperatures (16°C). Ultimately, adjustment of crop load to 25-50% seems to improve ‘Hass’ avocado fruit skin colour change, especially for early to mid-season fruit. Therefore, we could hypothesize that early to mid-season fruit prioritize sugars towards the seed not the skin. Sugars (glucose) are a substrate in the synthesis of purple colour associated pigment in ‘Hass’ avocado viz. cyanadin-3-O-glucoside.

Keywords: ‘Hass’ avocado fruit, skin colour change, pre-and postharvest factors



TRANSCRIPTOMICS OF ADVENTITIOUS ROOTING POTENTIAL IN AVOCADO PROPAGATION

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Avocado (*Persea americana* Mill.) is a highly nutritious fruit of immense popularity. As orchards expand to meet consumer-driven increases in demand, the rapid propagation of elite cultivars is of the utmost importance. The clonal propagation of avocado rootstocks however, is a significant bottleneck to the industry due to the immense recalcitrance to adventitious root (AR) generation. This recalcitrance hinders both existing nursery-based propagation, in addition to the development of emerging tissue culture pipelines. We have observed that in tissue culture, shoots of some cultivars generate AR much more readily than those of others, including some of the more industrially relevant cultivars. To examine why one cultivar was AR responsive to a treatment in which the other cultivar was not, an RNAseq with qPCR validation was completed. Plant material was sequenced from tissue cultured shoots of an easy-to-root (AR+) and a difficult-to-root (AR-) cultivar 72 hours after treatment with either mock or root-inducing substrates. A selection of genes significantly differentially regulated between treatments and across cultivars were selected for validation by qPCR. These genes were also profiled across additional treatments and time points (0 hours and 24 hours) for each cultivar, to further dissect their relationship to rooting phenotype. The molecular profiles of these genes, many of which have not previously been implicated in AR, provide invaluable insight into avocado AR regulation and will guide improvements to rooting protocols into the future.

Keywords: Avocado, Transcriptomics, Micropropagation, Adventitious root formation,



EFFECT OF PACLOBUTRAZOL OR POTASSIUM NITRATE SPRAYED DURING THE PERIOD OF INFLORESCENCE DEVELOPMENT AND SHORTLY THEREAFTER ON FRUIT RETENTION, SIZE AND YIELD IN MALUMA HASS AVOCADO

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Prior research has shown that sprays of paclobutrazol (1.25 or 2.5 g/l a.i.) during the inflorescence development period of Hass avocado reduce the vigour of new shoots arising in spring and increase fruit size. As a consequence, yield is increased, and the canopy expansion reduced. Furthermore, the fruit calcium concentration was increased. Calcium concentration and fruit disorder incidence are considered to be negatively correlated. Potassium nitrate application during inflorescence development has been associated with increased fruit retention in Mendez avocado

Application of both paclobutrazol and potassium nitrate on Maluma Hass avocado inflorescences was evaluated in the current study. Paclobutrazol with or without potassium nitrate at 2 or 3% (w/v) was spray applied when the inflorescences were developing and setting fruits (September 2017). Potassium at 2 or 3% was again applied 10 days subsequently. Mature leaves at the base of the inflorescences were sampled to assess the effect of the sprays on leaf nutrient concentrations. The fruits on labelled inflorescences were counted subsequently in mid-November, mid- December, and at harvest to assess the patterns of fruit drop. Tree yield, and the fruit size distribution were determined at harvest. Physiological disorder incidence of 20 fruits sampled per tree was determined after extended “export” cold storage. 10 fruits were also sampled per tree for paclobutrazol residue testing. The results are discussed with a view to commercial adoption of the applications in question.

Keywords: Plant growth regulator; vigour control; canopy spread; residue; fruit calcium



BREAKING THE GLASS CEILING OF AVOCADO YIELDS: ACCOUNTING FOR THE PERIODIC DEMAND FOR WATER AND NUTRIENTS

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‘Hass’ avocado (*Persea Americana* Mill.) trees are vigorous and the potential photosynthetic capacity of mature trees can support commercial crop yields higher than 30 t ha⁻¹. However, alternate bearing and fruit abscission generally limits the long-term average crop yield to less than 10 t ha⁻¹. The main objective of this study was to assess the seasonal water and nutrients requirement of ‘Hass’ avocado trees, especially during flowering and the early period of fruit development that may affect later on the fruitlet abscission and determine crop yield. Different field and lysimeter experiments in Israel indicated that obtaining fruit yield of 30 t ha⁻¹ is achievable. These experiments clearly indicated the importance of understanding the phenological process of ‘Hass’ avocado and that optimal irrigation and fertilization managements may be the crucial key for doubling ‘Hass’ avocado yield. The experimental irrigation and fertilization treatments in these studies have practically not affected the vegetative growth, flowering or fruit-set processes, but have induced significant differences on fruitlet abscissions and accordingly, on fruit yield. Fruitlet abscission was the outcome of a multifaceted process starting few months before it occurred, rather than a sudden and abrupt event as one could imagine from the visible aspects of this phenomenon. The causes for fruitlet abscission were attributed to malfunction of embryo or seed induced by water and/or nutrient deficiency during the early period of fruit development. The specific conclusions were: (i) continuous fertilization of all the necessary nutrients, including phosphorus and micronutrients throughout the year; (ii) special effort should be made to provide periodic demand for water and nutrient during the inflorescence and fruit-set processes; (iii) plant-based methods should be used for controlling the irrigation management (scheduling and quantities); (iv) fruit load should be taken into account while planning irrigation and fertilization management.

Keywords: fertigation scheduling; fruit analyses; Lysimeter; *Persea Americana*; Zn nutrition



MICROPROPAGATION; EFFICIENT ALTERNATIVE FOR CLONAL PROPAGATION OF AVOCADO (*PERSEA AMARICANA* MILL.)

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The world avocado industry is growing at an exponential rate and the gross world production value is over US\$ 4550 million. Popularity of this fruit is ever increasing due to its high nutritional value and health benefits. The industry is setting high productivity targets through orchard expansion and high-density plantings to cater the demand.

Avocado is a perennial, grafted orchard plant. To maintain consistent beneficial traits of rootstock and scion, clonal propagation of elite cultivars is essential. Therefore, the rapid growth of avocado industry is largely depending on plant propagation. However, the industry practice of clonal plant propagation adopts a lengthy and laborious process due to the great difficulty in rooting avocado cuttings from mature trees. This creates short supply of plants and high investment requirements for orchard expansion in many countries. An efficient alternative mass propagation technology is paramount to meet the expected hype in terms of expansion, especially in countries where high labor costs are involved for propagation. Micropropagation technology has been very effective for commercial propagation of many plant species. However, avocado being a woody plant, is highly recalcitrant to in vitro conditions. Over three years of research carried out in Mitter-laboratory, University of Queensland has successfully established the world's first high throughput micropropagation pipeline for one cultivar of avocado. Various parameters have been optimized to identify optimum conditions for all stages in micropropagation pipeline. Large number of plants have been acclimatized with 97% survival under nursery conditions. Micropropagated rootstocks, conventionally propagated rootstock and seedling rootstocks grafted with scion cv. 'Hass' have been planted in field for evaluation. The technology developed has a great impingement on both Australian and global avocado industry by meeting timely supply of high demand for clonal avocado plants.

Keywords: Avocado, Micropropagation, Shoot tip culture



ADVENTITIOUS ROOTING IN AVOCADO - UNRAVELLING THE BOTTLENECK TO PROPAGATION

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Avocado (*Persea americana* Mill.) is a highly nutritious fruit of immense popularity. As orchards expand to meet consumer-driven increases in demand, the rapid propagation of elite cultivars is of the utmost importance. The clonal propagation of avocado rootstocks however, is a significant bottleneck to the industry due to the immense recalcitrance to adventitious root (AR) generation. This recalcitrance hinders both existing nursery-based propagation, in addition to the development of emerging tissue culture pipelines. We have observed that in tissue culture, shoots of some cultivars generate AR much more readily than those of others, including some of the more industrially relevant cultivars. To examine why one cultivar was AR responsive to a treatment in which the other cultivar was not, an RNAseq with qPCR validation was completed. Plant material was sequenced from tissue cultured shoots of an easy-to-root (AR+) and a difficult-to-root (AR-) cultivar 72 hours after treatment with either mock or root-inducing substrates. A selection of genes significantly differentially regulated between treatments and across cultivars were selected for validation by qPCR. These genes were also profiled across additional treatments and time points (0 hours and 24 hours) for each cultivar, to further dissect their relationship to rooting phenotype. The molecular profiles of these genes, many of which have not previously been implicated in AR, provide invaluable insight into avocado AR regulation and will guide improvements to rooting protocols into the future.

Keywords: avocado, adventitious root, RNAseq



AVOCADO INNOVATION IN MEXICO'S CENTRAL HIGHLANDS

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Mexico is the main producer, consumer, and exporter of avocado in the world. The Morelos' state, in the Central Highlands, was the second most important productive area, but its stance has been declining. Its yield and profitability are below the national average. Thus, the objective of this research was to analyze the dynamic of the innovations to find the key factors to increase the productivity and profitability of this area. A statistical sample of avocado farmers was surveyed. The innovations adoption mean was 48.4%. Administration and financing, organization, harvest and marketing, and irrigation were the key factors associated with the increase of yield and profitability. However, their innovations were the least adopted. The farmers used more the innovations related with environment care, mineral nutrition, crop management, and plant health. They had a high mean innovation breach (49%). The density and centralization index of the technical network was higher than the social one. But it is smaller. The main providers of technical knowledge to the farmers were the sellers of inputs. The personnel of the National Institute for Agricultural Research, and from the State Committee of Plant Health were less important. The education of the farmers was the factor with higher association with the yield. The avocado farmers can be divided in three groups. Those who adopted the higher number of innovations (63%) were the smaller one (18%), but they had the higher yield (12.1 t ha⁻¹). Based on this result, a training program, and a strategy to improve the adoption of innovations have been devised. It included the participation of actors with high number of interactions in the social network.

Keywords: yield, profitability, productivity, network analysis





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ORAL PRESENTATIONS



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II International Symposium on Date Palm

ORAL PRESENTATIONS

KEYNOTE 1

FERTILIZATION AND FRUIT SETTING IN DATE PALMS

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Control of pollination and fertilization in date palm are essential for development of high quality fruits. A high level of fruit set may cause an excessive fruit load, which will require expensive fruit thinning in order to prevent reduction in fruit size, quality and marketability. On the other hand, inefficient pollination results in low yield. The date palm female flower has three separate carpels. Upon pollination, only a single carpel develops into a fruit, while the others two degenerate. When pollination is inefficient, none-fertilized flowers may develop into parthenocarpic fruits, which have no commercial value. The aim of this study was to examine the fertilization and fruitlet development in 'Medjoul' dates under different environmental conditions, and to study the early development of normal fruitlet and developing parthenocarpic ones. Since the date palm is a very large plant, it is not practical to modify the environmental conditions of the entire tree. Therefore, temperature regimes were modified in planta in specific units, "Modular Phytotrons", assembled on individual inflorescences. Water-incubated pollen, irradiated pollen and non-pollinated control were used to induce abnormal fertilization and fruitlet development. We performed macro- and microscopic analysis, as well as molecular analysis during fertilization, fruit-setting and early fruitlet development of both normal and parthenocarpic fruits. The study enables better understanding of the fertilization process, as well as normal and parthenocarpic fruit development in date palm. The results of this research provide important implications for pollination techniques and fruit thinning protocols in the field.

Keywords: Date palm, Fertilization, fruit thinning, fruit development, temperature effects



IRRIGATION WATER MANAGEMENT IN DATE PALM (*PHOENIX DACTYLIFERA* L) UNDER ARID ENVIRONMENT

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Date palm (*Phoenix dactylifera* L.), a traditional crop closely linked to Arab culture, is well adapted to the hyper-arid environment of Kuwait. Nevertheless, the present irrigation practice in Kuwait relies on applying large quantities of water (> 200 m³.tree-1.yr-1) and use of inefficient delivery systems with enormous economic and environmental consequences. Recognizing the need for developing sustainable, efficient irrigation practices, long-term studies were conducted since 2009 to determine real-time irrigation needs of three widely cultivated date palm varieties, compare different soil moisture probes for real-time soil moisture monitoring and irrigation diagnosis, and evaluate the response of date palm varieties to deficit irrigation (50, 75 or 100% of crop evapotranspiration (ET_c) under Kuwait's harsh growing conditions. The lowest (3.22 mm/ day) and the highest (12.73 mm/day) ET_c were recorded in February and June, respectively. The annual ET_c varied between 2,307.16 mm.yr-1 in cv. Nabusaif and 2,725.08 mm.yr-1 in cv. Siwi, respectively. Consequently, the net irrigation requirements of these cultivars varied between 23,392 and 27,251 m³. ha-1.yr-1, respectively. Results also indicated that irrigating the palms @ 50% of their ET_c using the surface drip system significantly improved water-use efficiency without adversely affecting tree performance. The drill and drop multi-sensor capacitance probes (ex. Triscan, Sentek, Australia) were able to provide accurate data under challenging conditions and enabled better irrigation and water use insights that were valuable for irrigation water management. Compared to conventional multi sensor probes, their easier set up and installation could encourage their more widespread use as a tool to improve on-farm irrigation management decisions in commercial date cultivation and enable research that can benefit the irrigated agricultural sector through extension services or consultants. Findings of a series of studies conducted on irrigation water management in Date palm will be discussed in this presentation.

Keywords: Evapotranspiration, water-use-efficiency, irrigation requirement, deficit irrigation, multi-sensor capacitance probes, water conservation, deficit irrigation.



EFFECT OF POTASSIUM APPLICATION ON DEGLET NOOR DATE PALM PRODUCTION AND QUALITY

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Traditionally date palm mineral nutrition in Tunisian oasis is based on organic matter given every four years. However with news oasis extensions, growers start to look to chemical fertilizers for their date palms. Potassium is one of the major mineral elements and it is a key element involved in fruit quality. This experiment was established in a commercial garden of Deglet Noor in Rjim Maatoug Area in South Tunisia, to study the response of date palm to potassium fertilization using potassium sulphate in reference to a control. Potassium was supplied by two ways: soil spreading or foliar spray at 2%. Results showed an increase of yield in response to K supply. Foliar spray improved also date quality. An increase of average fruit weight was observed for treated date palms. A mineral analysis was also done for leaves and fruits from the two treatments with potassium and the control, showing significative differences.

Keywords:foliar spray, soil spreading, nutrient analysis, potassium sulfate



PREDICTION OF QUALITY PARAMETERS NON-DESTRUCTIVELY FOR BARHI DATES AT DIFFERENT STAGES OF MATURITY UTILIZING NEAR-INFRARED (NIR)

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Non-destructive and quick tool was developed to evaluate Barhi fruits quality at Khalal stage of maturity. Barhi fruits is popular and characterized by its sweetness, crunchiness, and yellow color. In the current study, NIR was utilized to correlate quality parameters (total soluble solids, moisture content, and b* color) at five stages of maturity (from Khalal (green, to yellow), and Rutab (brown) with spectrum analysis. Barhi quality parameters were found to correlate successfully well using NIR with a high coefficient of determination (R²) 0.97 for TSS; 0.94 for MC; and fair of 0.64 for b* color. It can be concluded that NIR is an effective non-destructive tool to predict fruit quality of Barhi at different stages of maturity during various postharvest operations.

Keywords: Near-infrared (NIR); Non-destructive; Barhi fruits; Dates, Maturation; quality.



TETRAPLOID DATE PALM

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A date palm ploidy chimera, showing a diploid and a tetraploid sector, gave rise to a tetraploid offshoot. This permitted to describe the effects of chromosome doubling on leaves, inflorescences and fruits. Tetraploid date palm leaves are longer, bear larger leaflets and spines and have a thicker rachis than normal diploid leaves. Tetraploid fruits are significant longer, wider and heavier than diploid fruits, with a larger pulp diameter, but show a larger percentage of inedible parthenocarpic fruits. Diploid parthenocarpic fruits are longer than seeded fruits, both tetraploid parthenocarpic and seeded fruits both show the same size. The occurrence of tetraploidy opens new perspectives in ploidy breeding in date palm. Pollination of tetraploid pistils with pollen from diploid males gave rise to a relative low number of triploid plantlets.

Keywords:ploidy, breeding, mutation



DEVELOPMENT OF MOLECULAR MARKERS FOR APPLICATION IN SEX DETERMINATION OF PHOENIX DACTYLIFERA L

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Date palm (*Phoenix dactylifera* L.) is one of the most economically important fruit crops in hot arid region, presently cultivated in many regions of Thailand. However, the problem that male and female trees could be clearly distinguished only five years after planting when the date palm is first flowering. The objective of research is to differentiate gender (male / female) in seedling stage of Thai date palm cultivar (KL1) by using a DNA marker technique. The DNA marker used as a PCR based with multiplex PCR among specific tetra-primers. These markers shown that, male date palm present two amplicons (430 bp and 320 bp) and female date palm present a single amplicon (430 bp). The result of the gender analysis of 100 seedling of the cv. KL1 were 50 male and 50 female seedlings. The 1:1 ratio found between male with female support the theory of gender distribution. It could be used in other cultivar; Deglet Nour, Hayani, Medjool, Tunisia and Bhahi, using the same DNA banding pattern. This study present the markers were developed for sex identification of date palm in seedling stage could reduce time from seven years (phenotype) to three hours (DNA marker).

Keywords: date palm, tetra-primers, multiplex PCR, DNA marker, gender



GENETIC CHARACTERIZATION OF DATE PALM (*PHOENIX DACTYLIFERA* L.) GERMPLASM CULTIVATED IN ALGERIA

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Algeria is one of the leading dates producer in the world and where 2.2 millions of inhabitants are economically dependent. Furthermore, dates production cover more than 20% of the total surface devoted for arboriculture. World date palm germplasm accounts thousands of cultivars, since in the only recent investigations on Algerian date palm inventory, over 940 cultivars have been reported to exist. This high genetic variability is mainly due to dioecious reproduction and to the secular traditional farming system practiced, particularly in the South-western Algeria. In the last decade, hundred of SSR loci for the identification of date cultivar have been developed in our Department and by the world , in order to build the first National database and to provide useful SSR markers for different application in molecular breeding. The present research reports the characterization of the most important 40 cultivars grown in Algeria and assessed by microsatellite markers. The results indicate that these markers, as expected, were very effective tool for evaluating genetic diversity in date palm and will certainly allow to better manage the genetic resources and to wider and enrich the present collection with new selective material for future breeding program. Cross-transferability in different species and genera was also evaluated.

Keywords:Diversity, Identification, SSR Markers, Analysis, Cross-transferability



CHARACTERIZATION AND SENSORY ANALYSIS OF SOME TUNISIAN DATE CULTIVARS CONSUMED AT EARLY MATURITY STAGE

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In Tunisia, more than 200 common date palm cultivars (*Phoenix dactylifera* L.) are currently listed. Some of these cultivars are consumed at early maturity stage (Khalal) and are generally under valorized. The objective of this study was a physicochemical and sensorial characterization of eleven common date fruit cultivars that could be consumed at the Khalal stage. The studied cultivars presented different physical characteristics expressed on size, weight, skin color and firmness. All cultivars presented visually a yellowish skin color confirmed by L* (55, 39 – 62, 12) and a* (5, 90- 10, 92) parameters. Firmness values are ranged from 2,73 to 6,62 Kg.cm-2. Moisture content, total soluble solids and titratable acidity were determined. Sensorial characterization based on visual characteristics and taste (astringency, sugar content and texture), showed that 'Bser Hlou', 'Arichti', 'Hlaw Bidha' and 'Lemsi' were the most appreciated cultivars. Results showed also, that some of the studied cultivars have high contents of total phenols and tannins and high antioxidant activity.

Keywords: date palm; postharvest; maturity stage; bioactive compounds



RECENT ACHIEVEMENTS ON DATE PALM MICROPROPAGATION

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Plant tissue culture technology has been extensively applied for the micropropagation of date palms in the arid regions. Elite date palm cultivars are micropropagated for establishing new commercial plantations. Somatic embryogenesis and organogenesis are the two pathways commonly used in date palm micropropagation. These two regeneration methods are manipulated by the growth hormones in different concentrations and combinations. Long term growth hormone usage during micropropagation process caused physiological disorders such as delayed flowering, production of abnormal inflorescences, dwarfing and pollen incompatibility in field grown micropropagated date palms. These physiological disorders caused customer dissatisfaction and concern. Quality assurance on uniform growth, early flowering and high yield from micropropagated palms without any physiological disorders in the field will support the marketing of micropropagated plants and survival of commercial laboratories. In our laboratory in Kuwait, for the last 25 years, date palm micropropagation integrated with field evaluation was carried out. More than 40 date palm cultivars were micropropagated and maintained in our date palm orchard. Through all the data collected during the long-term laboratory operations and field evaluation in commercial farms, recently, we have developed innovative techniques on low cost date palm micropropagation without compromising in quality of the product. The new developments are: 1. Reduction in 2 years requirement for plant production to 1 year, 2. Minimal usage of growth hormones only during initiation, 3. New liquid media for growth and multiplication, 4. Inverted culture technique for plantlet growth, elongation and hardening, and 5. Photoautotrophic culture before greenhouse transfer. The micropropagated date palm plantlets produced through our new system showed 100% survival and were healthy in the greenhouse due to the development of leaf cuticle, functional chloroplasts and stomata during the in vitro culture process. No physiological disorders were observed in our experimental field containing 5,000 micropropagated date palms. The details of our study are presented.

Keywords: Phoenix dactylifera, micropropagation, inverted culture technique, acclimatization, physiological disorders, commercialization.



FIRST FIELD RESULTS WITH SIVANTO PRIME TO CONTROL DATE PALM WEEVIL

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Red palm weevil (RPW, *Rhynchophorus ferrugineus* Olivier, 1970; Coleoptera: Curculionidae) is the most dangerous pest amongst others on date palm. It quickly spreads within farms and regions world-wide as the infestation is hardly detectable. The destructive larvae feeding inside the tree require effective control measures. A potent pest management product recently developed by Bayer AG represents an excellent control tool: Sivanto Prime (Flupyradifurone). It is based on the natural alkaloid stemofoline which delivered the lead structure for a new chemical class called Butenolide. Flupyradifurone is a systemic insecticide strongly effective against a broad spectrum of sucking pests beside others in a wide range of crops. In first field trials in Saudi Arabia to control RPW, Sivanto Prime was tested as soil drench application at 20, 30 & 40 g AI/tree in addition to 3.5 g AI/tree as overhead spray, at three times with a monthly interval. The newly developed not destructive evaluation method allowed more than one assessment timing. At 218 days after the last application Sivanto Prime still showed a strong residual efficacy. By using direct stem application it could be demonstrated that Sivanto Prime injected once at 20g AI/tree either under natural infestation in Saudi Arabia or under artificial infestation in UAE could stop the RPW development and prevented new infestation. The current results suggest a strong curative effect against all pest stages, with control levels similar or better than market standards. All Sivanto Prime treatments revealed to be plant safe.

Keywords: date palm, red palm weevil, innovative pest management





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SUSTAINABLE APPROACH TO ASIAN CITRUS PSYLLID CONTROL USING MOVENTO AND SIVANTO INSECTICIDES

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Asian citrus psyllid (ACP) is the insect vector for *Candidatus Liberibacter asiaticus* (CLas), the bacterium causing Huanglongbing (HLB). HLB is the most widely spread and destructive citrus disease responsible for the death of millions of citrus trees throughout citrus growing regions across the globe. Controlling ACP is the primary line of defense to reduce the incidence and severity of HLB in citrus trees. Many insecticides are effective in controlling populations of ACP. However, the greater use of some broad spectrum insecticidal products can have negative effects on natural enemies of secondary insect pests of citrus, resulting in outbreaks of those pests. This changing insect pest spectrum can dictate a switch in cultural practices and selection of insecticides. Although the mode of action (MOA) is important when selecting insecticides for control of ACP, equal consideration should be made to selecting insecticides with lower risk to beneficial insects and parasitoids and which fit well into integrated pest management (IPM) systems. Movento™ (spirotetramat) and Sivanto™ (flupyradifurone) are two newer insecticides that complement each other in the control of ACP. These insecticides are representatives from different MOAs and studies have demonstrated less negative effects on many beneficial insects and parasitoids common in citrus resulting in greater ecological sustainability in citrus production. Movento is safe to most predatory and parasitic insects, and pollinator studies demonstrate Sivanto's favorable honey bee safety profile.

Keywords: Citrus, Asian Citrus Psyllid, Integrated Pest Management, Beneficial and Pollinator Compatibility



FRUIT YIELD OF 'PERA' SWEET ORANGE GRAFTED ONTO CITRANDARINS IN CENTRAL REGION OF SÃO PAULO STATE, BRAZIL

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Based on the need of more cultivars efficient in the citrus industry, we investigated tree size and yield of 'Pera' sweet orange [*Citrus sinensis* (L.) Osbeck] grafted onto seventeen rootstocks produced by crosses between 'Sunki' mandarin (SM) x 'Rubidoux' trifoliolate (RT) [(*C. sunki* (Hayata) hort. ex Tanaka x *Poncirus trifoliata* (L.) Raf.)]. The 'Swingle' and 'W-2' citrumelo (*C. paradisi* Macfad x *P. trifoliata* (L.) Raf.), as well the 'Sunki' mandarin (SM) x 'Benecke' trifoliolate (BT) [(*C. sunki* (Hayata) hort. ex Tanaka x *P. trifoliata* (L.) Raf.)] were used as controls. The trial was established in the Central region of São Paulo State, Brazil, with irrigation, in a randomized block design, with three replications and four plants per plot (550 trees ha⁻¹). Fruit yield, canopy volume and yield efficiency of 4-year-old trees were evaluated in July 2017. Data were submitted to analysis of variance and means were compared by the Scott-Knott test (P-1). Trees grafted onto SM x RT 18, 124, 128, 137, 70, 73, 68, 26, 47 and 139 exhibited better horticultural performance related to fruit yield efficiency (kg m³ of the canopy) when compared to those onto the control rootstocks. Therefore, we identified rootstocks more suitable to high-density planting of new orchards.

Keywords: High-density planting, *Poncirus trifoliata*, rootstock, *Citrus sinensis*.



RESEARCH ON THE EFFECTS OF FOLIAR UREA APPLICATIONS ON FRUIT SET AND YIELD IN 'WASHINGTON NAVEL' ORANGES

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Low bi-uret urea application on 'Washington Navel' orange trees at six application times and a nontreated control was investigated for effects on fruit set and yield. Low bi-uret urea (1.75 %) was applied at 0.16 kg pure N per tree with 10 trees per treatment. Tagged leaves were counted at full bloom, small fruit, post-June abscission and pre-harvest periods. Yield per tree was recorded in the harvest period. All of the urea applications had positive effects on fruit set. As far as the fruit ratio reaching the harvest period from the June abscission is concerned, the February application produced significantly better fruit set than the untreated control. Our results indicate that foliar application of low bi-uret urea in February resulted in significantly improved yield. Urea application significantly increased the amount of the fruit.

Keywords: Washington Navel, Low bi-uret urea, fruit set, yield



RESEARCH ON ADAPTATION OF DIFFERENT TROPICAL FRUIT SPECIES TO ANTALYA CONDITIONS

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All the tropical fruit consumed in Turkey has been imported with the exception of banana (partial) and avocado. Banana, pineapple, coconut, avocado and mango are major tropical fruit species among this importation. In this project, adaptation of some guava, litchi, longan, passiflora and pitaya cultivars to Antalya conditions (Alanya and Gazipaşa) were investigated in between 2013 and 2016. In this research, adaptation of the species to different locations by means of; growth responses to ecological conditions, yield and quality performances and fruit marketability were investigated. The results showed that all tested species can be grown in Macar and Yakacık locations which represent microclimatical (warmer) conditions. Besides, pitaya and passiflora species those were superior for yield, quality, early fruiting and marketing. Guava was superior for plant adaptation but not for marketing due to the short shelf-life. In addition, taste and flavour of guava was not appealing for most of the consumers. While the taste of mango was found very appealing, plants were found to be quite sensitive to cold and sunburn in the first years of planting. The other species, litchi and longan bear fruit in the second year of planting. Litchi has found attractive in terms of fruit taste, appearance and marketing. It was found that mango, litchi and longan trees could reach high yield in longer time. On the contrary, pitaya, passiflora and guava were bear in shorter time. According to initial findings, it is concluded that all tested species except for passiflora could not be grown in open-field in Alanya, representing subtropical conditions. In conclusion; guava, pitaya, longan, litchi and mango species were found in adaptation respectively while mango and litchi were superior for their fruit taste; pitaya was superior for fruit color, appearance, and marketability.

Keywords: Microclimate, subtropic, pitaya, passiflora, litchi, mango, quality, yield, marketing.



A ROBUST SET OF STANDARDISED PRODUCTIVITY AND FRUIT QUALITY TRAIT MEASURES FOR THE AUSTRALIAN PAPAYA INDUSTRY

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Productivity traits and visual appearance are the first quality determinants applied by growers, wholesalers, retailers or consumers along the whole of the papaya supply chain. However, many of these traits are quantitatively expressed, highly variable under different environments and open to subjectivity without clear descriptors or standardized ranges of acceptability, particularly for the recently developed new cultivars. Therefore, there is urgent need to update and expand on the initial descriptors captured within the Papaya Fruit Evaluation keybook developed by International Board for Plant Genetic Resources (IBPGR) in 1988.

After consulting with a reference group of papaya growers, breeders and marketers from across the papaya industry in Queensland, Australia, a suite of traits were identified that are considered to be highly important in applied papaya breeding and for future factorial standardisation for supply and marketing use throughout the papaya industry. The traits included: 1) Those associated with productivity: Total saleable yield, consistent fruit set over time (i.e. no yield gap), consistent fruit size, ease of harvest and disease resistance; and 2) Those related to fruit quality: Appearance, fruit shape, flesh colour, sweetness and flavour. Accordingly, the trait descriptors, ranges and their methods of analyses were compiled by Kanchana-udomkan et al. (2015) and subsequently adopted by the Australian papaya industry as a set of tools for robust, reliable and practical evaluation of these traits.

Keywords: fruit quality traits, tree productivity traits, protocol, breeding, evaluation



RUJAKBASE; AN MULTI-OMICS DATABASE FOR ENHANCING RESEARCH ON INDONESIAN FRUITS

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Genetic resources of fruits native to Indonesia is the richest in the tropical region and has a great potential in the future utilization. Therefore, a set of databases is needed to collect information in which can be used by the researchers and the growers. RujakBase is a web-based database that provides a valuable repository that is useful for basic, translational, and applied research. The main goal is to collect, analyze, integrate genetics, genomics, transcriptomics, and metabolomics data to enhance more rapid research progress. RujakBase platform was developed using Tripal module under the integration of Drupal-based CMS and GMOD Chado database scheme. The database can be accessed at <http://www.rujakbase.info>. All of the content includes organisms (species), sequence analysis, and publication were retrieved from public databases like NCBI and other reliable sources. The RujakBase currently consists of 10 genera of Indonesian native fruits namely Artocarpus, Baccaurea, Bouea, Flacourtia, Lansium, Nephelium, Pometia, Salacca, Spondias, and Syzygium. For the detail and future content, the database updates will frequently be performed.

Keywords: database, drupal, genetic resources, Indonesian native fruits, tripal



DEVELOPMENT OF AN ORGANIC SMALL-SCALE PINEAPPLE PRODUCTION SYSTEM IN CHAPADA DIAMANTINA, BAHIA, BRAZIL. 1. FROM SOIL PREPARATION TO PLANTING

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In Brazil, the second largest pineapple producer in the world, pineapple production is carried out by tens of thousands of small to medium-sized producers in a conventional system, with heavy use of mineral fertilizers and other synthetic chemical inputs, mainly for the control of fusariosis (*Fusarium guttiforme*) and pests. However, there is a growing national and international market for the consumption of organic pineapple. Embrapa Mandioca and Fruticultura established a technical partnership with the company Bioenergia Orgânicos, aiming to develop technical recommendations for the organic cultivation of pineapple, in the environmental conditions of the region of Lençóis, Chapada Diamantina, State of Bahia. Using several experimental designs, the technical team conducted over five years studies on all major aspects of pineapple cultivation, from the production of planting material to fruit harvesting. In this first part of the work, results and technical recommendations were obtained for the production of planting material from stem sections, soil preparation and the planting system for the cultivars Pérola, which is the most traditional one in the country, and Imperial, cultivar with resistance to fusariosis.

Keywords: *Ananas comosus* comosus, cultural system, cv.Pérola, cv.Imperial



MEMBRANE PHOSPHOLIPIDS COMPOSITION DURING SOFTENING PROCESS OF 'MANILA' MANGO (*Mangifera indica* L.)

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One of the main problems that limit the shelf life and that determines the perception of the quality of the fruits by the consumer is the softening process. It has been proposed, that softening process involves various mechanisms and metabolic processes, being the plasma membrane one of the most important structures involved. The objective of the present work is to generate basic knowledge about the participation of the integrity and functionality of the cell membrane in the loss of firmness of 'Manila' mango fruits. To study the mechanism by which mango fruits 'Manila' present a rapid softening or loss of firmness, it was first proposed to identify a treatment by applying a commercial wax to control the softening during ripening of the fruits. Plasma membrane integrity was also studied in the control and waxing treatment by quantifying the electrolyte leakage, the enzymatic activities PDL and phospholipids composition of the cell membranes. The results shown that the commercial application of wax did not affected the ripening process of the fruits, helps to decrease the loss of firmness, weight loss and improve the visual appearance. PLD activity is higher in the control treatment than in wax treatment 5.46×10^{-4} and 4.67×10^{-4} μm of choline/mg of protein, respectively. Phospholipid analysis indicated that there is a greater degradation in control fruit membranes than waxed fruits, which is demonstrated in a lower content of total phospholipids (1.31×10^8 y 1.58×10^8 abundance, respectively), as well as a decrease of these during the time of storage. It was observed that PC, PA and PE were the majority species. The molecular species PA (34: 1) was identified in greater abundance in the control treatment, suggesting that this is causing a delay in the maturation process.

Keywords: softening, membrane integrity, phospholipids.



CARPELOIDY IN PITAYA FRUIT

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Pitaya is a berry fruit with parietal placentation. The aberrant white color tissues embedded in the flesh are often seen in 'Fu Qui Hong' pitaya in Taiwan. In this study, we tried to infer their original tissue from morphological and histological observations, and whether this phenomenon happened is related to the environmental factors. Results were shown that these white tissues specific located on the placenta of stalk end, and could be divided into three categories: (1) filamentous-like structure, (2) folding and curving stigma-like structure, (3) flat banding structure that displayed circular arrangement. When compared the structures of stigma and style, they are highly similarity on trichome and the cell arrangement from the histological point of view. We suggested this may be the homeotic mutation in plants, which caused carpelloid structure occurred from the ovule. There are protuberances occur at adaxial end of placenta on 2 DAA (days after anthesis). Thereafter, povidone-iodine solution was used to differentiate the carpelloid tissues and immatured flesh on 10 DAA, and the obvious carpelloid structures were shown on 14 DAA. Interestingly, the carpelloid tissues highly occurred in regular harvest time (from June to May), and slightly or none in off-season (produced in December to May by night-breaking) in response to phenological growth of pitaya. The severe climate changes in recent years causes the high frequency of this phenomenon and was seen even in other pitaya cultivars. It is a notable issue in pitaya fruit business, and the further studies are needed to reduce this phenomenon.

Keywords: Hylocereus, dragon fruit, pistilloid, carpel, phenology



BIOCHEMICAL COMPOSITION OF SOME POMEGRANATE CULTIVARS AND GENOTYPES GROWN FROM HARRAN REGION

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Pomegranate fruit (*Punica granatum* L.) production and consumption has increased recently due to supported for the nutritional and medicinal characteristics and the antioxidant properties of this fruit. Although, many studies have been published on the morphological and biochemical characteristics of pomegranate cultivars, little information is available about the genotypes grown in Harran area (Southeastern region of Turkey). In the present study, pomological and physicochemical characteristics, organic acid, and phenolic compound contents of two cultivars and selected three local genotypes were investigated. The results showed that quantitative differences in pomological and biochemical composition of pomegranate cultivars and genotypes. In particular, fruit weight ranged from 178.70 g to 348.00 g, pH from 2.30 to 3.35 and brix from 14.00 to 17.00. Citric acid were the most dominant organic acid in pomegranate cultivars and genotypes followed by malic acid. Rutin and chlorogenic acid were the dominating phenolic compounds. The results revealed that there was diversity among pomegranate cultivar and genotypes for pomological and bioactive content. Genotypes were determined promising with high bioactive content therefore the genotypes can become study material for protecting gen sources and future breeding program.

Keywords: Pomegranate, organic acid, phenolic composition, Sanliurfa



INVESTIGATION OF FATTY ACID COMPOSITIONS AND SOME POMOLOGICAL CHARACTERISTICS OF DIFFERENT OLIVE CULTIVARS DURING MATURATION IN COOL SUBTROPICAL CONDITION OF TURKEY

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Olive (*Olea europaea* L.) has great genetic variation in Turkey as important crop due to its economic value. There are many cultivars, types and landraces with various morphological characters in different ecological conditions of Turkey, having good potential for productivity, oil quality and table olive characters. The northwestern region of Turkey with cool subtropical climate has most suitable ecological conditions for highest quality olives and olive oils. This research was carried out to pomological characteristics and fatty acid composition of eight local olive cultivars including 'Ayvalık', 'Domat', 'Edincik Su', 'Gemlik', 'Karamürsel Su', 'Memecik', 'Samanlı' and 'Uslu', which widely grown in Turkey. Cultivars were collected in intervals of about 10 days from September 15 to December 22 in 2014. In this research fruit weight (g of 100 fruits), pulp ratio (%), maturity index (MI) and fatty acid composition were determined. As a result of this study, 'Domat', 'Karamürsel Su' and 'Memecik' varieties had the largest fruits and 'Memecik' and 'Domat' cultivars had the highest pulp ratio (%). 'Karamürsel Su', 'Gemlik' and 'Samanlı' were found to the highest maturity index values at the end of harvesting time. 'Karamürsel Su' 'Domat' and 'Edincik Su' varieties had highest ratios of polyunsaturated fatty acids whereas 'Memecik' and 'Uslu' varieties had the highest ratios of monounsaturated fatty acids.

Keywords: *Olea europaea* L., domestic cultivars, maturity index, PUFA, MUFA



PHYSIOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF *Diospyros kaki* Thunb. UNDER VARIOUS CULTURE CONDITIONS

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In the Nikita Botanical Gardens the gene pool collection of persimmon preserved by two ways: open field collection and biotechnology collection. As a result of the development of a biotechnological system for subtropical fruits improvement and propagation, we studied physiological and biochemical features in plants of two persimmon cultivars Zolotistaya and Nikitskaya Bordovaya, growing ex situ and in vitro. In the collection plots under optimal vegetation conditions (early June), the water content in leaves of intact plants was 69-73% with water deficiency of 5-7%, photosynthetic activity – 0.70-0.73 a.u. The content of the protective compounds was high: the proline concentration was 55.63-70.65 mg/g, ascorbic acid – 1630-2188 mg/100 g, phenolic compounds – 2284-2362 mg/100 g. The enzyme activity was low: catalase – 1.70-1.81 gO₂/g • min, superoxide dismutase – 4.60-5.98 units/g, polyphenol oxidase – 0.083-0.085 units/g • s. As the hydrothermal stress increased (late July), the total water content slightly decreased up to 61-64%. The water deficit increased to 12% in the leaves of 'Nikitskaya Bordovaya' and not changed in 'Zolotistaya'. The indices of chlorophyll fluorescence induction denoted normal functioning of the photosynthetic apparatus. The content of proline and phenolic compounds decreased while catalase and superoxide dismutase activity increased ascorbic acid concentration and polyphenol oxidase activity changed differently. Under in vitro conditions, persimmon microshoots were cultured on MS medium with 4.0-5.0 mg/L BAP and 0.1-0.3 mg/L IBA. The total water content in leaves was high – 83-91% (water holding capacity was higher in 'Nikitskaya Bordovaya'), indices of chlorophyll fluorescence induction: (F_m - F_{st})/F_m = 0.54-0.60 a.u. The content of protective compounds and the enzyme activity were lower than in intact plants. Thus, it has been demonstrated that persimmon plants, under various culture conditions, were characterized with high resistance to the stress factors pressure. This study was funded by the research grant N 14-50-00079 of the Russian Science Foundation.

Keywords: persimmon, water regime, photosynthetic activity, protective compounds, enzyme activity, ex situ, in vitro



GROWTH AND DEVELOPMENT OF ASAI FRUITS IN GUAVIARE, COLOMBIA. I. MORPHOLOGICAL CHANGES DURING MATURITY

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Asai (*Euterpe precatoria*) is a wild palm that grows in different environments, floodplains and mainland that affects fruit performance during ripening and maturation. This study was carried out in order to determine morphological variations during fruit growth and development of asai in these two environments. Five stages were established I-V during asai ripening in both of them. The individual fruit changes were observed during maturity, mainly associated with color, so that, the fruits change from a dark green color until they reach a dark purple color during ripening. In general, the variables associated with the fruit showed significantly higher morphometric values for the palms located in the floodplains. In this study, a greater size and weights were observed in the fruits of the flood zones during the first 4 stages of maturation; however, towards state V, it was observed that the morphometric values of the fruits did not register significant difference when compared the two environments. Also, the number of fruits in the asai racemes was affected by the interaction between the state of maturity of the raceme. Raceme are distributed in apical, medium and basal parts (p

Keywords: racemes, apix, main land, floodable



GROWTH AND DEVELOPMENT OF ASAI (*Euterpe precatoria*) IN GUAVIARE- COLOMBIA. II. CHEMICAL CHANGES DURING RIPENING STAGES

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Asai (*Euterpe precatoria*) is a neotropical palm from the Amazonian region. It is a wild palm distributed in Venezuela, Brazil and Colombia. This palm grows in different environments, floodplains and mainland that influence fruit performance during ripening and maturation. This study was carried out in order to determine variations in respiratory activity, ethylene production, flavonoids, total anthocyanins, polyphenols and color in asai fruits during ripening in both environments in a forest in Guaviare, Colombia. These results showed that the fruits had five color stages: green, half ripen, ripen, fully ripen and mature, and exhibited a respiratory climacteric peak at the beginning of ripening, while the ethylene production was undetectable in fruits from the floodplain or firm land. Previous experiences with asai from Guaviare forests reinforce the present results; asai is a non-climacteric fruit that remains immature when it is harvested close to the green and half ripen stages. Phytoterapeutic compounds increased during the fruit ripening, anthocyanins, total phenolic compounds and polyphenols, which coincided with the color change from green to purple. The fruits had more total anthocyanins, total polyphenols and flavonoids during ripening; the fruits from the mainland always exhibited low phytoterapeutic compounds concentrations when compared to the floodplain fruits. This behavior could be associated with the extreme conditions in the floodplains, which reduces oxygen in roots and increases hydric availability and nutrients. As a result, the fruits from extreme conditions, such as the floodplains, were rich in phytoterapeutic compounds and could be considered for nutraceutic processing.

Keywords: Polyphenols, Total phenolic compounds, color, respiratory activity



PHYSICAL AND CHEMICAL ATTRIBUTES OF FEIJOA FRUIT IN VERACRUZ, MEXICO

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The feijoa is a new fruit tree recently cultivated in the tropical highlands of Veracruz, Mexico. Seedling trees of eight years old with a single application of compost per year yielded fruits of commercial size. Total soluble solids, pH, and acidity of the pulp in fruit stored at 4, 12 and 25 oC were similar to those reported in feijoa fruit growing in temperate zones. The carbohydrate, fat, fiber, ash, moisture and protein contents in the pulp differed slightly with those reported in the literature. The vitamin C concentration was higher in the shell than in the pulp. The concentration of vitamin C was 0.32 ± 0.05 mg g⁻¹ and 0.59 ± 0.11 mg g⁻¹ dry basis of the pulp and peel, respectively.

Keywords: Vitamin C, feijoa skin, guava pineapple, feijoa postharvest, new fruits for Veracruz



WINTER PINEAPPLE CAN BE CULTIVATED AND HARVESTED IN ONE YEAR

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The production of winter pineapple in Taiwan is planted in spring and harvesting in the autumn lasting for 18 months, which is a long term timing cost. This study aims to shorten the cultivation period and incorporate the managements not only to avoid the natural flowering and to speed up growth of seedling in winter but also to harvest winter pineapple in one year. This experiment selected seedlings around 500 to 700 grams, stripping the base of the old leaves, and completed field planting on 2016/11/21. To speed up the growth rate of seedlings and to avoid the winter natural flowering, high concentration of nitrogen fertilizer and ground mulch were used in this study. The plant can reach the standard size in summer for the artificial flowering to product commercial winter pineapple fruit. On 2017/6/8, the cumulative leaf number per plant reached 23 to 27, the height was 62 to 68 cm, the average length of D-leaf was 62 cm, and the successful rate of artificial flowering was 100%. Winter pineapples were harvested during 2017/10/24-10/30, meanwhile, 70% of pineapple fruit were at least 1.2 kg or higher in fresh weight, the average numbers of fruitlets were 113, and the total soluble solids can reach 12.4°Brix, which meets marketing criteria. Thus, we suggest that this cultivation and field management technique can shorten , winter pineapple production period to 12 months and improve land use efficiency.

Keywords: mulching, nitrogen fertilizer, growth rate, incorporated production model



MORPHOLOGICAL DIFFERENCES IN VEGETATIVE AND FRUIT CHARACTERS AMONG EIGHT PEPINO (*Solanum muricatum* Ait.) CULTIVARS IN JAPAN

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Despite the fact that the popularity of pepino (*Solanum muricatum* Ait.) cultivation is declining in Japan, we were able to purchase seedlings for eight pepino cultivars. We cultivated these eight pepino cultivars to investigate the characteristics of the plant and fruit as this information was not already available. Cultivation was conducted twice: i.e. from winter to summer (Experiment 1) and from autumn to spring (Experiment 2). The average number of flowers per inflorescence was markedly higher in 'Gold Q'. At the completion of the experiment, the average stem length (from the soil surface to the shoot apex) was longer in 'Applinnimee', 'Royal' and 'Royal Custard' but shorter in 'Philly'. The average fruit weight was higher in 'Applinnimee', 'Gold No.1' and 'Royal' (300 g or heavier in both experiments) but lower in 'Gold Q', 'Monroe Dance' and 'Philly'. The soluble solids content of fruits was highest in 'Gold Q' (7.6°Brix in Experiment 1 and 10.3°Brix in Experiment 2), relatively high in 'Gold No.1', 'Royal' and 'Royal Custard', and lowest in 'Gold Boy'. Fruits were heart-shaped in 'Applinnimee', circular in 'Gold Boy', 'Gold No.1' and 'Gold Q', rectangular in 'Monroe Dance', elliptical in 'Philly', and obovate in 'Royal' and 'Royal Custard'. The average proportion of purple streaks to total fruit surface was higher in 'Applinnimee', 'Royal' and 'Royal Custard' and lower to intermediate in other cultivars. Also, fruit weight and the soluble solids content of each cultivar varied with its cultivation period. These results provide useful information for the future production and breeding of pepinos.

Keywords: plant, stem length, fruit weight, soluble solids content



COMPARISON OF GROWTH AND FUNCTIONAL COMPONENTS OF CACAO (*Theobroma cacao*) IN JEJU ISLAND, KOREA

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Cacao (*Theobroma cacao*) is the base ingredient of chocolate originating in the Amazon region of South America. The cultivation of cacao is cultivated in Central America, Africa, Southeast Asia and tropical climate regions with annual average temperature of 23~27°C and annual precipitation 1,500~2,800mm. In order to select suitable cacao plants for cultivation of cacao in Korea, the Research Institute of Climate Change and Agriculture in Jeju Island conducted seed sowing and seeding of nine strains including cacao 'PA-310' in 2016. As a result of germination rate and survival rate of cacao, we selected cacao system suitable for cultivation in Korea. As a result, PA-310, PA-107, CCN-51 T1 and ICS-135 were selected for high germination and survival rates. Four selected cacao strains were cultivated by shading treatment at 35%, 55%, 75% and 95% for growth and functional content of cacao were compared. As a result, the content of total phenolic components was high in the 55% shading treatment and the highest in the PA-107 strain was 5.6 ug/ml. Total flavonoid contents showed no difference according to shading treatment. It is considered that PA-310, PA-107, CCN-51 T1 and ICS-135 system cultivation is suitable for cacao cultivation in Korea and 55% shading cultivation is effective for seeding cultivation.

Keywords: Cacao, Selection, Growth, functional content, Republic of Korea



GROWTH CHARACTERISTICS EVALUATION OF SOME PAPAYA LINES FOR PRODUCTION OF GREEN PAPAYA IN KOREA

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In order to develop papaya (*Carcia papaya* L.) as a new income crop, the growth characteristics of 9 papaya lines were investigated. Seeds were sown in November 2015 and were planted at 2.0m × 2.5m, in plastic greenhouse of Jeju Island, Korea, .from June to August 2016 The minimum temperature of greenhouse was kept above 8°C in winter season. The leaf length and leaf width were the longest in JCCCP0004. Harvesting times of mature fruit were early July but JCCCP0005 was started at late August. The rate of merchantable green papaya over 500g was higher in JCCCP0002, JCCCP0008, and JCCCP0009. The rate of merchantable ripened fruit over 250g were the highest in JCCCP0008. The fruit weight was the highest in JCCCP0009 at 848g. The soluble solids content were higher in JCCCP0001 and JCCCP0007 than that of others. Firmness was the highest in JCCCP0008 at 27.6 N. In taste evaluation, JCCCP3 was the highest in texture, aroma, juice.

Keywords: *Carcia papaya*, Cultivation, evaluation, varieties



COMPARISON OF FRUIT AND GROWTH CHARACTERISTICS OF MANGO CULTIVARS CULTIVATED UNDER GREENHOUSE CONDITIONS IN KOREA

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To select better the cultivar than 'Irwin' cultivar, we evaluated fruit and growth characteristics of 12 mango (*Mangifera indica* L.) cultivars cultivated under greenhouse condition. The greenhouse cultivation condition was as follows: the temperature was kept in 20~25°C from January to March, 15~20°C from March to May, 25~30°C from June to October, 10°C from November to January. We used the heating by electric and fuel in greenhouse enclosed with dual-vinyl covers for maintaining the temperature from Nov. to March. Compared with 12 mango cultivars, the most of cultivars were more vigorous growth than that of 'Irwin'. The harvest season was from the late of May to the late of July. The soluble solid content (SSC) was 14.7~26.9 °Brix dependent on cultivars. The color of fruit skin was various: red, yellow, yellowish green, red-yellow, green, etc. As a result of these, we selected 4 cultivars that appropriated to cultivate under the cultural environment in Korea. 'Van Dyke' : harvest time-the late of May, the fruit weight-342g, SSC-15.7 °Brix, the skin color-red. 'Geumwhang' : harvest time-the late of Jun, the fruit weight-339g, SSC-20.1 °Brix, the skin color-red like 'Irwin'. 'Jawha' : harvest time-the first of July, the fruit weight-877g, SSC-18.3 °Brix, the skin color-green. 'Daenong No1.' : harvest time-the late of July, the fruit weight-822g, SSC-19.0 °Brix, the skin color-green, especially fruit firmness was very strong, 10.4N, that was 5 times stronger than that of the other cultivars and therefore useful as cooling material as well as fresh fruit.

Keywords: Greenhouse, Mango, Subtropical fruit



EFFECT OF CALCIUM TREATMENT IN IMPROVEMENT OF FREEZE TOLERANCE IN 'MIYAGAWA' SATSUMA MANDARIN (*Citrus unshiu* Marc. cv. Miyagawa)

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Extreme cold waves have occurred frequently and caused freeze damage to 'Miyagawa' Satsuma mandarin (*Citrus unshiu* Marc. cv. Miyagawa) in Jeju in recent years. Calcium is known to improve freeze tolerance in various crops. First of all, in order to confirm the valid concentration of $\text{Ca}(\text{NO}_3)_2$ solution which elevates freeze tolerance in 'Miyagawa', leaves were treated with $\text{Ca}(\text{NO}_3)_2$ in various concentrations. Lethal temperature 50% was the lowest when $\text{Ca}(\text{NO}_3)_2$ was treated at 20 mM. To enhance freeze tolerance of 'Miyagawa' after applying $\text{Ca}(\text{NO}_3)_2$ at 20 mM, freeze damage and cold related genes expression in $\text{Ca}(\text{NO}_3)_2$ treated leaves were compared to that of control leaves. Untreated and distilled water treated leaves were used as controls. When -7°C was treated using a water bath, malondialdehyde (MDA) content in $\text{Ca}(\text{NO}_3)_2$ treated leaves were lower than that of controls, which indicates less degradation of cell wall in leaves. The result was the same in the case where $\text{Ca}(\text{NO}_3)_2$ was applied at field. However, $\text{Ca}(\text{NO}_3)_2$ treatment did not lead to decrease of electrolyte leakage or changes of the expressions of some well-known cold related genes. $\text{Ca}(\text{NO}_3)_2$ treatment protects 'Miyagawa' leaves by preventing cell degradation. Further study is required to determine whether calcium treatment enhances freeze tolerance by regulating gene expression directly.

Keywords: Citrus, Freeze tolerance, Satsuma mandarin, Calcium treatment



OVERVIEW OF SUBTROPICAL FRUITS IN THE LAST QUARTER CENTURY IN TURKEY

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Turkey has a unique geography where many fruit species can be cultivated, because of its different ecological characteristics. Approximately 35.7% (11.500.000 da) of the fruit growing areas in the country (32.800.000 da) are subtropical fruits (olive, tea, mandarin, orange, pomegranate, lemon, fig, banana, grapefruit, kiwi, persimmon, loquat, bitter orange, avocado, etc.). Turkey produces 43.1% of the fruit production (18.850.000 tons) of subtropical fruits (8.115.000 tons). Approximately 30.3% (247.300.000 trees) of total fruit trees in the country (817.000.000 trees) are subtropical fruit trees. In Turkey, the subtropical fruit production increased by 105.6% and the number of trees increased by 85.5% in the last quarter century.

Keywords: Subtropical Fruits, Production, Turkey



REACTION OF SOUR-PASSION FRUIT GENOTYPES TO BACTERIOSE UNDER FIELD CONDITIONS IN FEDERAL DISTRICT, BRAZIL

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The genus *Passiflora* is composed of several species, with the majority used for “in natura” consumption. This genus also has great ornamental and medicinal potential. Originated mainly from South America countries, it is estimated that 80% of the world production comes from Brazil. The high incidence and severity of the diseases has been decreasing the productivity in the last few years, affecting mainly the fruit quality and the longevity of the orchards. The bacteriose, caused by *Xanthomonas axonopodis* pv. *passiflorae*, is considered to be one of the main illnesses that reach the culture of sour-passion fruits (*Passiflora edulis* f. *flavicarpa* Deg.). In order to contribute to the development of more promising sour-passion fruit cultivars, the following work evaluated 10 sour-passionfruit genotypes for resistance to bacteriose under the field conditions of the Federal District, Brazil. The experiment was carried out with a randomized complete block design with four replications and five fruits per plant. For the evaluation of the severity analysis note scales were used, with variation of 1 to 4, where note 1 means no disease symptoms (resistant); note 2, up to 10% of the fruit surface covered by lesions (moderately resistant); note 3, from 10.01 to 30% (susceptible) and note 4, more than 30.01% (highly susceptible). Three evaluations of incidence and severity were made from March to May, 2017. There were no statistical differences in incidence and severity results, and all genotypes were classified as resistant. The genotype AP1 P3 x ECRAM R3 obtained a lower result of mean severity (1.3), while FB200 P1 R2 x MAR 20#2005 P4 R3 obtained the highest mean severity result (1.69).

Keywords: *Xanthomonas axonopodis* pv. *passiflorae*, diseases, severity, incidence, passion fruit



REACTION OF SOUR-PASSION FRUIT GENOTYPES TO SEPTORIOSE UNDER FIELD CONDITIONS IN FEDERAL DISTRICT, BRAZIL

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The genus *Passiflora* is composed of several species and it is used for “in natura” consumption as well as for ornamental and medicinal purposes. It is estimated that 80% of the world production comes from Brazil. The high incidence and severity of the diseases has been decreasing the productivity in the last few years, affecting mainly the fruit quality and the longevity of the orchards. The culture of sour-passion fruit (*Passiflora edulis* f. *flavicarpa* Deg.) is attacked by several pathogens, among them the fungus *Passiflora septoriae*, which causes septoriose. In order to contribute to the development of more promising sour-passion fruit cultivars, the following work evaluated 10 sour-passion fruit genotypes for resistance to septoriose under the field conditions of the Federal District, Brazil. The experiment was carried out with a randomized complete block design with four replications and five fruits per plant. For the evaluation of the severity analysis note scales were used, with variation of 1 to 4, where note 1 means no disease symptoms (resistant); note 2, up to 10% of the fruit surface covered by lesions (moderately resistant); note 3, from 10.01 to 30% (susceptible) and note 4, more than 30.01% (highly susceptible). Four evaluations of incidence and severity were made from April to July, 2017. There were no statistical differences in incidence and severity results, and all genotypes were classified as resistant. The genotype AP1 P3 x ECRAM R3 obtained a lower result of mean severity (1.1), while MAR 20#15 R3 obtained the highest mean severity result (1.36).

Keywords: *Septoria passiflorae*, diseases, severity, incidence, passion fruit



EFFECT OF FOLIAR SPRAY OF NAA AND PACLOBUTRAZOL ON VEGETATIVE GROWTH OF RAMBUTAN

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Rambutan is one of the most important fruit crops in Southeast Asia countries. However, the harvest season is usually limited due to undesirable excessive shoot flushing occurred during rainy season. The excessive shoot flushing make flower initiation delay. Although the trees produce flower several weeks after the shoot flushing, harvest season would be very limited and the price in market decline. For the purpose of elongation of harvest season, development of techniques to control flower initiation are required. Paclobutrazol is widely used to control flower initiation in mango and durian, and 1-naphtalenacetic acid (NAA) is used to reduce excessive vegetative growth in citrus cultivation. In this experiment, effect of foliar spray of paclobutrazol (100, 500 and 1000 ppm) and NAA (100, 500 and 1000 ppm) on vegetative growth was observed by using pot-planted rambutan nurseries. The shoot growth after the treatment was suppressed in all the treatment. The characteristics of shoot development showed as shortened node in paclobutrazol treatment trees, while shoot tips were browned and stopped development in NAA treatment trees. Flowering was not observed in this experiment.

Keywords: *Nephelium lappaceum*, plant growth regulator, shoot flush



ITALY'S CONTRIBUTION TO KIWI FRUIT PRODUCTION: 47 YEARS OF EXPERIENCE IN THE LATINA PROVINCE

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The first 2 experimental plantations of kiwi fruits in Italy were set up by the author in the Province of Latina (Lazio Region) in 1971. Today, Lazio Region has an area of approximately 11,000 hectares and a production of ca. 200,000 tons of kiwi fruits, the most substantial in Italy (26,000 hectares and a production of 500 thousand tons). This region obtained in 2004 the IGP Kiwi Latina brand, the only one in Italy.

Significant progress has been made over the last few years in all fields, in particular the selection of pedoclimatic areas that respond better both in terms of productivity and relationship between investment and profit. With reference to aspects related to quantitative and qualitative production, relevant progress has been gained in the fields of artificial fertilization and cultivation techniques (pruning, fertilization etc.).

Keywords: Kiwi fruits, new cultivation techniques, experience, progress, Italy



INVESTIGATION THE FLOWERING BEHAVIOR OF CITRUS DEPRESSA HAYATA IN TAIWAN

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Citrus depressa, also called shikuwasa in Japanese, is an important functional fruit in Taiwan and Okinawa in Japan. C. depressa has several flowering periods within one year in Taiwan. To reveal the flowering behavior of shikuwasa, 15 one-year-old grafted pot plants of shikuwasa were set at the open field. After moderate pruning in December, it took 3 weeks to develop the 1st flush. Thirteen weeks after pruning, the flowers anthesis. The flowers in shikuwasa come from axillary and multiple in one node, but some is leafy flush with terminal flower. We also investigated the new-growth flush type, flowering time, and fruit setting rate of 5-year-old trees in the commercial orchard from February to August, 2017. Twenty current shoots were randomly selected in each month and all the shoots developed the 2nd flushes, and the shoots in March developed the most 3rd flushes. Flowers developed on the 3rd flushes of shoots in March, but on the 2nd flushes of shoots in April and May. The selected shoots in February were with 6 flowers per shoot in average. The fruit setting rate of axillary flowers was 5.8%, however, the fruit setting rate of leafy flush with several flowers was 32.7%. The BBCH scale for C. depressa presented is broadly applicable because it describes a total of 7 principal growth stages for bud, leaf, and shoot development, flower types, flowering, fruit development, and fruit maturity. More studies about the flower induction in shikuwasa are under progress.

Keywords: anthesis, fruit setting rate, BBCH-scale



EFFECTS OF ETHREL ON FLOWERING IN 'HEY-YEH' LITCHI

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Litchi has three types of flower sexualities, and only the hermaphrodite female flowers are able to fruit. The timing of female flowers' flowering and the number of separated sexuality flowers are related to the yield. We hope to use Ethrel, ethylene releasing chemicals, to control the flowering timing and flower numbers. In this study, we sprayed 50 and 100 mg·L⁻¹ of Ethrel on 'Hey-Yeh' litchi during two different inflorescence developing stages, including (1) Stage I: the inflorescence visible and immature florets swollen, and (2) Stage II: the first floret opened of the inflorescence, respectively in spring of 2017. The result indicated the most total number of florets per inflorescence is those applying 50 mg·L⁻¹ Ethrel at the florets swelling period. The Ethrel application at the florets swelling period would accelerate hermaphrodite female flowers' flowering process by both concentrations. The flowering time of Stage II also ended earlier than the control. The preliminary results showed the potential of Ethrel application to affect the flowering time and numbers of litchi flowers, and it could be a potential strategy for 'Hey-Yeh' to avoid unstable weather during the flowering time.

Keywords: flower sexuality, flowering time, plant growth regulator



EFFECT OF COATING MATERIAL ON QUALITY OF 'MANEE-ESAN' PUMMELO FRUITS DURING STORAGE

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This study was conducted to determine the effect of coating material on quality of 'Manee-Esan' pummelo fruits during storage. The pummelo fruits, harvest at 7 month after full bloom were coated with 0, 1 and 2% chitosan and 0, 15 and 20% carnauba wax. The coated chitosan, carnauba wax and uncoated fruits were stored at 10 °C with 85-95% RH and room temperature (25 °C). Samples of five fruit from each treatment were evaluated for weight losses before removal to ambient storage. Flesh firmness, some chemical changes and sensory test. The result showed that pummelo coated with chitosan and carnauba wax and then stored at 10 °C reduced the weight losses of the fruit by 20-50% depending on the storage time. The changes in flesh firmness, soluble solids, titratable acidity and ascorbic acid contents of the pummelo in all treatments were not significantly different. The pummel fruits coated with 20% carnauba wax and stored at 10 °C had good eating quality which is acceptable to consumers and extended the storage life for 120 days.

Keywords: chitosan, carnauba wax, pummelo



INVESTIGATION OF BIOACTIVE MOLECULES AND ANTIOXIDANT CAPACITY OF IRANIAN ORNAMENTAL POMEGRANATE CULTIVARS (*Punica granatum* var. *pleniflora*)

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Pomegranate was demonstrated to be high in antioxidant activity and strong in phenolic, flavonoid and tannin contents in its fruit, flower and also aerial part. Flowers of ornamental pomegranate (*Punica granatum* var. *pleniflora*) have been used in traditional Iranian medicine. In this study total phenols (TP), anthocyanins (TA), flavonoids (TF) and tannins (TT) content along with DPPH and ABTS scavenging capacity of six ornamental pomegranate cultivars (Koshe Nar Baharestan, Sarvestan, Shahdad, Zinati Saveh, Rijab, Kenar Takht) was investigated. According to our results, Sarvestan cultivar exhibited higher total anthocyanin and Zinati Saveh cultivar exhibited higher total phenols and flavonoids content. Also, Zinati Saveh cultivar exhibited higher total tannins. Also, higher DPPH and ABTS scavenging capacity observed in Zinati Saveh cultivar. Owing to higher bioactive molecules resulting higher antioxidant capacity, Zinati Saveh cultivar has promising potential for human health.

Keywords: Pomegranate, Human health, Antioxidant capacity, Bioactive molecule



OPTIMISING FOLIAR NITROGEN UPTAKE OF MANGO: EFFECT OF ADJUVANT AND TIME OF POTASSIUM NITRATE SPRAY

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Reliable flowering is necessary to obtain consistent mango production and foliar application of potassium nitrate (KNO₃) is one of the techniques that can promote flowering. We determined the effect of adjuvant and time of spray application on the leaf N content of mango to identify optimum conditions that can optimise N uptake from foliar KNO₃. The treatments were addition of 0, 100, 250, and 500 mL Li 700/100 L of 3% KNO₃, which was sprayed in the morning (8:00am) or night (8:00pm) on the sunny side and shaded portion of the tree. Each treatment combination was replicated five times. The solution was sprayed onto pre-identified shoot terminals until run-off. Shoot terminals were collected at 4, 12, 24, 48, and 96 hours after spraying (HAS) and analysed for total N content. Results showed that total N contents were comparable in mango leaves across rates of adjuvant, time of application, and location of the leaves at 4 and 12 HAS but varied significantly at 24, 48, and 96 HAS. Leaf N content was higher in leaves with adjuvant than those without adjuvant and when spray was done in the evening. Total N content was also higher in leaves from the shaded part of the tree than those exposed to sunlight. The results indicate that addition of adjuvant and spray application in the evening help optimise N uptake of mango leaves from foliar KNO₃.

Keywords: Adjuvant, foliar spray, mango, nitrogen uptake, potassium nitrate



DETERMINATION OF GROWTH PERFORMANCE IN FIG CULTIVARS APPLIED GAMMA RADIATION IN DIFFERENT DOSAGES

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This research is conducted between 2013 and 2014 in the Directorate of Fig Research Institute. The development of new figs (*Ficus carica* L.) cultivars through mutation is very important in terms of figs industry in Turkey and for this purpose, Sarılop as dried fig cultivar and Bursa Siyahı as fresh fig cultivar are used. The project started in 2007 with the application of 6 different gamma irradiation doses (⁶⁰Co) onto budsticks of two fig cultivars. Six levels of cobalt gamma radiation dosages (0.0, 10.0, 16.9, 25.3, 50.7 and 67.0 gray) are applied to the group consisted of 25 budsticks from Sarılop and Bursa Black cultivars. M1V1 (mutation one vegetation one), M1V2 (mutation one vegetation two) and M1V3 (mutation one vegetation three) plants via grafting are obtained within the three years. M1V1 (mutation one vegetation one) plants are evaluated for survival ratio and shoot growth. LD50 values are determined as follows: 50.7 gray (Gy) for Sarılop, and 25.3 Gy for Bursa Siyahı, respectively. At the end of three years, 1828 M1V3 figs are obtained, including 992 from Sarılop and 836 from Bursa Black. These young plants are planted in 2010 at a distance of 3x1.25 places to experimental parcels. The growth performance of these individuals in the orchard conditions is observed for each dose in 2013-2014 and the parameters such as plant height, stem diameter, shoot diameter, shoot height, number of nodes, crown width are examined and finally growth performances between doses are determined. Again, epistatic impact deaths are examined among these individuals. Epistatic effect is found to be highest in Sarılop cultivar 16.60% at 67.0 gray dose and 9.82% at 25.3 gray dosages in Bursa Black.

Keywords: mutation, gamma radiation, fig, growth performance



THE EFFECT OF SALINITY ON LEAF CHLOROPHYLL CONTENT OF SATSUMA MANDARIN ONTO TROYER CITRANGE ROOTSTOCK

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Salinity is a severe and increasing constraint on crop productivity. Salt stress occur in areas where soils are naturally high in salt and precipitation is low or where irrigation, hydraulic lifting of salty underground water. The salination existing in topographically low lying lands near the seashore is also affected by seawater intruding into coastal aquifers and mixing with fresh water coming from inland sources. Salt stress is a major abiotic stress that can affect yield, plant growth, physiological and biochemical activities. The decline in photosynthesis due to salinity stress could be due to lower stomata conductance, depression in carbon uptake and metabolism, inhibition of photochemical capacity or a combination of all these factors.

Citrus known to be sensitive to saline conditions are threatened the most since the major growing areas are in the coastal regions. But the tolerance to salinity varies among different citrus species and depends on the rootstock.

In this study, effect of salinity on leaf chlorophyll content of satsuma mandarin cv. Owari onto Troyer citrange rootstock was investigated. The trees were irrigated with five levels (0.65-2.00-3.50-5.00 and 6.5 dS m⁻¹) saline water. Irrigation, which started in June and continued until the onset of rains in October, was via drip system. The experiment had 3 trees per treatment with four replicates in a randomized block design. The result showed that there was clear effect of salinity concentration on the leaf chlorophyll amount of satsuma mandarins. Chlorophyll a, b and total were differed with salinity concentration, leaf age and periods. Young leave had less chlorophyll than older at the beginning of season. End of season chlorophyll content of both leaves were found similar.

Keywords: Salinity, chlorophyll content, rootstock, citrus



INFLUENCE OF INORGANIC FERTILIZER ON THE EARLY GROWTH AND NUTRIENT CONCENTRATION OF BUSH MANGO (*Irvingia gabonensis*)

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Irvingia gabonensis also known as bush mango is one of the highly useful fruit trees that is being classified as endangered species. So most past efforts on this crop has been on conservation. Recently, it was discovered that its long gestation period can be reduced by budding. Budded seedlings of *Irvingia* are in short supply and there is need to accelerate seedling growth for attainment of buddable size if farmers' needs are to be met. A greenhouse experiment was therefore undertaken to study the growth and nutrient concentration of *Irvingia* as affected by five levels of inorganic fertilizer (0, 30, 60, 90 and 120kg NPK/ha). Results revealed that with the exception of leaf number, the growth parameters of *Irvingia* were not significantly influenced by NPK fertilizer before 20 weeks after transplanting (WAT). At 24 WAT, stem girth and leaf number were significantly increased with increase in fertilizer rates up to 90kg/ha. While the concentration of nitrogen (N) in the leaf, stem and root showed non significant increase, the phosphorus (P) in the leaf, stem and root of the seedling was significantly influenced by the fertilizer application up to 120kg/ha. Similar influence was obtained in the concentration of potassium (K) in the stem and root but not leaf of *Irvingia* seedling. In conclusion, this study revealed that application of inorganic fertilizer up to 90kg NPK/ha does influence the growth of *Irvingia*. Though initial response may be slow, the application will on the long-run reduce the gestation period by reducing the time taken to reach buddable size.

Keywords: *Irvingia*, Bush mango, inorganic fertilizer, nutrient uptake



EFFECT OF MORINGA BASED EDIBLE COATINGS TO ENHANCE QUALITY AND SHELF LIFE OF PAPAYA (*Carica papaya* L.)

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The study investigated the efficacy of moringa based organic coatings as postharvest chemical treatment to reduce disease incidence on papaya (*Carica papaya* L.) (cultivar: papino) fruit during storage time. Fruits were treated with prochloraz as well as moringa based chitosan (CN) of two levels (1 and 1.5%) and moringa based 1% carboxyl methyl cellulose (CMC). Treated fruit were stored in cold storage at 10 °C for 21 days and fruit were then left outside at room temperature for 10 days for shelf life study. Fruit physical and chemical parameters were measured and the collected data were then exposed to GenStat 18.0 version (statistical package) for analysis. Results showed that treated fruit with moringa based edible coatings showed significant reduction in ethylene production, respiration rate and mass loss. And further moringa based organic coatings displayed antifungal properties by suppressing fungal growth. In conclusion the moringa based organic coating can potentially be used by fruit industries and this would have a better preference than synthetic chemical as it has no safety concerns.

Keywords: moringa, chitosan, carboxymethyl cellulose, prochloraz



INVESTIGATING THE EFFECT OF MORINGA LEAF EXTRACTS INCORPORATION IN EDIBLE COATING ON MAINTAINING 'MARSH' GRAPEFRUIT (*Citrus paradise*. MacFad) QUALITY AND PROLONGING SHELF LIFE

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Increasing health awareness towards the use of edible coating as postharvest fruit treatment has gained a huge demand in international markets. This study investigated the moringa leaf extracts based edible coatings for commercial use to maintain the quality and extending shelf life of 'Marsh' grapefruit. Fruits were treated with five treatments where T1 = Citrashine® natural wax, T2 = 1 % Moringa Edible Coating (MEC) + 1 % CMC (Carboxymethyl cellulose), T3 = 1 % MEC + 1 % Chitosan (CN), T4 = 1 % MEC + 1.5 % CMC and 1.5 % MEC + 1 % CN. Treated fruits were stored at 3oC for six weeks. Fruits coated with 1.5% MEC + CMC had higher mass loss (11.96%) compared to citrashine (4.01%) and 1% MEC + 1% CMC (4.83%); fruit colour increased with storage as fruit treated with citrashine had higher colour index (-0.932) compared edible coatings. Fruits coated with citrashine had no chilling injury (CI) and disease compared with fruits coated with edible coatings. In conclusion the moringa based edible coating does not have a positive effect in 'Marsh fruit' and accordingly this finding warrants more studies need to be done in search for other alternative organic products.

Keywords: 'Marsh' grapefruit, edible coating, quality parameter, chilling injury



THE EFFECTS OF MINERAL ELEMENTS ON THE NARINGIN PRODUCTION IN CITRUS

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Huazhoujuhong (*Citrus grandis* Osbeck var. *tomentosa* Hort.) is a traditional Chinese Medicine ingredients, with its fruits rich in flavonoids, esp. naringin. Naringin is biosynthesized under the catalyzation of 1,2-RhaT, a glycosyltransferase in citrus. The abundance of inorganic elements in soil maybe related with the content of naringin in the fruits, however, the stone in Huazhou rich in aluminum(Al) and potassium(K). Thus, the effects of mineral elements on enzymatic of Cm1, 2-RhaT transgenic tobacco BY2 cell line, and Na⁺, Fe³⁺, Cu²⁺, Zn²⁺ and Al³⁺ were investigated. As a result, 0.25 mmol / L Al³⁺ + could significantly promote the activities of 1,2-RhaT leading to the accumulation of naringin in BY2 tobacco cells. Additionally, the enzymatic function of tobacco 7-dGlcT, another glycosyltransferase, had also been enhanced. Furthermore, 0.05 mmol / L Cu²⁺ + could significantly altered the enzymatic functions of the two glycosyltransferases. Transcriptomic evidence has been provided to explain the phenomenon.

Keywords: Huazhoujuhong (*Citrus grandis* Osbeck var. *tomentosa* Hort.); Naringin; 1,2-RhaT; Mineral elements



EVALUATION OF SOME MANGO (*Mangifera indica* L.) CULTIVARS UNDER JORDAN CONDITION

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Mango (*Mangifera indica* L.) is one of the most popular tropical fruits in the world. In Jordan we started recently cultivated mango trees on organized plantations. This research experiment was carried out during two seasons (2017 – 2018) to evaluate some physical and chemical characteristics of three mango cultivars (Keitt, Tommy Atkins and Maya) at ripening stage. This experiment was arranged in Randomized Complete Block Design (RCBD) with three replicate. Studied mango cultivars had statistically effect on yield and fruits characteristics. Keitt cultivar recorded the highest yield per tree during both seasons, followed by Tommy Atkins.

There were significant differences of average fruit weight, width and length among studied mango cultivars. Keitt cultivar had the highest fruit weight followed by Tommy Atkins whereas the lowest fruit weight was at Maya. On the other hand Maya cultivar had the highest total soluble solid percent (TSS%) among the investigated three cultivars ,whereas Keitt cultivar had the lowest TSS%.

Keywords: Tropical, Yield, Fruit Weight, Tommy, Keitt and Maya



DETERMINING POMOLOGICAL AND BIOCEMICAL FUTURES OF SOME PECAN NUTS VARIETES WHICH IS GROWN IN GAP REGION

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Pecan nuts is hard-shelled fruit and belongs to family of Carya varieties. It is grown in different parts of the World. It is grown in on the slopes of the Aegean and Mediterranean regions facing the sea. In aditon, positive results were obtained in the studies on the pecan walnut which is grown GAP region. In this study, five different types of pecan nuts were analyzed. Those types are Ideal, Harris süper, Mahan, Schley, and Mohawk. Those types has been analysed for pomological features such as Fruit Weight (9.096;10.722;5.910;5.425;10.845) mm , Fruit Length (42.702; 44.177; 51.833; 34.514; 38.539) mm, Fruit Width (21.995; 24.026; 22.439; 23.950; 26.224) mm, Fruit Height (23.795; 24.280; 23.660; 23.209; 25.412) mm, Fruit Crust Thickness (1.101; 0.833; 0.584; 0.739; 0.826) mm, and Fruit Internal Weight. (4.093; 6.106; 2.941; 2.323; 5.857) mm. In additon to total fat (45.41, 50.74, 45.27, 46.18; 58.69), percent moisture (6.260, 4.421, 11.560, 2.700, 2.068), ash (9.61, 11.89, 13.56, 12.40, 10.53). Also it has been analysed for fruit oil acids such as saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, trans fat, omega-3, omega-6, omega-9. In this study, similar results were obtained with the literature . Due to its pomological and chemical properties, it has been determined that Mahan and Ideal varieties are most suitable for GAP region.

Keywords: Pecan ; pomological features; chemical properties





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POSTER PRESENTATIONS

NATIVE POLLINATORS OF CALIFORNIA AVOCADO AS AFFECTED BY INTRODUCED POLLINATOR GARDENS

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Avocado is a neotropic tree which has been commercialized world-wide, yet it's native pollinators have been little studied. The most frequently studied pollinator has been the old-world insect, *Apis mellifera*. In commercial orchards it is common practice to introduce honey bee colonies, although it is not clear exactly what the extent of their effect is in California orchards in the presents of native bees and other pollinators. The purpose of this study is to evaluate the range of avocado flower visitors and to assess whether those numbers can be affected by the introduction of gardens that might promote their numbers in the orchards during the avocado bloom period. Measuring pollinator performance is difficult because of weather impacts, alternate bearing habit and the high level of fruit shedding in avocado. In this study, pollination gardens have been established in three avocado orchards in coastal California near Santa Barbara, just north of Los Angeles. These gardens have been established since 2014 with a variety of perennials that can supply nectar and pollen over the year and especially during the prolonged flower season. The three orchards where the gardens are established each exceed 40 ha. Gardens have been established in just one portion of the orchards, so that flower visitation can be assessed near and far from the gardens. The individual visitation activity of flower visitors was evaluated per unit time and their abundance on avocado flowers near the gardens and away from the gardens. Visitation was also similarly assessed on the pollinator gardens. Pan traps were also used to assess the presence of native bees in the orchards.

The most abundant visitors in all years have been Syrphid spp. along with a variety of other flies and wasps. The most abundant native bee species have included *Ceratina*, *Halictus*, *Agapostemon* and several andrenid species. The highest diversity and abundance of visitors has occurred after the high rainfall year of 2016/17 after previous drought years.

Keywords: *Persea*, native bees, bee habitat, wasps, sryphid flies, gardens, pollinator management



IN-SITU ASSESSMENT OF HARVEST MATURITY OF 'HASS' AVOCADO (PERSIA AMERICANA) USING PORTABLE VIS-NIR SPECTROMETER

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Harvest maturity of avocado is currently estimated based on dry matter content (DM). The DM is analysed destructively from few samples representing the entire orchard using time-consuming methods. However, the maturity parameter of avocado that is known to have a direct link to eating quality is oil content (OC). Successful studies indicating non-destructive assessment of avocado OC are limited. Consequently, this study was conducted to develop models for in-situ non-destructive assessment of maturity stage of 'Hass' avocado using portable visible to near infrared spectrometer (Felix, F-750, Vis-NIR system) equipped with xenon-tungsten lamp as light source, and lead-sulphide detector. Partial least square (PLS) regression models for assessing OC, DM and moisture content (MC) of avocado fruit were developed from spectral and biochemical reference data using The Unscrambler® X chemometric software. Cross-validation was used to develop models. Previous studies have indicated a change in the operation of spectrometers at different temperatures. As a result, the robustness of models developed in this study was increased by acquiring three spectra from each sample at 10, 20 and 30 °C from morning to early evening. A model for assessing OC was successfully developed as indicated by its model's high regression coefficient ($R^2 = 0.979$) and the ratio of performance deviation (RPD = 6.817), and low root mean square error of prediction (RMSEP = 1.115%). Successful models were developed for predicting MC ($R^2 = 0.955$; RPD = 4.221; RMSEP = 0.405%) and DM ($R^2 = 0.984$; RPD = 7.789; RMSEP = 0.220%) as well. Commercial application of portal spectrometers with the developed models can increase the number of assessed harvest maturity parameters and the number of reference samples because the system can estimate the maturity parameters without harvesting of sample fruit.

Keywords: Avocado oil content, Chemometrics, Fruit quality



DE NOVO TRANSCRIPTOME OF PERSEA AMERICANA CV. HASS PROVIDES INSIGHTS ON GENES RELATED TO FATTY ACIDS DURING FRUIT DEVELOPMENT

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Persea Americana is a basal angiosperm from the Lauraceae family. This species have a diploid genome with an approximated size of ~920 Mpb and produces a climacteric and fleshy fruit. Avocado fruit have a high content of vegetable oils that are beneficial for human health and they are used as harvest index aswell. The fruit development is a particularly long process and its long blooming stage process (2 months) produces fruits with significant differences in physiological ages within the same tree. Currently there's no detailed genomic information of this species. We carried out a RNA-Seq approach during 4 stages of fruit development; 150 days after fruit set (DAFS), 240 DAF, 300 DAFS (harvest) and 390 DAFS (late-harvest). The avocado de novo transcriptome contains 62,203 contigs (\bar{x} =988bp, N50=1,050bp). We found on the avocado de novo transcriptome over 99% (CEGMA) and 80% (BUSCO) ultra-conserved genes in eukaryote and plantae database. Annotation was performed with BLASTx, resulting in a 58% of annotated contigs (90% of differentially expressed genes (DEGs) were annotated). DEGs analysis ($FDR \leq 0.001$) found 8,672 genes across all development stages. We found a total of 679 significantly enriched unique GO terms comparing 150 DAFS as static with the other stages. Finally, we have assembled a high quality transcriptome and this is the first step to further explore and discover genes associated to fruit development.

Keywords: fruit development, oil content, transcriptomic



POTENTIAL USE OF MORINGA LEAF EXTRACT WITH EDIBLE COATING TO REDUCE THE PROCHLORAZ APPLICATION RATE IN POSTHARVEST AVOCADO (*PERSEA AMERICANA* MILL.) FRUIT

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This experiment was conducted to investigate the efficacy of prochloraz combined with moringa based edible coating in enhancing the quality and reduce incidence of postharvest diseases of 'Fuerte' avocado fruit. Five postharvest coating treatments: Control, Moringa (M) 2% + carboxymethyl cellulose 1% (CMC), 810 ppm of prochloraz, 405 ppm of prochloraz with M + CMC and 202.5 ppm of prochloraz with M + CMC were applied to treat a fruit. Avocado fruit treated with mixture of 405 ppm of prochloraz and M + CMC had significantly lower mass loss, slowed down fruit softening and maintained fruit firmness compared to control. The same treatment had a high ability to retain C7 sugars, mainly mannoheptulose which is known to inhibit fruit ripening, while integrated application is also ensuring reduced maximum residual limit values (MRL's) on a fruit. Although the treatment 405 ppm of prochloraz + (M+CMC 1%) coating had a potential to preserve fruit quality, further research needs to be done to identify the actual performance of the coating in inhibiting disease infection before commercializing it as alternative novel postharvest product.

Keywords: Moringa, carboxymethyl cellulose, prochloraz



THE USE OF INSTANT CONTROLLED PRESSURE DROP (DIC) METHOD IMPROVES THE EXTRACTION OF BIOACTIVE COMPOUNDS FROM 'HASS' AVOCADO SEED

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Avocado seed represents 12-16% of the fruit and is considered as an underutilized resource that makes it a matter of concern regarding its final disposal by the avocado processing industry. The extraction of bioactive compounds from agroindustrial wastes is an alternative to take advantage of in order to generate products of commercial and/or social interest with high economic value. The instant controlled pressure drop (DIC; Détente instantannée Contrôlée) is a technology that promises to improve the extraction of bioactive compounds by a thermo-mechanical pretreatment of the HTST type (High Temperature Short Time) combined with an instantaneous vacuum decompression. The aim of this work was to evaluate the use of DIC technology as a treatment of Hass avocado seeds to improve the extraction of phenolic and flavonoid compounds, as well as the evaluation of the antioxidant capacity of the extracts. Two treatment conditions were used, the first (PT1) consisted of submit the seeds to a pressure of 5 bar during 30s at 49°C, while the second (PT2) consisted of 6 bar, by 40s at 74°C. Methanolic extracts were used to quantify the total phenolic compounds and total flavonoids by spectrophotometric methods. Total antioxidant capacity was determined by the DPPH and ABTS methods. The results showed that there is no statistical significant difference in the amount of total phenolic compounds of methanol extracts obtained from PT1 and PT2; however, the amount extracted was approximately more than 18% higher compared to extracts of non-treated seeds. The PT2 extracts showed a higher content of total flavonoids, although, both treatments were superior to the non-treated seed extracts. PT1 and PT2 allowed increasing three times the antioxidant capacity on non-treated seed extracts. Currently, in vitro antifungal activities against *Colletotrichum gloeosporioides* are being carried out under both DIC treatments to control anthracnose disease of avocado fruits.

Keywords: Avocado seed waste, DIC, phenolics, flavonoids, antioxidant capacity



PRELIMINARY ASSESSMENT OF MATURITY AND PICKING DATES OF AVOCADO UNDER LEBANESE GROWING CONDITIONS

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Introduced in Lebanon since the seventies, avocado has progressively gained a place in the Lebanese production system. Avocado trees are growing along the coastal areas where climatic conditions are appropriate for the development of this subtropical fruit crop. Although avocado fruit is witnessing a great acknowledgement in the last few years in both the local and export markets, the maturity index under the Lebanese conditions remain not yet identified. In this study, we determine the earliest picking dates for the most important midseason varieties cultivated in Lebanon, Hass, Lamb Hass, Pinkerton and Reed, cultivated at different elevations in four different geographic areas. Both dry matter and oil content in the period extending from January to April were examined with respect to the Californian Avocado Standardization Bill minimum maturity standards. Based on the resulting data, a minimal dry matter index will be proposed for each variety as a harvest maturity indicator in Lebanon. This preliminary harvesting index will need to be refined over time with the extension of samples to more geographic cultivation areas and different climatic conditions.

Keywords: *Persea americana* Mill., dry matter, oil content, maturity index, altitude, Lebanon.



GIRDLING AS A TOOL TO UNRAVEL THE 'HASS' AVOCADO SKIN COLOR PROBLEM

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Skin color change problem has been reported by overseas market to the South African Avocado Growers Association (SAAGA) board. The problem has been associated with chilling damage of early harvest fruit due to maturity state. Girdling method is used to restrict basipetal movement of photosynthates around tree cambium resulting in accumulation of assimilates above girdled position. Increased fruit assimilates has been interpreted to improve fruit quality. Therefore, the aim of this study was to evaluate the effect of tree girdling and harvest time on 'Hass' avocado fruit color change. Avocado fruits were harvested from two geographic locations (Limpopo and Mpumalanga), during the early and middle season, at an orchard block with a slope (upper and lower slope), from girdled and non-girdled trees. After Harvest fruits were then immediately transported to the ARC – ITSC postharvest laboratory for storage and analysis. At the laboratory, fruits were sorted and graded manually (3 replicates of 30 fruits/rep.), and then stored at 5.5°C for 28 days. Thereafter fruits were withdrawn from cold storage and ripened at 21°C. During ripening, avocado fruits were evaluated for chilling damage, firmness, subjective (eye color) and objective skin color (L, C and hue), and pathological, physiological damage. Generally, girdling had negative impact of fruit quality. Poor skin color development was observed (± 70 % color change) on both production regions for all harvest times. Further, Higher chilling damage was observed on fruit from girdled trees compared with fruit from control trees during the early harvest season 75 and 62 % respectively. Overall improved internal quality was observed on fruit harvested during the middle harvest from both girdled and non-girdled trees. Tree girdling had no effect on 'Hass' avocado fruit skin color development. However, harvest time had a positive effect on colour development and fruit quality.

Keywords: Avocado fruit (*Persea americana*); Firmness, Lightness, Chroma, Hue angle and Cold damage



QUANTIFYING FRUIT SHAPE IN AVOCADO: A BETTER WAY FORWARD

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For decades now, the rating of avocado fruit shape has been tied to an arbitrary system containing discrete values that do not coexist on a linear scale. The goal of this presentation is to present a new methodology using pre-existing, commonly available software and equipment to capture and analyse images of fruit. Through use of Adobe Photoshop, pictures taken w/a DSLR or other digital camera can be reduced in scope to the length and width of the fruit. These resulting images can then be mined for the volume of negative and positive space, the length and width of these spaces, and the overall ratio of length to width of the entire image. This mined data allows for comparison of regularity through the entire shape of the fruit and ratio of volume between hemispheres, among other possible analyses. Analysis thus generated can be used to identify desirable phenotypic traits and to correlate them to environmental, genetic, and physiological measurements.

Keywords: avocado, fruit, phenotyping, image analysis



THE EFFECT OF VOLATILES AND EDIBLE COATINGS ON POSTHARVEST AVOCADO (*PERSEA AMERICANA* MILL.) FRUIT QUALITY

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Naturally produced plant products as postharvest fruit treatments are gaining huge interest among consumers, growers, and agro-industry. Volatiles and edible coatings have been known to have potential in enhancing fruit quality during postharvest fruit storages; they are well received by various markets since they do not pose any health problems after consumptions. However, there were only few reports that are documented reporting on effects of volatiles in gaseous form in association with edible coating. It is therefore this experiment was designed to investigate the effects of volatiles and edible coating in avocado (*Persea americana* Mill.) fruit physical quality as well as disease incidence. Eight different types of essential oils: Basil, Cinnamon, Clove, Jasmine, Geranium, Pepper mint, rosemary, Thyme and two levels of Carboxyl Methyl Cellulose (CMC) (0.5%, 1%) levels were applied to two avocado cultivars (Fuerte, and Hass) and after treatments the fruit were stored in cold temperatures (5.5°C) for 21 days simulated the export condition. The volatiles were sprayed using auto spray, programmed every 12 h only during cold storage. Results showed fruit treated with the volatiles and CMC had significantly lower mass loss, respiration rate than control. Volatiles had an inhibition against *C. gloeosporioides* and *A. alternate*. Scanning electron microscopy analysis further revealed damaged hyphal structures for all pathogens exposed to coatings as well as volatiles while such structures remained intact in uncoated fruit. The findings reported in this study demonstrated that volatiles and CMC suppress diseases, prolongs the shelf-life and maintain the overall quality avocados during postharvest supply chain.

Keywords: Avocado, Carboxyl Methyl Cellulose, Volatiles





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BIODIVERSITY OF MEDICINAL AND AROMATIC PLANTS IN MODERN AND TRADITIONAL DATE PALM FARMS IN NORTHERN AND CENTRAL OMAN

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A survey was done on modern and traditional date palm farms in northern and central Oman. The survey included 9 farms from 3 different governorates and one modern farm. The data were analyzed using PAST software to determine the diversity parameters. Fifty-one medicinal and aromatic plants from 16 different plants species and 13 different families were found on traditional system farm while none of them were found in the modern system farm. Al Batinah South governorate had the highest number of individuals and the higher number of the species followed by Ad Dakhliyah governorate. The data analysis showed a high evenness index (0.92) and a low dominance index (0.12). Also, it showed a high similarity among the species which is expressed by the Simpson index (0.88). Oman has more than 7.5 million date palms (*Phoenix dactylifera*) which makes date palm a significant crop in the country. Moreover, about 81% of the total cultivated lands irrigated by traditional flood irrigation systems including the date palm farms. Many plants that grow in the farm surrounding areas are considered as weeds but also have medicinal value. Those plants are still used in the traditional medicine in Oman to treat minor diseases and knowledge has been transmitted over generations.

Keywords: Agroecology, Dates, Date Palm, Farming Systems, environment, horticulture, oman, biodiversity

