

## 3<sup>rd</sup> International Symposium on Guava and Other *Myrtaceae*





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## International market of fresh and processed guava: challenges and perspectives for the Mexican case

J. S. Padilla-Ramirez<sup>1,A</sup>, E. González-Gaona<sup>1</sup>, J. Ambriz-Aguilar<sup>2</sup>.

Guava is one of the most important fruit crops in Mexico. During the last decade average cultivated area has been about 22.8 thousands hectares with an annual production of 291 thousands tons. National mean of guava fruit yield is 12.7 ton ha<sup>-1</sup> however; it may fluctuate since less than 2 to 20 ton ha<sup>-1</sup>, depending on the region and level of technology used. Approximately 85% of the total production volume is for fresh consumption, while the rest is used for processing at different scales. Most of the commercialization of fresh guava is for national market and is mainly concentrated in five or six Mexican cities. Nevertheless, those cities represent a potential market of more than 40 millions people. Although, guava is produced in more 20 States of the country, three of them represent an 89% of the total cultivated area. Guava fruit type mainly produced in these regions is called "media china", which has a high preference by the consumer because of its nice flavor and pleasant aroma. Recently, guava crop has received more attention for the different actors of the production system, which allowed reaching important objectives such as the exportation of 15 thousands tons of fresh guava to the United States during the last four years. This was possible thanks to the work done on the campaigns against fruit fly, as well as the approved irradiation treatment. Other important achievement includes the registration and release of the first five Mexican guava varieties. Even so, some of challenges that guava production in Mexico has to face in the near future to be more competitive are: development and use of more improved varieties having comparative advantages (fruit size and form, lower seed number, pulp color, ascorbic acid content, total soluble solids, greater firmness, etc.); incorporate better agronomic practices (pruning, nutrition, irrigation, etc.); more environmentally and healthy control of pests; open the harvest widow to ensure more stable production through the whole year and increase fruit quality and uniformity, among others. Besides these technical factors, it is also going to be needed: to enhance organization of guava producers; increase infrastructure (packing and cold storage facilities, etc.); to have more access to technical assistance and better profits for their guavas. As long of some of these elements start to be incorporated to the guava production systems, it could be possible to have a better perspectives for the future of the Mexican guava.

**Keywords:** annual production, fresh and industry markets, exportation.

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**Session I – *Myrtaceae* Genetic Resources**



## Taxonomy and importance of *Myrtaceae*

S.K.Mitra<sup>1,A</sup>, T.K.S.Irenaeus<sup>1</sup>, M.R.Gurung<sup>1</sup>, P.K.Pathak<sup>2</sup>

The Myrtaceae or Myrtle family comprises at least 140 genera and some 3800 to 5600 species. Many important trees and shrubs belong to Myrtaceae. There are four genera of interest which produce edible fruits: *Psidium*, *Eugenia*, *Syzygium* and *Feijoa*. The genus *Psidium* contains about 150 species of which *P.guajava*, *P. cattleianum*, *P. friedrichsthalianum*, *P. guineense*, *P. littorale*, *P. acutangulum* etc. are commercially important. The *Eugenia* is a small group in which important species are *E. braziliensis*, *E. uniflora*, *E. victoriana*, *E. axillaris*, *E. aggregate*, *E. dysenterica*, *E. lutescens*, *E. luschnathiana* etc. The *Syzygium* has about 500 species and most of them have originated and grow mainly in the south-east Asia. The important species are *S. jambos*, *S. malacense*, *S. suborbiculare*, *S. paniculatum*, *S. aqueum*, *S. cordatum*, *S. cumini*, *S. forte*, *S. samarangense* etc. The feijoa (*Avea sellowina*) grown mostly in Brazil and Uruguay. The fruit is rich in protein, carbohydrates and fiber. The *E. uniflora* (Pitanga) fruit pulp is a good source of carotene and ascorbic acid. The fruit of *P. guajava* is considered as one of the richest source of antioxidant among the tropical fruits. This paper will discuss the taxonomy and importance of trees and shrubs of Myrtaceae family.

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## ***Psidium* L. (Myrtaceae, Myrteae) in Bahia State, Brazil**

Ligia S. Funch<sup>1,A</sup>, Leslie R. Landrum<sup>2</sup>, Marla Ibrahim U. de Oliveira<sup>1</sup>

Considered as the eighth most diverse family among the angiosperms, Myrtaceae has about 5000 species grouped into ca. 140 genera, with *Psidium* L. being one of the most representative in the Americas, occurring from México to northern Argentina. Included in the tribe Myrteae, subtribe Myrtinae, and informal group "*Pimenta Group*", this genus comprises over 70 species most of which widely cultivated, such as *P. guajava* L. (common guava) and *P. guineense* Sw. (guinea guava, "araçá"). It differs from other genera by cryptic characters related primarily to the gynoecium, such as trilocular ovary, multiseriate ovules arranged in a peltate placenta, and a hard, bony seed coat. Specialists report the presence of about 60 species in Brazil, and this study aims to contribute to the increase of knowledge about the diversity of this taxonomic group in Bahia. From the investigation of materials from major national and international herbaria (ALCB, ASU, CEPEC, HRB, HUEFS, HUNEB, MBM, NY, R, RB, SP, SPF and UB), 20 taxa were recorded for the State: *P. amplexicaule* Pers., *P. appendiculatum* Kiaersk., *P. bahianum* Landrum & Funch, *P. brownianum* DC., *P. cattleianum* Sabine, *P. cauliflorum* Landrum & Sobral, *P. firmum* O.Berg, *P. ganevii* Landrum & Funch, *P. glaziovianum* Kiaersk., *P. grandifolium* Mart. ex DC., *P. guajava*, *P. guineense*, *P. myrsinites* DC., *P. myrtoides* O.Berg, *P. oligospermum* DC., *P. rhombeum* O.Berg, *P. rufum* Mart. ex DC., *P. salutare* var. *pohlianum* (O.Berg) Landrum, *P. schenckianum* Kiaersk., and *P. striatulum* Mart. ex DC. Identification keys, descriptions and comments are provided for these taxa. The main differences between them were found to be in the mode of bud opening, in the format of the calyx-lobes, and in the leaf dimensions, although the number of secondary veins and the presence of hairs in the latter have also proved to be significant. *Psidium* seems well distributed in different types of vegetation, but some species are restricted to "restinga" (*P. amplexicaule*), forests (*P. firmum*), "cerrado" (*P. myrsinites*), and "caatinga" (*P. rhombeum* and *P. schenckianum*). *P. bahianum*, *P. cauliflorum*, and *P. ganevii* have recently been described and are endemic to Bahia, showing the importance of floristic surveys involving taxonomic studies for a better understanding of the flora of the state, with the consequent use of this data for conservation purposes.

**Keywords:** Myrtoideae, taxonomy, floristic survey, Northeastern Brazil, guava.

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## Discriminant analysis of wild guava tree by morphological descriptors and microsatellites

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The guava (*Psidium guajava* L.) is a fruit tree cultivated in tropical and subtropical regions of the world. Its fruit has high nutritional value and its cultivation strengthens the familiar agriculture. In Brazil, few genotypes are cultivated causing genetic vulnerability. Thus, it is important for breeding, the searching of new genotypes in wild populations. This work aimed to evaluate the genetic diversity of 66 wild guavas of six localities in the south of the state of Espírito Santo and in Caparaó, Minas Gerais, Brazil, by morphological descriptors and microsatellites. For each plant it was evaluated 11 quantitative and 17 multicategorical variables of five young leaves, ten developed leaves and five fruits. The DNA was extracted from young leaves and genotyped with 18 microsatellites. Data were analyzed by the discriminant method of k-nearest neighbors. The higher apparent error rate was obtained by quantitative, multicategorical and molecular data, respectively. The differentiation among accessions by molecular markers has allowed the characterization of guava groups of common origin. However this characterization was not possible with the analysis of morphological data. Genetic diversity was observed between and within the localities regardless the type of trait studied, indicating variability to be exploited in guava breeding and in conservation programs of the culture.

**Keywords:** *Psidium guajava*, breeding, conservation.

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## Preliminary study of wild guava tree from Espírito Santo and Minas Gerais by continuous descriptors

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The characterization, selection and introduction of new guava genotypes with important traits for breeding are of awesome importance looking at competitiveness in the guava market. Genetic variability studies by metrical characteristics of leaf and fruit, may indicate wild genotypes genetically divergent and with proper traits for crop improvement. The most important characteristics for improvement are continuous, controlled by many genes. The aimed of this work was to do a descriptive analysis with 11 continuous descriptors in 66 wild guava trees that may indicate promising genotypes to breeding. There were collected five young leaves, ten developed leaves and five fruits of each plant in the localities of Alegre, Guaçuí, Cachoeiro de Itapemirim, Mimoso do Sul, Muqui and Jerônimo Monteiro in the south of the State of Espírito Santo and also at Caparaó in Minas Gerais. For each plant there were evaluated: young leaf length (YLL) and width (YLW), developed leaf length (DLL) and width (DLW), fruit mass (FM), length (FL) and diameter (FD), pulp mass (PM) and diameter (PD) and seed mass (SM) and number (SN). The assessment of genotypes by location was done by average chart within 95% confidence interval. In general, the mean values of the studied characteristics were higher for fruits from Guaçuí (FM, FL, PM, SM and SN) and Jerônimo Monteiro on leaf (YLL and DLW) and fruit (FD and PD) descriptors. They were followed by leaf descriptors from Muqui (YLL) and Caparaó (YLW). In Guaçuí was found maximum values for fruit descriptors FM, FL, FD, PM, SM and SN, and Muqui maximum values for the descriptors FD, SM and SN. These results suggest that the Guaçuí and Muqui genotypes, except those that bear many seeds, can be exploited because they have presented some important characteristics for improvement, such as large fruit mass and size.

**Keywords:** genotypes, genetic variability, breeding.

**Acknowledgement:** To FAPES, UFES and CNPq.

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## Characterization of the Guapuriti (*Plinia rivularis*) fruit

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The Guapuriti (*Plinia rivularis* L) is a native species in regions of Argentina, Paraguay, Uruguay and Brazil. In Brazil its natural occurrence is from the State of Pará to the State of Rio Grande do Sul. Like other species of the Myrtaceae family it has a potential for agricultural exploitation or urban landscaping. However, little is known about its characteristics and productivity. The objective of the present work was to obtain information regarding morphology and eating quality traits of the Guapuriti fruits. Fruits from one Guapuriti entry were separated based on the ripening stage (mostly green skin; red skin and totally black skin). Fruits were hand harvested and sent to the laboratory and analyzed for morphological characteristics (longitudinal - DL- and transversal -DT- diameters, -DL/DT ratio, number of seeds per fruit, pulp yield, fruit color and humidity, along with the weight of 1000 and seed water content). Quality traits were determined through the analysis of soluble solids – SS-, titratable acidity – AT-, and L-ascorbic acid content. The means were analyzed through the Tukey test ( $p < 0.05$ ). The results indicated that Guapuriti fruits were slightly flattened with a black colored skin when ripe and with a high water contents (80.4%) and low pulp yield (19.46%). In the last stages of ripening the fruit reach 12.3° Brix and 27.3 mg ascorbic acid per 100g of pulp. Acidity on the basis of citric acid is very low (0.06%). Each fruit bears 1 to 2 seeds also with high water content (57.45%).

**Keywords:** Myrtaceae, native fruit tree, morphology and fruit chemistry.

**Acknowledgement:** For UFRGS PPG Fitotecnia and for Capes and CNPq for the financial support and for Dra. Candida Monteiro, Capes CNPq

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## Prospecting on the agronomical potential of guabiju trees in Rio Grande do Sul, Brazil

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Guabiju [*Myrcianthes pungens* (O. Berg) D. Legrand] is a tree of the Myrtaceae family, naturally occurring from the State of São Paulo, Brazil, to northern parts of Uruguay. In Rio Grande do Sul (RS), this species grows in forests from several regions. Fruiting occurs from December to April, its eatable dark violet globe-shaped fleshy fruits may be appreciated for consumption in natura or processed. This work aimed at finding guabiju entries which might eventually present superior characteristics regarding fruit quality. Ripe fruits from 15 entries, located in eight regions of RS, were harvested in Feb-Mar/2011. They were brought to the Horticulture Laboratory of DHS and grouped into sampling units composed by 100 fruits, divided into 4 replicates of 25 specimens. Each fruit was weighed and had its equatorial and longitudinal diameters (DMF and AMF, respectively) determined. Skin color at the equatorial portion was measured by means of the CIELab system. Afterwards, the fruits from each replicates were peeled and pulped, with stratification of skin, seed and flesh. With regard to biometrical parameters, wide variability was observed in mass average (1.32 to 7.19 g) and flesh content (42.0 to 65.4%). A highly significant relation was observed between the parameters DMF and AMF with the mass average. To a higher AMF/DMF ratio, tending to one (spherical form), greater mass average was mostly associated, differently from flatter formats. With regard to skin color, the values for orthogonal coordinates  $a^*$  and  $b^*$  are near zero, where the main color component is grey. Low skin luminosity ( $L^*$ ) variation coefficient (2.14%) was found in ripe fruits from the analyzed entries. It may be concluded that there is variability between guabiju entries, being identified potential materials for cultivation and genetic improvement with regard to biometrical characteristics of fruits.

**Keywords:** Biometry, *Myrcianthes*, Myrtaceae.

**Acknowledgement:** Financial support of FAPERGS and CNPq.

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## Germination characteristics of three accessions of Suriname cherries (*Eugenia uniflora* L.)

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The Suriname cherry (*Eugenia uniflora* L.) belongs to the Myrtaceae family. The species is propagated by grafting, cuttings or seeds. Seeding is the most common form of propagation. Recalcitrance is an aspect that influences seed germination and the Suriname cherry shows that characteristic. A study was carried out with the objective to evaluate the germination, water contents, thousand seed weight, number of seeds per fruit and emergence speed index (ESI) of three accessions of the Suriname cherry. Ripe fruits were collected from three trees in the county of Viamão, metropolitan region of Porto Alegre, Brazil from September to December, 2011. Accesses were designated as AD, AE and AC. After harvest, the seeds were taken from the fruits and dried for 24 hours at ambient conditions. Germination tests were performed under constant light conditions and at 25°C temperature using sand as substrate. The ESI was determined according to the Rules for Seed Analysis (RAS). The experimental design was completely randomized and each treatment (access) composed by four replicates of 50 seeds each. The averages were submitted to analysis of variance and differences determined by the Tukey test ( $p < 0.05$ ). The AD accession differed significantly from the other two accesses: AE and AC with regards to germination percentage (94.5%), ESI (22.0) and number of seeds (2 seeds per fruit). The largest ESI value obtained by AD indicates its greatest potential in terms of the production of seedling rootstocks. That accession also presented the earliest seed germination (started after 15 days) among the evaluated accessions. Emergence peaks were concentrated between 36 and 51 days after seeding. The access AD stood out among the three evaluated accesses with higher germination, number of seeds per fruit, vigor and precocity of germination.

**Keywords:** Myrtaceae, propagation, seed.

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## Chemical and biochemical characterization of guava and araçá fruits from different regions of Brazil

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Guava and araçá, both belonging to the genus *Psidium*, are important options for the Brazilian agribusiness due to their fruit characteristics, such as appearance, taste and richness in minerals and phenolic compounds. These fruits can be consumed 'in natura' or in several processed forms. The active germplasm bank is an important tool for characterization of genetic material and studies of plant breeding. This study aimed to characterize, chemically and biochemically, fruits of guava and araçá accessions from different regions of Brazil and grown in the Active Germplasm Bank of Embrapa Tropical Semi-Arid, in Petrolina, Pernambuco State, Brazil. Sugar, proteins, soluble solids, titratable acidity, calcium, magnesium, iron and phosphorus contents were determined. Large variations were observed in the analyzed compounds, which could be attributed to the diversity of genotypes and also to the environmental conditions, which affect the plant metabolism. The average titratable acidity in araçá was 1.16% of citric acid, while in guava it was 0.5%. The average content of soluble solids showed no significant difference between samples, with guava accessions presenting the highest "ratio" levels, which amounted to 37.69 against 16.64 in araçás. The total protein content was similar between the accessions of guava and araçá, with a mean value of 0.65% on fresh weight. A higher variation in the magnesium and iron levels (2.5 and 5 times, respectively) was observed, both between guavas and araçás. On the other hand, no significant difference was found in the levels of calcium and phosphorus. The high variability observed in most parameters of both accessions is an important factor to the improvement of these species. Most accessions of guava showed titratable acidity and soluble solids higher than those found in guava commercial cultivars and, in araçá, these levels were even higher, which makes them promising for commercial exploitation. Moreover, both fruits of guava and araçá present as good sources of sugars and minerals. Special attention should be given to some accessions of guava and araçá from Maranhão and Pernambuco States, respectively, which showed elevated levels of many chemicals and should be targets of breeding programs for the improvement of new cultivars of *Psidium*.

**Keywords:** *Psidium* spp, composition, plant breeding.

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### Comparison of wild guava with the cultivar Paluma.

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The production of guava (*Psidium guajava* L.) in Brazil has grown gradually with the expansion of agricultural frontiers. However, the widespread cultivation of few commercial varieties leads to concerns about the genetic vulnerability of guava orchards. This study aimed to evaluate 12 guava genotypes from Cachoeiro de Itapemirim (CA-1; CA-2; CA-3), Jeronimo Monteiro (JE-1; JE-2; JE-3), Mimoso do Sul (MI-1; MI-2; MI-3) and Muqui (MU-1; MU-2; MU-3), sampled in the south of the Espírito Santo State, Brazil, and to compare them to the average of three plants of the cultivar Paluma by the characteristics: fruit weight (FW), pulp weight (PW) and fruit length (FL). The ANOVA was applied to the data. The evaluation of the clustering of genotypes was done by the method of Scott Knott. Clustering was performed for each characteristic evaluated. The Paluma genotype appeared as an isolated group for all characteristics. For the FW characteristic, the second group aggregated the CA-2 and MI-3 genotypes as similar. For the characteristics PW and FL, the second group gathered the JM-1 genotype in addition to the genotypes CA-2 and MI-3. The third group was composed of the remaining genotypes in the analyzes with FW and PW. A fourth group was formed only by analysis of the characteristic FL (JE-2 and MI-1 genotypes). It was evident that three genotypes were superior to others for the characteristic analyzed. These results are interesting for studies of breeding in the region, searching for superior genotypes to be introduced in guava pre-breeding and breeding programs.

**Keywords:** fruit, genetic, potential.

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## Germination in guava genotypes in south Espírito Santo and Caparaó, Minas Gerais, Brazil.

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Adésio Ferreira, Marcia Flores da S. Ferreira

The guava (*Psidium guajava* L.), which belongs the Myrtaceae family, originated from the tropical regions of America. In Brazil, its production has been increased gradually with the expansion of new agricultural frontiers and its cultivation has strengthened the familiar agriculture. This species can be propagated in two ways: by seeds and by vegetative propagation. Due to the occurrences of some production problems, such as good quality seedlings, it is necessary to search for genotypes with adequate dispersion. The objective of this study was to evaluate the performance of 29 guava genotypes collected in six localities in Southern Espírito Santo and Caparaó (MG), comparing them to the average of five plants of the variety Paluma, in relation to the germination characteristics: days to the start of germination (GI) and germination speed index (IVG). The ANOVA was statistically significant only for GI. The Scott Knott clustering presented three groups: the G1 was composed of three genotypes collected in Alegre, two genotypes in Cachoeiro de Itapemirim, and two genotypes in Caparaó (MG). The second group was formed by 11 genotypes and Paluma. It was found that 50% of the genotypes studied are similar, or superior to 'Paluma'. These results are interesting to study the genetic improvement of this crop in the region to pursuit superior genotypes to be introduced in breeding and pre-breeding, but others studies and assessments should be developed.

**Keywords:** conservation, horticulture, genetics.

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## Camu-camu: a mysterious plant with an excellent source of natural vitamin C

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The 'camu-camu' (*Myrciaria dubia* (Kunth) McVaugh, Myrtaceae), a fruit tree typical to the Amazon region, occurs naturally along the banks of rivers, lakes and narrow channels in clear as well as dark waters. Due to the very high vitamin C (ascorbic acid) content of the fruits, it has great agronomical, technological, nutritional, and economic potential which has yet to be exploited. This characteristic has awakened the interest of researchers as well as the Japanese food industry. Studies have proven the nutritional potential of the fruit as a source of vitamin C, varying from 845 to 3133 mg per 100 g of fruit pulp. The vitamin C content of three samples of 'camu-camu' collected in the east of Roraima State was analyzed. One sample was from the Maú river, the other two (an isolated plant and another population) were from the Urubu river, both of these rivers being tributaries of the river Tacutu. Acid ascorbic was determined by HPLC. The fruits from an individual plant on the Urubu river presented the highest concentration of ascorbic acid,  $6112.6 \pm 137.5$  mg in 100 g of pulp. The populations of 'camu-camu' from the Urubu and Maú rivers presented ascorbic acid concentrations of  $5737.5 \pm 236.1$  mg (pulp rind) and  $3571.5 \pm 12.0$  mg per 100 g, respectively. The access Candeias showed an excellent stability of ascorbic acid, with 2.30%, after 32 months of storage. This unprecedented finding shows the need for further studies, considering the genetic variability of 'camu-camu' and its nutritional potential as a source of vitamin C.

**Keywords:** *Myrciaria dubia*, Ascorbic acid, Stability

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### Physical and chemical fruit characterization of three genotypes of 'Pêra do Cerrado'

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The 'Pêra do Cerrado' (*Eugenia klotzschian* Berg.), Myrtaceae, occurring in the Brazilian 'cerrados', can present an alternative to the rural producers, since more and more exotic fruits have been consumed, especially in large cities. The fruits, are big, pear shaped, yellowish green, cream-colored pulp, juicy and acidic of pleasant taste. The seeds are small with 1 to 2 in each fruit. Moreover, it has great potential as ornamental, due to the small plant size and beauty of its flowers. This study aimed to evaluate the physical and chemical fruit characteristics of three genotypes of 'Pêra-do-Cerrado', with about 25 years old, from the active germplasm bank, UNESP/FCAV, Jaboticabal, Brazil. The experimental design used was completely randomized with three genotypes and each plant was considered as a treatment, being the plants originated from seeds, and five repetitions. The results were significant ( $p < 0.05$ ) for the following characteristics: average of mass rind (7.77g), soluble solids (4.29 oBrix), the resistance of mature fruits (0.30 N) and staining ring for the Hue angle with an average of 86.04. There was no significant difference between genotypes for pulp percentage (83 %), longitudinal and transverse length, (73.27 mm and 47.2 mm), respectively, pH (3.07), titratable acidity (0.67), ascorbic acid (5.44 mg x 100g<sup>-1</sup>), ratio (6.60) and the values found in colorimeter ( $L^* = 53.03$  and  $a^* = 43.86$ ). Fruits from plant 1 showed the highest values for soluble solids (5.04 oBrix), while in the fruits from plant 3 were found to have the lowest values for peel weight (5.58 g) and Hue angle ( $h = 82.32$ ). Also, it was observed that each plant produced quite different fruits but the fruits of genotype had better commercial appearance, indicating that the cloning of the material is essential for the maintenance of the studied traits.

**Keyword:** Myrtaceae, soluble solids, fruits.

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### Propagation of *Eugenia candolleana* by grafting

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Brazil stands out as one of the greatest center of diversity of many fruit trees, especially from the Myrtaceae family. However, most of them are virtually unknown to consumers, although they have show potential for cultivation. More knowledge about a culture is important to help the preservation of the species. *Eugenia candolleana* L is a rare *Eugenia* from the Southern Brazil Atlantic Forest. It is a shrubby tree, growing to 23 feet, with ornamental and production potential. The fruit can be eaten and is well appreciated. This species is commonly propagated by seeds, what is disadvantageous due to time lag to start flowering and harvesting that imposes difficulties for preservation of the species. Technical information on the production system of *E. candolleana* plants are still lacking. This study was carried out at the "Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal" FCAV/UNESP, from August to December 2011 aiming to check the possibility of vegetative propagation by grafting on this species. Leafless scions bearing three buds were taken from adult plants and kept in the Germplasm Bank of the UNESP. They were grafted to the rootstocks by cleft or whip graft, using plastic polyethylene transparent tape or parafilm degradable tape. The grafts using polyethylene transparent tape were protected with polyethylene bags. The rootstocks used were propagated by seeds. After grafting, the plants were kept at 50% shade level. The experimental design was entirely randomized in a 2x2 factorial arrangement (method of grafting and tape), with 4 replications (10 plants per replication). After 120 days, the survival index, length, number of sprouts and number of leaves were evaluated. There was no effect related to the tape type and grafting method on survival (39.3% survival), but the kind of tape has influenced the number of sprouts (there were more sprouts with the use of the plastic polyethylene transparent tape). There was significant interaction between the factors length of sprouts and number of leaves when the degradable tape was used associated to cleft graft (12.1 cm of length and 12 leaves). It is concluded that the *E. candolleana* could be propagated by cleft grafting associated to parafilm degradable tape to produce better quality seedlings.

**Keywords:** vegetative propagation, native species, Myrtaceae.

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## Characterization of the Cambui (*Myciaria tenella* O. Berg) - a native fruit from Brazil

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The Cambui tree is native to Brazil which fruits are harvested for fresh consumption as in State of Sergipe, Brazil. Because of the regional importance of the species, this work aimed to characterize the Cambui fruits and seeds. Mature fruits were harvested from the "Reserva do Caju", in the municipality of Itaporanga d'Ajuda, Sergipe, Brazil. There were biometrically analyzed 200 fruits and seeds. In addition, fruit, pulp and seed color were evaluated, based on RHS Color Chart. There were found two different fruits skin colors: 1. yellow [orange - red (group 32A)] with yellow pulp [yellow - orange (group 17A)]; and 2. purple [violet - blue (group 93A)] with red pulp [red - purple (group 60A)]. The seed were, green [yellow-green (group 152A)] with dark stripes [Brown (group 200C)]. The fruit mean diameter was 9.23 mm/fruit, and mean width 8.50 mm/fruit. In relation to seeds, the mean value obtained for the variables diameter, width and thickness were 5.34 mm/seed, 6.52 mm/seed and 5.08 mm/seed, respectively. The Cambui seeds are highly variable as expected, since it is a native species that grows without any type of management.

**Keywords:** Seeds, Myrtaceae, biometric, HRS Color Chart.

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## Introduction of kinds and genera concerning to the family *Myrtaceae* Juss. on Apsheron condition

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In Mardakan arboretum of NAS of Azerbaijan Republic within 2006-2012 given from the countries of the world on Absheron dry subtropical plants, concerning to families Myrtaceae Juss. and 3 genera, 19 kinds of plants, the scientific bases on study of bio-ecological features, agrotechnical and their rational use were prepared. The object of research was served by (with) the following kinds: *Myrtus communis* L., *Callistemon lanceolatus* (Sm.) DS, *Eucalyptus albens* Mig., *E. algeriensis* Trabut., *E. globules* Labill., *E. leucoxylon* F. Mull., *E. polyanthemos* Schauer., *E. porosa* L., *E. rostrata* Sche., *E. sideroxylon* A.Gun., *E. umbelata* Dom. Investigated 19 kinds, and bushes from valuable collections Mardakan arboretum, 11 kinds for the first time by us were introduced in Azerbaijan; their bio-ecological features are investigated, their opportunities adaptating are found out and are recommended for gardening of Absheron. History of these 19 tree kinds introduction long years on dry subtropical, tropical and subtropical climatic conditions, and also as a result of a retro of the forecast extending opportunities of adaptation are created conditions for formation on Absheron steady of complexes. This adaptation itself in turn except for attributes, available at plants, promoted purchase of other attributes. In result phenological of supervision a seasonal nature of dynamics (changes) of growth between kinds. The laws between flowering, development both fall of fruits and seed, and also their productivity have come to light. Were rather analyse of a condition between natural dwelling-place and introduction by places introduction; the factors accelerating and which are slowing down vegetate are opened; the periods are specified optimum. Introduction on Absheron are divided (shared) into 3 groups: a) vegetate the period at trees early beginning - early coming to an end; b) vegetate the period early beginning - late coming to an end; c) vegetate the period late beginning - late coming to an end. On the basis of norm and optimum of quantitative attributes not typical criteria vegetate of terms are determined. The

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statistical laws, seasonal growing of trees were revealed in view of regular, ecological and geographical attributes and it creates an opportunity to give the forecast about successes introduction of new kinds. During work the criteria of stability of trees and bushes to a water mode, under the ecological factors to dry-resisting, hat-resisting, frost resistance were revealed; to action of acids, salts and on the basis of it the kinds are grouped. The scientific results can be used for preservation different biological and agrofloretical of complexes of Absheron peninsula, restoration and their rational use.

**Session II – *Myrtaceae* Pest, Disease and Nematodes**



## Major guava nematode: genetic control perspectives

Regina Maria Dechechi Gomes Carneiro<sup>1,A</sup>, A, Vânia Moreira de Feitas<sup>2</sup>  
Cesar Bauer Gomes<sup>3</sup>

The worst nematode problem affecting guava is that created by root-knot nematode which is a recognized limiting factor in commercial guava production in Central and South America. Considering the difficulty of identifying *Meloidogyne enterolobii* (= *M. mayaguensis*) only by the perineal pattern, this species has been misidentified in different regions around the world and identified frequently as *M. incognita*. The species identification is possible using esterase phenotype and molecular markers. Using these techniques, only *M. enterolobii* was detected on guava, confirming the incorrect identification. The intraspecific genetic variability of sixteen *M. enterolobii* isolates from different geographical regions and hosts were analysed with different neutral molecular markers (RAPD, ISSR and AFLP) and showed a high level of homogeneity among the populations. Considering the small variability among *M. enterolobii* isolates, genetic resistance could be considered the most effective method of control, but only one accession of *P. friedrichstalianum* (Costa Rican wild guava) was resistant and compatible as rootstock with *P. guajava* cv. Paluma, in field conditions. Although this root-knot nematode displays a very wide host range, our studies showed that 14 fruit trees are non host to *M. enterolobii* (atemoya, avocado, cashew, citrus rootstocks, coconut, mango, soursop) or poor hosts (assai palm, common mulberry, jaboticaba, 8 grape rootstocks, passion fruit, sapodilla and soursop); only four fruits trees are good hosts (fig, banana, grape 'Chardonnay' and 'Solferino' and malon). Considering the impossibility to cultivate guava in field infested by *M. enterolobii*, these fruits presented as non hosts or poor hosts could be used by the growers, but more studies should be done in infested areas to support the results obtained in green house conditions.

**Keywords:** *Meloidogyne enterolobii*, enzymatic and molecular markers genetic resistance, grafting compatibility, *Psidium* spp., non host fruit trees.

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### **Resistant accessions of *Psidium* spp. to *Meloidogyne enterolobii* and histological characterization of resistance**

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Gomes<sup>1</sup>, Jean Kleber Mattos<sup>2</sup>

*Meloidogyne enterolobii* has been reported in some states of Brazil causing severe damage on commercial guava (*Psidium guajava* L.). Fifty-two accessions of *Psidium* spp. were selected from collections maintained in different Centers of Embrapa. Plants of different accessions were grown from seed in plastic bags and, when they reached 15-20 cm in height, they were inoculated with 10,000 eggs/plant of *M. enterolobii*. Six months after inoculation, the different accessions were evaluated for resistance to *M. enterolobii*. Only one accession of *P. cattleyanum* (yellow wild guava), one of *Aca sellowiana*, one of *P. friedrichsthalianum* (Costa Rican wild guava) and one of the *P. rufum* accessions were resistant to *M. enterolobii*, showing  $FR < 1.0$ . All 47 wild accessions of *P. guajava* were susceptible, as well as two accessions of *P. guineense* and *P. acutangulum*. When used as rootstocks in greenhouse conditions, *P. cattleyanum* and *P. friedrichsthalianum* were compatible with *P. guajava* cv. Paluma, but in field conditions only the Costa Rican guava survived. Most root-knot nematode resistance mechanisms in host plants that have been examined induced a hypersensitive response (HR). However, there was no typical HR in resistant wild guava *P. cattleyanum* and nematodes were able to develop normal feeding sites similar to those in susceptible roots 6-13 days after inoculation (dpi). From 27-32 dpi giant cells' deterioration was observed and females showed arrested development and deterioration. Nematodes failed to reach maturity and did not start laying eggs in resistant roots. These results confirmed that the induction of resistance is relatively late in this system. Some males were observed inside the roots 27-32 dpi. These results will be useful to design gene expression experiments to dissect RKN-mediated resistance at the molecular level.

**Keywords:** *Psidium guajava*, wild guavas, genetic resistance, grafting compatibility, histopathology.

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## Towards guava wilt disease resistance in South Africa

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Soil-borne vascular wilt pathogens cause among the most devastating plant diseases worldwide. Guava wilt disease (GWD) caused by *Nalanthamalapsidii*, has resulted in the loss of more than half the guava production area in the Limpopo and Mpumalanga provinces of South Africa during the '80s. Resistant guava selections were developed - subsequently rekindling the guava industry in these areas. Renewed outbreaks of guava wilt disease in 2009, now also affecting the tolerant cultivar TS-G2, is placing the guava industry under threat once again. Alternative control measures are currently not available and although host resistance remains the most logical choice for control, the lack of known sources of plant resistance and additional pathogen races are obstacles in the development of GWD resistant selections. Research progress and biotechnology advances towards guava wilt resistance will be reviewed.

**Keywords:** Guava wilt disease, control, resistance, biotechnology.

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## Pathogenicity of two type conidia of *Nalanthamala psidii* in guava

Chih-En Wu<sup>1</sup>, Wen-Hsin Chung<sup>1</sup>

Guava (*Psidium guajava* L.) is an important crop in tropical and subtropical area. More than 177 pathogens had been reported in guava worldwide, and the wilting disease is the most destructive one. In Taiwan, the causing agent of guava wilt disease is *Nalanthamala psidii* (Sawada & Kurosawa) Schroers & MJ Wingf., first reported in 1926, and had seriously impaired the yield of guava since the 1970s. The pathogen can penetrate from wound and cause wilting symptom in few months. Two types of conidia, short-elliptical conidia (SC) and long-elliptical conidia (LC), of *N. psidii* can be produced in PDA medium. The SC could be produced on the guava debris only in the field. However, LC could not be produced in the field but produced in artificial medium. The objective of this study is to analyze the biological characteristics of two types of conidia in causing wilting disease on guava. In this study, the LC could be produced in Czapek's medium with L(-) Sorbose, and the inoculums concentration are 10<sup>6</sup> conidia /ml. Moreover, three pairs of true leaves guava seedlings were used for test plants and each plant was inoculated 100  $\mu$ l. The results indicated that the guava leaves could show discoloration after 2 weeks inoculated with LC and SC and show wilting after 4 weeks inoculated. However, the guava leaves showed discoloration after 4 weeks inoculated with LC. Thus, the inoculums with LC and SC could cause more serious symptom and faster than inoculated with LC inoculums in guava only. It is necessary to carry out the role of LC and SC in causing wilting disease of guava in future and its ecology in field.

**Keyword:** guava, wilting disease, *Nalanthamala psidii*.

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### Surveillance of Field Infection of *Nalanthamala psidii*, the Causal Agent of Wilt of Guava (*Psidium guajava*)

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Guava wilt, caused by *Nalanthamala psidii* Schroers & Wingf., is a destructive disease in South Africa and South-East Asia. Diseased guava showed discoloration, defoliation, wilt and eventually dead of the entire plant. Controversies about the primary infection of *N. psidii* in the field had been reported before. However, the inoculum source and infection site are still unclear. Therefore, this study was conducted to investigate the infection of *N. psidii* in the field using mSGSSM, a semiselective medium for *N. psidii*. In 2010, guava trees naturally infected by *N. psidii* and showed wilt symptoms were selected and investigated in this study. Tissues from trimming and pruning wounds on twigs and branches were surface sterile using 75% EtOH for 10-15 sec, detached, and placed in mSGSSM in a Petri dish (9 cm diam.), 6-8 pieces/dish. Then, diseased trees were cut down and the roots were pulled up, washed with tap water, air dried and labeled. The tissues from main and lateral roots (diam. > 0.5 cm) were detached at an interval of 10 cm from the trunk and placed in mSGSSM dishes, 6-8 pieces/dish. Petri dishes mentioned above were incubated with 12 hrs light at 30°C and then examined for the growth of *N. psidii* after 7 days. A total of 8 wilted guava trees were sampled from the experimental field of Fengshan Tropical Horticultural Experiment Branch, Kaohsiung City, Taiwan. Among them, the isolation proportion of *N. psidii* in 7 plants was higher (20.3-56.8 %) in the roots than in the trimmed twigs and branches (1.9-29.2 %). These results suggest that in addition to wounds on twigs and branches, root is also crucial for the infection of *N. psidii* in guava orchards.

**Keywords:** Guava wilt, *Psidium guajava*, *Nalanthamala psidii*.

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## Reaction of *Psidium* accessions to the nematode *Meloidogyne enterolobii*

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Brazil was the 7<sup>th</sup> world guava producer in 2008, producing 298,798 ton in 15,641 ha. However, the presence of the root-knot nematode, *Meloidogyne enterolobii*, has been caused severe loss to guava growers. From 2001 to 2008 it was estimated a direct economical loss of around 70 million dollars and 3,703 unemployment of workers in five Brazilian States, due the attack of this pest. Based on this, it was evaluated 146 *Psidium* accessions, guava and araçazeiros from ten Brazilian States, in greenhouse and nursery conditions in order to find out resistant accessions to be used as rootstock of commercial guava cultivars. At greenhouse, plants with 15 to 20 cm height were inoculated with 10,000 nematode eggs, in an experimental incomplete block design, with five to ten replications. Under field nursery conditions, after seed germination, the plants were transferred to plastic bags with nematode contaminated soil. After five months of inoculation, the greenhouse accessions were evaluated for nematode damage according to presence of root gall or egg mass scale: 0 = no root galls or egg masses, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100, and 5 = more than 100 root galls or egg masses. A reproductive factor (RF) was estimated and the accessions classified as resistant or susceptible. The plants grown at field nursery were visually evaluated for the presence of root galls after five months of transplanting to plastic bag. A total of sixty-six *Psidium*, including fourteen araçazeiro and fifty-two guava accessions, were evaluated at field nursery conditions. Among the araçazeiros, two were classified as resistant, and another presented segregation to the tolerance to nematode. All guava accessions were susceptible in both evaluation conditions. Among the nineteen araçazeiro accessions evaluated in greenhouse, three were resistant to the nematode (RF < 1) and nine were immune (FR = 0). A further investigation performed among some tolerant araçazeiros accessions collected in the Brazilian sub tropical region (South), it was observed a poor plant development in the semiarid region of Northeast Brazil and low grafting compatibility with commercial guava cultivars. The current strategy to overcome this guava pest include the development of inter specific *Psidium* hybrids among tolerant araçazeiros and susceptible guava in order to obtain hybrids with adequate plant height and stem diameter, highly compatible when used as rootstock of commercial guava cultivars.

**Keywords:** guava, araçazeiro, grafting, compatibility.

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## Evaluation of 16 guava genotypes for resistance to *Meloidogyne enterolobii*

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One of the main causes of production losses of guava is the attack of root-knot nematodes *Meloidogyne enterolobii* (sin. *M. mayaguensis*). Several strategies to control this nematode have been investigated and the planting of crops with resistant cultivars is the most viable alternative. Among the priorities of breeding programs identifying sources of resistance to pathogens and selection of resistant genotypes is important for the incorporation of resistance genes in commercial cultivars. This study aimed to evaluate 16 progenies of guava (*Psidium guajava* L.) obtained by seeds, for resistance to *M. enterolobii*. Fruits of 16 plants were collected in the localities of Alegre (ES) and Caparaó (MG) and later there were obtained families of six plants per plant. The experiment was conducted in a completely randomized design, with a concentration of 500 eggs J2 of *M. enterolobii* inoculated per plant of six months old. After 135 days the evaluation was conducted and calculated the reproduction factor (RF), determined by the relationship between initial population and final population. To classify plants for resistance, plants with  $RF < 1$  were considered resistant and  $RF > 1$  susceptible. The plants 5, 6 and 7 had mean values for  $RF < 1$ , suggesting the existence of genes for resistance in these families. In genotypes 2, 3, 8, 11, 15 and 16, all plants obtained showed  $RF > 1$  being considered susceptible. These results allowed us to infer about the existence of resistance genes in *P. guajava* to *M. enterolobii*.

**Keywords:** *Psidium guajava*, nematode, breeding.

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## Guava wilt disease - the South African perspective

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The guava industry in South Africa was established in the Western Cape Province in the early 1900's and in the Limpopo and Mpumalanga Provinces in 1938. Guava orchards cover almost 1200 hectares in South Africa with 547, 442 and 140ha respectively in the areas above. The total production per annum is approximately 41 000 tons. The bulk of this (31 000 tons) is processed while 10 000 tons is sold in the formal fresh market. The guava export market amounts 20% and constitutes mainly guava puree and pulp. Since 1981 guava wilt disease (GWD), caused by *Nalanthamala psidii*, has been a serious disease in most guava-producing areas of the Mpumalanga and Limpopo Provinces of South Africa. Control measures other than eradication of diseased trees do not exist. Two resistant rootstocks TS-G1 and 'TS-G2' were developed by the Agricultural Research Council's Institute for Tropical and Subtropical Crops (ARC-ITSC) by 1995, and Plant Breeders Rights were granted to 'TS-G2' in 2000. These rootstocks were developed by screening thirty thousand guava seedlings in vitro using cell free filtrates derived from *N. psidii*. The release of the TS-G2 rootstock by the ARC made it possible for the industry to re-establish guavas in areas affected with GWD and saved the guava industry in Mpumalanga and Limpopo from extinction. In 2009, a second outbreak of GWD was reported from several localities, which also affected the resistant TS-G2 cultivar, placing the guava industry under threat once again. Measures currently undertaken to address this new threat include screening of chemical and biological products against the GWD isolates as short term solution as well as further in vitro screening of thousands of seed for a long term solution. This paper gives an overview of guava wilt disease in South Africa and aspects included are, symptomology, taxonomy of the pathogen, epidemiology, screening for resistance and management practices.

**Keywords:** *Nalanthamala*, Wilt, Symptoms.

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### Tolerance of *Psidium guajava* x *P. guineense* hybrids to *Meloidogyne enterolobii*

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Guava (*Psidium guajava*) is ranked among top ten fruit species in Brazil, with large importance in the São Francisco river valley (SFRV). Guava orchards have been destroyed in the SFRV by the *Meloidogyne enterolobii* nematode, reducing the guava area from around 5,000 to 2,500 ha. No effective control has been identified to overcome this nematode. Previous studies at Embrapa Tropical Semi-Arid have found that around 110 guava accessions were susceptible, while some *Brazilian Psidium* wild species, called 'araçazeiro', were tolerant to this pest, but with limitations to be used as guava rootstock. The goal of the present study was to obtain and evaluate inter specific hybrids among *P. guajava* x *P. guineense* to be used as guava rootstock or identified F2 plants resistant to the nematode. Susceptible guava mother plant GUA161-PE and tolerant plants ARA138-RR and ARA153-BA, established at an experimental field station in 2008, Petrolina, PE, were used to obtain inter specific hybrids. Guava mother bud flowers presenting petals rupture were emasculated in the anthesis and used for pollination. The pollinated flowers were protected with plastic bags for 15 days. Parents and putative hybrid seeds were sowed in 20 kg plastic pots and inoculated with 10,000 nematode eggs/pot when plants were 20 cm height. Four months after inoculation roots were harvested and evaluated to the scale: 0 = no mass eggs or galls, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100, and 5 = more than 100 galls or egg mass. Plants classified lesser than two were considered tolerant. Inter specific hybrids were genotyped with SSR markers or phenotyped for dominant trait. Fifty-five ARA138-RR out sixty-three plants were lesser than two, 10 out 20 ARA153-BA plants were lesser than two and all GUA161-PE presented scale greater than two. All ten evaluated GUA161-PE x ARA138-RR hybrids were high tolerant to *M. enterolobii*, presenting scale = 0, while ten evaluated GUA161-PE x ARA153-BA were susceptible to the nematode. Hybrids were independently confirmed by two SSR markers and also by leaf veins trait. The results suggested tolerance variability for *M. enterolobii* among and within *P. guineense* accessions, and that tolerance to the nematode should be controlled by dominant alleles. It is expected that inter specific *Psidium* hybrids presenting more exuberant stem and canopy, the principal limitation of *P. guineense* plants, will make possible the use of such hybrids as guava rootstock for commercial orchards and genetic studies.

**Keywords:** Guava, tolerance, araçazeiro, compatibility, root-knot nematode.

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**Population fluctuation of *Meloidogyne enterolobii* (= *M. mayaguensis*) in guava orchard and biological control with associated nematophagous fungi and cover crops**

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This study is of great interest for the culture of guava, since there are no nematicides registered. Management practices are designed to allow nematodes to live with the disease. The research aimed: 1) to evaluate the ability of egg parasitism of *Meloidogyne enterolobii* (= *M. mayaguensis*) fungi *Pochonia clamydosporia* Goddard, isolate FCAV-1 and FCAV-2, *Paecilomyces lilacinus* Thom., Isolate FCAV-1, FCAV-2 and FCAV-3, 2) to evaluate the predatory ability of the fungi *Arthrobotrys musiformis* Drechsler, *Arthrobotrys* sp. *Dactylella leptospora* Grove and *Monacrosporium elegans* Oudem to second juvenile stage of this nematode, in vitro, 3) to evaluate the resistance of cover crops such as millet (*Pennisetum glaucum*), peanut crop (*Arachis pintoï*) and *Crotalaria spectabilis* under greenhouse conditions, 4) to evaluate the efficacy of nematophagous fungi, organic mineral fertilizer and the aforementioned cover crops, alone and in combination to control *M. enterolobii* (= *M. mayaguensis*) in an orchard of guava trees, and, 5) to study nematodes population dynamics from February to December 2009 in guava orchard with and without irrigation. It was confirmed that the combined use of cover crops resistant to *M. enterolobii* (= *M. mayaguensis*) and nematophagous fungi significantly reduced the population density. The trend line of population fluctuations of *M. enterolobii* (= *M. mayaguensis*) in guava trees in São Paulo, Brazil, displays peak population in the hottest and rainy months of the year (February and December).

**Keywords:** *Arthrobotrys musiformis*, *Paecilomyces lilacinus*, Nematode

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### **III *Myrtaceae* – Plant Breeding and Post-Harvest Management**



## Post harvest management of guava: present status and future needs

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The guava has the potential to become a commercially important tropical fruit crop not only for processing, but also for fresh consumption. Most of the guava produced in different countries is destined for domestic markets. Some of the major constraints that might have limited the potential of the guava as an important export crop are problems related to pests and diseases, the availability of good dessert cultivars and the effectiveness of post harvest handling and storage technology. The currently available technology for low temperature storage, modified atmosphere storage (MAP) or coating can keep the fruit for about three weeks, which is considered adequate. If fruit is to be exported to distant markets, the existing technology need to be upgraded to improve the shelf – life. Treatments designed to alleviate chilling injury such as MAP and/or delayed storage or calcium – infiltrated MAP fruit seem effective in maintaining quality and extending the shelf life of guavas. In addition, effective measures to control post harvest diseases also need to be developed further. This paper will review the present status of technology on post harvest physiology and storage of guava and will suggest the future research needs.

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## Guava world-wide breeding: major techniques and varieties and future challenges

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Guava is one of the most important fruits in a large number of countries of the world. In most countries where guava is important, genetic studies and breeding is done in different degrees and ways. Germplasm conservation and studies are practiced in places such as Colombia, Venezuela, USA, Malaysia and Nigeria. In these and other cases, objectives are to collect, introduce, characterize and select guava genotypes with defined and appropriate characteristics to production. Most of the improvement programs are based on controlled artificial pollination, using crossings among plants that present characteristics of interest for obtaining new cultivars. Plants crossed may be of the same species in the inter-varietal crosses or from different species, constituting the inter-specific crosses. Conversely, countries such as Israel, Thailand, Cuba, Mexico, Brazil, Pakistan and India, specially the late one, present active and productive guava breeding programs. Problems such as pests and diseases (nematodes, wilt), high seed content and poor yield with small fruits are mainly due to high heterozygosity and frequent cross pollination in guava plants. On the other hand, this fact resulted in a very high variability in seedling populations from which promising genotypes have been selected, such as 'Paluma', the main Brazilian variety and many others, like 'Kumagai', 'Pedro Sato', 'Cortibel'. In India there are more than 150 cultivars, but only a few with commercial importance such as Allahabad Safeda, L-49 (Sardar), Pant Prabhat, Lalit, Banarasi Surkha, Hisar Safeda, Hisar Surkha, Lucknow Safeda, Arka Amulya, Arka Mridula, Kg, Chittidar, which have been identified for commercial planting particularly in northern India, main guava growing region. However, in the last 10-15 years crop improvement work carried out resulted in release of several superior selections and or hybrids, such as 'Safed Jam', 'Kohir Safeda' and 'Arka Amulya' in India, 'Século XXI' in Brazil, and others. Breeding programs also uses techniques such as interspecific crosses and induced mutation, contributing to bring variability in different senses and characteristics. Molecular techniques and other new biotechnological tools are very helpful to study the extent of genetic variation among cultivars as well as to find out genetic markers for wilt resistance to improve efficiency in developing wilt resistant clones and rootstocks. Development studies still have to be done in aneuploidy breeding, development of autotetraploids and in vitro genetic manipulation of somatic cells.

**Keywords:** *Psidium guajava*, *Myrtaceae*, cultivars, hybridization, perspectives.

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### Phenological behavior of guava trees (*Psidium guajava* L.) under different climatic conditions of Mexico

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Guava (*Psidium guajava* L.) is an important fruit crop in Mexico. There are around 23 thousand hectares producing 300 thousand tons per year. Most of the commercial guava orchards are located at three Mexican states, which represent almost 90% of the total area. However, guava is cultivated in at least others 16 states of the country, where it plays a significant role in the fruit culture of small scale. Thus, it is possible to find guava trees since sea level until almost 2,000 masl. These broad altitudinal variations in the areas where guava trees are grown have an important influence on their phenological behavior, mainly due to temperature differences. Therefore, the objective of the present work was to study the phenological development of guava trees during 2011 at three locations of Mexico having different climatic conditions. All guava trees under study were obtained (by air layering) from the germplasm of INIFAP and established from 2 to 6 years before in the following locations and states: Santiago, Ixcuintla, Nayarit (21°49.5'N; 105°11.1'W; 8 masl); Huanusco, Zacatecas (21°44.7'N; 102°58.0'W; 1508 masl) and Temascaltepec, Mexico (19°02'N; 99°58.6'W; 2076 masl), with a hot-sub humid; semi hot-semi dry and temperate to semi cool-sub humid climate types, respectively. Annual mean temperature fluctuates from 25°C to 18°C at the hottest and coolest sites, respectively. Phenological development of guava trees was greatly influenced by temperature conditions at each location. Duration from pruning to flowering (P-F) ranged from 60 to 115 days, whereas the period from flowering to beginning of harvest (F-BH) varied from 100 to 180 days at Santiago Ixcuintla and Temascaltepec, respectively. Phenology of guava trees at Huanusco was intermediate between the other two locations. Although, it was observed a great variation on the number of days for the phenological development among locations, heat accumulation was similar for all sites. Guava trees required about 800 to 850 and 1950 to 2000 heat units for stages P-F and F-BH, respectively. Thus, phenological development of guava could be predicted using heat units accumulation.

**Keywords:** heat units, climate, temperature.

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### **Comparative analysis for °Brix and ascorbic acid concentration of guava fruits under two fertilization treatments in Zacatecas, Mexico**

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Guava fruit is appreciated because its high vitamin C or ascorbic acid (AA) content with respect to other fruits. Approximately 92% of the total guava production in Mexico is consumed as fresh fruit, while the rest is destined to the industry where the total soluble solids (°Brix) content is important. For such reason in the present study the AA and °Brix content of five guava genotypes were determined. Guava trees were fertilized during the crop cycle of 2011 using two different application methods: 1) soil fertilized and 2) fertilized thorough the drip irrigation system. However, both fertilization treatments received the same dosage. The variation in the concentration of ascorbic acid and total soluble solids among fertilization treatments was compared. The guava fruits were obtained from the Experimental Station of "Los Cañones" located in the municipality of Huanusco, Zacatecas, Mexico. Then, guava fruit samples were taken to the laboratory for processing. Registered data included average and standard deviation. Also a t Test was performed to determine significant differences. Four guava genotypes showed statistical significance for ascorbic acid content at the second fertilization treatment as compared with to first treatment, only one of the guava genotypes did not showed significant variation. Considering both fertilization treatments, values for AA content had a range of 200 to 500 mg AA/ 100g of fruit, whereas for °Brix, values ranged from 11.5 to 20.5. These results are in agreement with other values reported previously for guava fruit in the region of study.

**Keywords:** ascorbic acid, guava, fertilization.

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### Effect of high oxygen atmospheres combined with different levels of carbon dioxide and nitrous oxide on post-harvest pathogens of "Kumagai" guava

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The restriction to the use of a number of fungicides in response to health concerns over pesticide contamination has stimulated the search for alternative technologies for post-harvest disease control. This study evaluated the effect of controlled atmosphere storage conditions using high oxygen atmospheres combined with different levels of carbon dioxide and nitrous oxide (80% O<sub>2</sub> 20% CO<sub>2</sub> 70% O<sub>2</sub> 30% CO<sub>2</sub>, 60% O<sub>2</sub> 40% N<sub>2</sub>O, 40% O<sub>2</sub> 60% N<sub>2</sub>O, 20% O<sub>2</sub> 60% N<sub>2</sub>O and air) on post-harvest disease control of "Kumagai" guavas. After disinfection, 10 fruits were put in a box and wound-inoculated with *Colletotrichum gloeosporioides*, *C. acutatum* (causal agents of anthracnose) and *Guignardia psidii* (causal agent of black spot), the main postharvest diseases of guava. Desired gas mixtures were supplied continuously for 96 hours from cylinders connected to the flow board. Fruits were storage at 25°C. After a period of gas exposure, disease severity was evaluated every two days. After 10 days of storage the means were compared using Tukey's test ( $p \leq 0.05$ ). Fruit inoculated with *C. gloeosporioides* and *C. acutatum* in atmospheres with 20% O<sub>2</sub> 60% N<sub>2</sub>O showed low levels of disease development compared to those stored in air. This combination resulted in severity reductions by 69.0 and 61.0%, respectively. To *G. psidii*, the disease suppression was greater in atmospheres with 70% O<sub>2</sub> 30% CO<sub>2</sub>, leading to 33% severity reduction.

**Keywords:** post-harvest diseases, atmosphere control, anthracnose.

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### **Heritability estimates of guava (*Psidium guajava* L.) agricultural important characters evaluated in three populations.**

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Most economically significant fruit traits show quantitative variation which is controlled by a combination of genetic and environmental factors. In order to improve quantitative traits successfully in any breeding program, genetic and environmental effects need to be evaluated. Guava (*Psidium guajava* L.) is the most valuable cultivated species of the Myrtaceae family. The inheritance studies of quantitative characters in this specie are insufficient worldwide and in Cuba they have not been approached up to date. Three populations of guava were planted according to a Complete Random Design at the Tropical Fruit Tree Research Institute, Havana Province, Cuba. Fourteen quantitative fruits traits were evaluated during a period of four years. Factorials Analyses of Variance (Model II) were done with the data sets with the aim of estimating the variance components and the heritability in broad sense. The heritability in narrow sense was estimated by a progeny-progenitor regression analysis. These analyses were made using the SPSS program. In the three populations, most of the characters presented low and medium values of heritability in broad sense, with the exception of calix diameter-fruit ratio that showed high heritability in one of the populations. The length of fruit showed high values of heritability in narrow sense, while the others traits presented low and medium values. Most of the variables showed a genotype x environment interaction variance that was statistically significant, which facilitates the application of a better refined model for the genotype x environment interaction analysis.

**Keywords:** broad and narrow sense heritabilities, fruit variable, variance components.

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## **Antioxidant and biochemical content in Brazilian guava germplasm with white, red and pink pulps**

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Guava is considered to be an excellent source of antioxidant compounds due to the high content of lycopene and vitamin C. The international guava market is dominated mainly by white pulp fruit, differing from the Brazilian market, which pays a high price for guava cultivars with dark red pulp fruit. The goal of the present study was to analyze the content of Brazilian guava accessions contrasting for pulp colors to support the breeding program of guava, focusing on cultivars producing fruits with a high content of functional compounds. Sixty guava accessions established in a field germplasm bank, at Embrapa Tropical Semi-Arid, Petrolina, Pernambuco State, Brazil, were evaluated for total antioxidant activity, phenolic compounds, ascorbic acid, flavonoids, lycopene and beta-carotene, titrable acidity, soluble solids and total soluble sugars. The accessions, including guavas of white (n = 10), red (n = 23) and pink pulp (n = 27), were grown in a block design experiment, with two replications/ accession. An ANOVA was performed, decomposing the degrees of freedom for the three pulp color groups in order to test the contrast to the nine evaluated compounds. The accessions presented high variability ( $p < 0.01$ ) for all compounds. Guava white pulp did not presented variability for the majority of compounds, except soluble solids, while guava red and pink pulps presented high variability ( $p < 0.01$ ) for most compounds, except flavonoids in pink pulp guava and flavonoids, beta-carotene, soluble solids and total sugars in red pulp fruit. The white\*red and pink pulp contrast was significant ( $p < 0.01$ ) for most compounds, except for titrable acidity and soluble solids, with the greater mean values found in the accessions of pink red pulp, except for total soluble sugars. The red\*pink contrast was also significant ( $p < 0.01$ ), except for titrable acidity and soluble solids, with greater values found in the accessions of red pulp fruit, except for lycopene and total soluble sugars. The compounds mean values were, approximately, 1.5, 1.4, 1.7, 1.8, 2.7 and 3.1 times greater for antioxidant activity, phenolic compounds, ascorbic acid, flavonoids, lycopene and beta-carotene, respectively, quantified in the pink and red pulp guava accessions when compared to white pulp. These results

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indicated that pink and red pulp guavas have a potential of greater beneficial contribution to the human diet than white pulp guava.

**Keywords:** *Psidium guajava*, Brazilian accessions, functional compounds

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## Bioactive compounds and antioxidant activity in guava fruit cultivated in Sub-Middle São Francisco Valley, Brazil

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Northeast Region in Brazil has a relevant role on the development of Brazilian Fruit Crop, being Petrolina/Juazeiro region a great exporter of some fruits and a supplier to different States in Brazil. Guava (*Psidium guajava* L.) distinguished among tropical fruits not only because of its good sensorial characteristics, but for being considered a source of vitamin C, A and of the group B, as tiamin e niacin. It contains fibers, minerals (as phosphorus, iron and calcium) and lycopene, a carotenoid that helps to prevent cardiovascular diseases and cancers. However, the content of these compounds change among cultivars and cultivation conditions. The objective of this study was to determine the bioactive compounds content and the total antioxidant activity (TAA) of fruits for the main cultivars of guava fruit produced on Sub-middle of São Francisco Valley, Brazil: 'Paluma', 'Rica' and 'Pedro Sato'. Fruits were harvested on physiological maturity, in April 2009, from irrigated areas of commercial production located in Petrolina, Pernambuco State, Brazil. After harvest, fruits were divided in four replicates, being each one constituted by 20 fruits. They were maintained in ambient temperature ( $25.9 \pm 1.7^\circ\text{C}$  and  $66 \pm 5\%$  R.H.) until complete the ripening, when they were evaluated for: vitamin C, yellow flavonoids, antocianins, total carotenoids and total extractable polyphenols (TEP), as well for antioxidant activity, using both methods ABTS and ORAC. Among cultivars, 'Rica' showed the highest vitamin C content (107.40 mg.100g<sup>-1</sup>), yellow flavonoids (4.04 mg.100g<sup>-1</sup>) and total carotenoids (0.75 mg.100g<sup>-1</sup>). Pedro Sato cultivar distinguished for its higher TEP (149.97 mg.100g<sup>-1</sup>) and TAA, for both methods, ABTS (15.31 'M Trolox.g<sup>-1</sup> pulp) and ORAC (17.23 'M Trolox.g<sup>-1</sup> pulp). For these variables, it was observed a high correlation, confirming a contribution of polyphenols for the antioxidant activity, even others compounds quantified had contributed to this too. Because of these

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nutritional advantages, it is recommended to verify the commercial acceptance of Rica and Pedro Sato cultivars in the market explored by the growers nowadays, as well as its use for agroindustrial processing, considering that both are cultivated in small scale in that region.

**Keywords:** *Psidium guajava* L., food composition, functional properties.

**Acknowledgement:** The CNPq for granting the graduate student stipend from the first author.

### **Chemical characterization of guava fruit produced in sub-middle of São Francisco Valley, Brazil**

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Brazil is one of the main world producers of guava fruit. However, the expansion of consumer market is conditioned to fruit quality and improvement on postharvest conservation technologies. As other fruit of economic importance, guava is widely cultivated in irrigated areas in semi arid region, in Northeast Brazilian Region. In this region, quality attributes can be distinguished, recognizing that they are influenced by cultivars, soil and climatic conditions and cultural practices. For example, inappropriate management during harvest and postharvest time accelerate the senescence processes, affecting sensibly the quality and limiting the period for commercialization. The objective of this study was to evaluate chemical characteristics of the three main cultivars of guava fruit produced in Sub-middle of São Francisco Valley, Brazil: 'Paluma', 'Rica' and 'Pedro Sato'. Fruits were harvested on physiological maturity, in April 2009, from areas of commercial production located in Petrolina, Pernambuco State, Brazil. After harvest, fruits were divided in four replicates, being each one constituted by 20 fruits, totalizing 80 fruits per cultivar. They were maintained in ambient temperature (average values of  $25.9 \pm 1.7^{\circ}\text{C}$  and  $66 \pm 5\%$  R.H.) until complete the ripening. Fruits were evaluated for: soluble solids (SS) content, titratable acidity (TA), SS/TA ratio, pH, soluble sugars content and reducing sugars. Among the evaluated cultivars, 'Paluma' showed the highest soluble solids content (11.1 °Brix), titratable acidity (0.59% citric acid) and soluble sugars content (7.41 g.100 g<sup>-1</sup>). The highest values for SS/TA ratio and reducing sugars were observed in 'Pedro Sato', showing values of 25.52 and 6.48 g.100 g<sup>-1</sup>, respectively. In addition, pH changed from 3.92 to 4.25. Rica and Pedro Sato cultivars showed chemical characteristics similar to 'Paluma', the most produced cultivar in that region. So, it can be stimulated their cultivation with the goal of exploiting in natura fruit market and the agroindustrial processing. In a general way, all studied cultivars attend the quality patterns established by Ministry of

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Agriculture, Livestock and Food Supply for pulp of fruits and they can be commercialized for internal and external market.

**Keywords:** *Psidium guajava* L., cultivars, quality, postharvest physiology.

**Acknowledgement:** The CNPq for granting the graduate student stipend from the first author.

## Developing a fermented functional food from Guava

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*Psidium guajava* L. is an important fruit cultivated and consumed widely across the globe. The fruit is endowed with enormous nutritional properties like vitamin C, vitamin A and vitamin B6 and B12 in addition to important minerals. The fruit suffers severe post harvest damage as it has a very short shelf life and ripe fruits are prone to bruising and fungal decay. The problem of post harvest losses is aggravated in the distant areas of Indian sub continent where the transport and storage facilities are limited. We took up fermentation of the ripe and raw guava using probiotic micro organisms like *Lactobacillus casei* and *Lactobacillus acidophilus*. A white flesh 'Lucknow49' and pink fleshed 'Bangalore' variety has been used in the study. Shake flask fermentation was carried out for 25 hours and the antioxidant potential of the broth was evaluated by DPPH method. The radical scavenging activity was 89.33 % and 59.95 % using raw white and pink variety fruits respectively with *L. casei* being the fermenting organism. The fermentation was terminated at 25 hours as the antioxidant potential declines after this time point. The antioxidant activity declines in ripe fruits and we observed a similar reduction in the fermentation broth of ripened fruits of 'Lucknow49' and 'Bangalore' varieties. Probiotic strain *L. acidophilus* displays a compromised fermenting potential with reference to guava fruits of both the varieties with the maximum antioxidant activities being 49.82% and 72.09% for raw 'Lucknow49' and 'Bangalore' varieties, respectively. A microbial cocktail of *L. acidophilus* and *L. casei* improves the antioxidant potential (radical scavenging activity 91.75%) of the fermented product in both the varieties. Our findings indicate that developing this novel fermented product from guava offers an innovative solution to address the post harvest losses of this fruit crop in conjunction to value addition. The fermented product is creamy white amorphous powder after lyophilisation and is amenable for blending with an array of food items like soft drinks, bars, juices, cookies, confectionery and cereals for bio fortification.

**Keywords:** *Lactobacillus acidophilus*, fermentation, radical scavenging.

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## Pollen viability of guava genotypes from different locations

Sara M. Coser<sup>1</sup>, Milene M. P. Fontes<sup>1</sup>, Marcia F. da S. Ferreira<sup>1</sup>

The guava, *Psidium guajava* L., a *Myrtaceae*, is a fruit tree of economic importance in many tropical and subtropical regions of the world. The pollen viability is important for plant breeding, because it reflects the efficiency of fecundation and fertilization of the male gamete. The genotype of an individual is the result of the contribution brought by the formation of gametes in the zygote. The higher the rate of pollen viability and germination, the greater the possibility of production of different combinations of alleles and ultimately, genetic variability. This work aimed to evaluate pollen viability of 19 guava genotypes of five localities in the south of the State of Espírito Santo and Caparaó (Minas Gerais), Brazil by two methods: staining and "in vitro" germination of the pollen tube. For the staining method, flower buds were fixed in methanol: acetic acid PA (3:1), while for in vitro method was used pollen in natura. For estimation of pollen viability by staining (with Lugol and 2% Acetic Orcein 2%), there were prepared slides by the technique of crushing and then evaluated three slides per plant for each staining and an average of 500 pollen grains per slide. The germination of the pollen tube was verified in Petri dishes containing 10g/l sucrose and 10% agar as culture medium. The dishes were maintained at 28° C temperature in a germination chamber during 2 hours period. There were used three replications and 500 pollen grains evaluated per dishes. The observations were made using an optical microscope at 40X magnification. The analysis of variance was applied and the means compared by the Tukey test ( $p < 0.05$ ). There were observed significant differences among the locations studied for the variable pollen viability when both staining and in vitro techniques were applied. All genotypes have shown high viability (above 70%). The significant differences observed between genotypes within a species are indicative of the existence of genetic variability for that characteristic. The viability by germination of the pollen with the in vitro technique was inferior to those presented by staining, with low index of pollen germination except for two genotypes of CCA location (91.8% and 72.7%). The results obtained indicate that viability seems to express the potential of pollen germination, but not its occurrence.

**Keywords:** *Psidium guajava*, pollen grains, fertility.

**Acknowledgement:** CAPES.

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## Selection of superior genotypes of guava fruit by quantitative descriptors

Sara M. Coser<sup>1</sup>, Adésio Ferreira<sup>1</sup>, Marcia F. S. Ferreira<sup>1</sup>

Guava (*Psidium guajava* L.) is a tropical fruit of greater economic importance, belonging to family Myrtaceae. Brazil is the world largest producer of red guavas and the State of Espírito Santo helps with production of 9,711 tons and cultivated area of 414 ha. In this State, cultivars were selected from seed established orchards. These selections, Cortibel, were implanted in orchards of several towns of the Espírito Santo and other States. The basic premise of plant breeding programs is the selection of genotypes with the greatest agronomic potential. The direct selection and selection index are plant breeding techniques that assist the selection of superior genotypes for an attribute or several attributes simultaneously. In order to select superior genotypes through eight characteristics of fruits (weight, length, total diameter, inner diameter, total diameter/ inner diameter ratio, weight of the pulp, seed weight and seed number) sixteen genotypes of guava (fifteen Cortibel selections: CI, CIII, CIIIh, CIV, CV, CVI, CVII, and CVIII CXI, and the commercial cultivar Paluma) were subjected to direct selection and selection index based on a sum of ranks, using the GENES program. Cortibel guava genotypes were selected as superior for all criteria evaluated, using a selection intensity of 20%, considering the direct selection as the selection index based on the sum of ranks. Paluma was not selected at any stage. The genotypes CI, CII and CVII showed better performance for the selected criteria.

**Keywords:** *Psidium guajava*, plant breeding.

Acknowledgement: CAPES

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**Session IV *Myrtaceae* – Biotechnology and Genomic**



## Guava Biotechnologies, genomic achievements and future needs

E. Ritter<sup>1,A</sup>

Compared to other crops, Guava biotechnology has been neglected to some extent in the past and is still in infancy. Some genomic resources have been generated within the EU-Project "Improvement of guava: Linkage mapping and QTL analysis as a basis for marker-assisted selection (GUAVAMAP; FP6-2003-INCO-DEV-2 No. 015111)". Detailed results can be seen at: <http://www.neiker.net/neiker/guavamap/>. Within this project SSR markers for *Psidium guajava* were developed massively. These were used to characterize Guava germplasm collections in different countries at the molecular level. A COS library was established in Guava. MADS-, HOMEObx and RGL sequences were identified in this library and PCR primers were designed for these sequences for downstream applications. On the other hand linkage maps were constructed in different genetic backgrounds and QTL analyses for several useful traits were conducted. Individual and combined parental linkage maps have been constructed in three mapping populations (Enana x N6, Enana x Suprema Roja and Enana x Belic L-207) based on AFLP, SSR and COS markers. These population maps contain between 500 and 1000 markers and have lengths of 1500 to 2200cM each. Individual linkage groups vary between 150 and 240 cM in length and contain between 35 and over 100 markers each. Also an integrated guava reference linkage map was established based on common markers map with a very high marker density of over 1700 markers. In addition QTL analyses have been performed in these populations. The traits for QTL analysis include plant height, petiole length, leaf length and width, yield, fruit number and average fruit weight, fruit length and width, internal and external pulp thickness, seed number and weight, vitamin C contents, acidity, and total soluble solids. Over 100 QTLs were detected for the different characters in the three populations and varied between 2 and 13 QTLs per trait. Individual QTLs explained between 5 and over 40% of the total variance. Total variance explained by the sum of all detected QTLs varied between 20 and over 50% between traits and populations. Some of the QTLs are co-located or closely linked to SSR markers, which allow an efficient selection for marker assisted breeding in different genetic backgrounds. Several QTLs

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for the same or for related characters occurred at the same location in different maps, allowing in this way to compare co-locations of QTLs in different genetic backgrounds. On the other hand also genomic resources at NCBI are scarce. Currently, for *Psidium guajava* only 58 nucleotide, 22 GSS and 9 protein sequences are available and a few more for other *Psidium* species. The continuous decrease in sequencing costs will stimulate the generation of new genomic resources in the near future. In this context also the large number of genomic resources and particularly the upcoming genome sequence of the related *Euclayptus grandis* (*Myrtaceae*) will be useful based on potential synteny between related species (<http://eucalyptusdb.bi.up.ac.za/>).

## High Throughput Sequencing Technologies for the Study of Species of Agronomical Interest

Gisela Mir<sup>1,A</sup>

High throughput sequencing technologies have already changed the way we face experimental biology at several levels. Huge amounts of data on DNA and RNA sequencing are continuously being deposited to several databanks maintained by different institutions. Although increasing amounts of data come at lower costs, projects such as the sequencing of a complex genome is still restricted to big groups or international consortiums with powerful computing resources. However, several applications have been developed to use these technologies for the study of species for which a reference genome is not available. In this sense, high throughput sequencing has successfully been used for large-scale discovery of SNPs or SSRs, for transcript profiling and identification of genes of interest and for population genetics among others. At the same time, initiatives for the development of open bioinformatics tools are allowing general access to the analysis of data from several sequencing platforms. In this talk we will review the most common high throughput sequencing technologies used to date. We will talk about their applications with special focus towards its use on the study of species of agronomical interest.

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## **“In vitro” propagation of Surinam cherry**

Daiane Silva Lattuada<sup>1</sup>, Paulo Vitor Dutra de Souza<sup>2</sup>

The Surinam cherry (*Eugenia uniflora* L.) is an important fruit species, representative of the genus *Eugenia*, Family Myrtaceae, which has ornamental and horticultural potential and could be included in re-establishment projects of degraded areas. In Brazil, most of the orchards of this species are formed by planting of ungrafted plants, which gives low genetic uniformity to the plantations. Vegetative propagation methods, such as micropropagation, are viable alternatives for the propagation of several fruit species and should also be tested with native species, allowing the formation of homogeneous orchards. However, one of the major obstacles in Surinam cherry propagation is the difficulty in obtaining tissues free of contamination. Oxidation, due to the phenolic compounds at the incision point is also a hindrance. In this context, Surinam cherry multiplication studies were carried out from 2008 up to 2010 focusing on growth regulators concentrations. Three concentrations (0.1, 0.2 and 0.5 mg.L<sup>-1</sup>) of either Naphtalene Acetic Acid (NAA) or 6-benzylaminopurine (BAP) were evaluated. Subcultures of the explants from the culture medium with BAP) were transferred to nutritive media supplemented with 0.2mg.L<sup>-1</sup> of NAA. Explants cultivated in culture medium with NAA were transferred to cultivation medium with 0.2mg.L<sup>-1</sup> BAP. Percentages of survival, explants sprouting and adventitious rooting were determined. Higher survival and adventitious shoot formation of the explants from media supplemented with BAP were determined. Root formation was observed in the presence or absence of NAA. At concentrations of 0.1 or 0.2 mg.L<sup>-1</sup> NAA complete plant regeneration was observed. Induction of adventitious shoots was determined in explants coming from medium with 0.1 and 0.2 mg.L<sup>-1</sup> NAA and replicated to the medium with BAP. The results indicate the possibility of in vitro cultivation of Surinam cherry when the explants are established in culture medium containing 0.2 mg.L<sup>-1</sup> BAP for multiplication and 0.1 mg.L<sup>-1</sup> NAA for rooting. However, there is still a need for improvement of rooting and sprouting percentages of the explants and to devise measures to reduce contamination of oxidation of propagation material.

**Keywords:** *Myrtaceae*, micropropagation, vegetative propagation.

**Acknowledgement:** For PPG Fitotecnia da UFRGS and for Capes and CNPq. for the financial support.

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**Genetic variability of cínaró (*Calycolpus moritzianus* O`Berg, Myrtaceae) from diverse locations in the Chama river basin in Mérida state-Venezuela**

Dariana Sarabia M<sup>1</sup>, Gustavo Fermin<sup>1</sup>

The genus *Calycolpus* is represented by 15 species distributed from Central America to Brazil, with the greatest diversity in northeastern South America in the highlands of Guiana and neighboring Venezuela and Brazil. In Venezuela, there are only 6 species recorded so far, distributed in environments ranging from forests to savannas. In our country, little is known about the Myrtaceae family and few studies have been published on their molecular aspects, which mostly have focused on guava. On the basis of publicly available data, it is evident that gene sequences from species belonging to this genus have not yet been reported. In this work, samples were collected from individuals of *C. moritzianus* from different localities in Merida state, a species that besides being emblematic of the state possesses an important food value, and it has great potential in ecological restoration and in the field of medicine due to its essential oils that have demonstrated to show therapeutic activity. DNA samples were used to amplify the ITS2 (nuclear) and rbcL (plastidic) genes by PCR, generating fragments of more than 300 and 1443pb, respectively. The contig and alignments were obtained using the software Bioedit and CLUSTAL X, respectively. A consensus sequence was generated for each of the genes, which are then proposed as the genetic barcode of the species. Once it was determined that the samples taken in the field corresponded to the same species, we performed the analysis of genetic variability of six different populations using primer pairs for SSR loci for *P. guajava*. Finally, we determined the diversity parameters of Nei (such as number of alleles, polymorphic loci, Shannon index, etc.) with the POPGENE. v1.32 program. Molecular markers demonstrate the existence of only one species, widely distributed in the Chama river basin, phylogenetically related to the genus *Myrtus* with ample phenotypic and genetic variability.

**Keywords:** DNA barcode, *Myrtaceae*, cínaró, variability, microsatellites, transferability.

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### Effect of gibberellin application on "in vitro" germination of red strawberry guavas (*Psidium cattleianum* Sabine)

Edwin A. Gutierrez Rodríguez<sup>1</sup>, Fabrício S. Nunes<sup>1</sup>, Daiane S. Lattuada<sup>1</sup>, Paulo V. Dutra de Souza<sup>1</sup>, Gilmar Schäfer<sup>1</sup>

Red strawberry guava (*Psidium cattleianum* S.) is a southern Brazil native fruit species belonging to the family Myrtaceae. The fruits are mostly destined for fresh consumption. The species can be also used in environmental remediation activities because of its intensive fruit and seed production. One of the main constraints for commercial production of red strawberry guava fruits is the obtaining of plants with desirable fruit characteristics and stabilized agronomical traits. So far, high heterogeneity in seed germination has been observed, increasing the production costs and time to establish orchards. The purpose of the study was to test the effect of gibberellin (Progibb) in the percentage of germination and speed index (G.S.I) of "in vitro" strawberry guava seeds. Seeds were selected from the central area of the fruit and sown (five in each Petri dishes),  $\pm 20$  mL LPM 50% medium, to which sucrose (10 g/L) and agar (0.8%) were added. The pH was adjusted to 5.8 before autoclaving and then followed by incubation at  $25^{\circ}\text{C} \pm 4^{\circ}$  under 12 hours photoperiod for 20 days. The isolated seeds were soaked for 18 hours in 0, 2, 10, 20 or  $50 \text{ mg}\cdot\text{L}^{-1}$  of the active ingredient in the solution. The experimental design was completely randomized and each treatment consisted of ten replications. The experimental units consisted of Petri dishes containing five seeds each. Averages were submitted to ANOVA and regression analysis and the statistical differences determined via Tukey test ( $p < 0.05$ ). Highest GSI was determined at the concentration of  $10 \text{ mg}\cdot\text{L}^{-1}$  a.i. whilst concentrations beyond  $20 \text{ mg}\cdot\text{L}^{-1}$  a.i. were harmful to the E.S.I. Gibberellin at  $10 \text{ mg}\cdot\text{L}^{-1}$  a.i. seems to be the most appropriate concentration for improving the uniformity of seed emergence of red strawberry guavas. Further studies are needed to confirm these preliminary results.

**Keywords:** plant growth regulator, seed, physiology, native fruits.

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### Genetic distance of guava genotypes from different altitudes by microsatellites

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The influence of altitude on the genetic diversity is poorly known. Since this factor interferes in the diversity of plants present in a site, it is possible that it also affects intraspecific diversity. The objective of this study was to evaluate the genetic distance among guava genotypes (*Psidium guajava* L.) through plants collected at different altitudes, by microsatellite markers. There were evaluated 66 plants of guava from seven localities at different altitudes: Jerônimo Monteiro (126m), Alegre (150m), Cachoeiro de Itapemirim (192m), Mimoso do Sul (198,5m), Muqui (214m), Guaçuí (603,5m) and Caparaó (906m). The DNA was extracted by CTAB method. The genotyping by PCR was performed with 18 SSR primers, with a final volume reaction of 15 $\mu$ L and 55°C annealing temperature. The amplification products were visualized on 3% agarose gel. The matrix of squared standardized mean Euclidean distance in relation to all loci was obtained and the genotypes were grouped by UPGMA method. The population of Jerônimo Monteiro, site of lower altitude, was the most divergent. The populations of Mimoso do Sul and Muqui were the most similar. The populations of Guaçuí and Caparaó, areas of higher altitude, were grouped, equally to the populations of Alegre and Cachoeiro de Itapemirim. The populations were very divergent and it was observed influence of altitude in the groups formed, excepting Jerônimo Monteiro. The populations of lower altitude were grouped and were dissimilar to the populations of higher altitude.

**Keywords:** *Psidium guajava*, diversity, altitude.

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## Genetic diversity of wild guava from southern Espírito Santo and commercial cultivars by microsatellites

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Breeding programs and species conservation depend on the knowledge of genetic variability of the species. This variability may be known from studies of molecular markers that detect genetic polymorphisms between individuals. This work aimed to evaluate the genetic diversity of guava collected in the south region of the State of Espírito Santo, Brazil, in Jerônimo Monteiro, Muqui, Mimoso do Sul municipalities, and commercial guava. Genomic DNA was extracted from young leaves of the cultivars Paluma, Pedro Sato, Século XXI and the regional varieties Cortibel I, II, III and IV as well as twenty-two plants collected in Jerônimo Monteiro, Muqui and Mimoso do Sul municipalities, by the CTAB method. Polymerase Chain Reaction (PCR) was performed with eighteen SSR (Simple Sequence Repeats) primers in a final reaction volume of 15  $\mu$ L and annealing temperature of 55°C. PCR products were visualized on 3% agarose gel stained with ethidium bromide and photographed in ultraviolet (UV). Values of Polymorphic Information Content (PIC) and Observed Heterozygosity (Ho) were estimated and the dissimilarity index calculated for multiallelic data with subsequent clustering of genotypes by UPGMA method. The genotype groups collected in the municipalities had low average PIC and Ho with a large percentage of loci with unique alleles. It was possible to identify divergent genotypes, demonstrating the efficiency of the applied marker. The wild genotypes were divergent in relation to commercial genotypes, except for some genotypes, especially from Jerônimo Monteiro. The wild genotypes are, therefore, of potential use in guava breeding to increase the options of genotypes grown commercially.

**Keywords:** *Psidium guajava*, SSR, breeding.

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**Session V: *Myrtaceae* Crop management and market**



## Unbiased approach to diagnose the nutrient status of guava

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The mineral nutrition of plants is a central topic of fruit production. Methods have been developed to diagnose and interpret the nutrient status of fruit crops despite inherent numerical biases. The critical value approach is distorted by the effect of nutrient interactions and physiological age on nutrient concentration values. Fully developed leaves are thus collected at a developmental stage during a phase of minimum or indeterminate nutrient changes and within short periods to minimize the effect of physiological age on nutrient concentrations. Although DRIS could represent nutrient interactions by dual ratios, it diagnoses  $D$  nutrients for  $D-1$  degrees of freedom and is affected by tissue physiological age. I propose using techniques of Compositional Data Analysis to remove the numerical bias due to nutrient interactions and trend analysis to remove the effect of physiological on nutrient concentrations and ratios. Tissue analytical data are strictly positive compositional data close to the unit or scale of measurement, i.e. multivariate data that cannot be interpreted without relating them to each other. Lagatu and Maume (1934) were the first to represent interacting nutrient using a ternary diagram with nutrients at vertices and closing the sum of nutrient concentrations to 100%. One nutrient composition is thus redundant as computed by difference between 100% and the sum of the other, leaving 2 or  $D-1$  degrees of freedom. By comparison, there are  $D(D-1)$  dual ratios in a  $D$ -parts compositional vector and most of them are thus redundant. Based on the principle of orthogonality, the nutrient balance concept projects  $D-1$  isometric log ratio coordinates into the Euclidean space, hence removing redundancy (Parent, 2011). Nutrient balances must be selected to reflect physiological and pedological processes as well as management issues in guava production. Since nutrient balances change over time, the balances must be detrended for diagnostic purposes. Our objective is to present a model of nutrient balance for use in guava production in order to facilitate interpreting relationships between plant, soil and management.

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## Influence of temperature on emergency of *Myrciaria glazoviana*

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The *Myrciaria glazoviana* L. is a fruit tree originated from the Brazilian Atlantic Forest. The fruits are small, yellow when fully ripe, bearing 1 or 2 seeds. The flesh is juicy with a sub acid flavor, very nutritive and it has the highest C vitamin content found among edible fruits of *Myrtaceae*. The species is propagated by seeds and show slow initial development, taking about a year for the seedlings to be planted in the field. The knowledge of specific seed germination requirements is important in plant production. The majority of the native species needs cultural management, including those related to the appropriate conditions for germination of their seeds. However, available information to the development of a methodology with species of *Myrtaceae* is still lacking, as in the case of *M. glazoviana*. The temperature is one of the major factors that influence the germination, and there are well defined capacity limits for each species. By knowing the optimum germination temperature it is possible to provide a maximum percentage of germination in a shorter time. Therefore, the objective of this research was to evaluate the effect of the temperature in the emergency of *M. glazoviana* seeds. The experiment was carried out at the Laboratory of Seeds, of the Department of Vegetable Production of Faculdade de Ciências Agrárias e Veterinárias - FCAV- UNESP - Campus of Jaboticabal/ SP, Brazil. The seeds were extracted from ripe fruits of plants from the Germplasm Bank of the UNESP, washed and placed to dry for 24 hours on paper towel. After this, the seeds were placed into plastic boxes having fine vermiculite as substrate and maintained at germinator under 20, 25 and 30°C, constant temperature and at room temperature (that was taken daily). The emergency rate was evaluated for 8 weeks. The experimental design adopted was entirely randomized with 4 replications and 10 seeds by replication. The data were submitted to variance analysis and compared by Tukey test (5% probability). *M. glazoviana* seeds emerged under all temperatures conditions (79.3% of emergency medium). Despite of the seeds kept at 30°C started emergence earlier than the other treatments, there was not influence of the temperature on the emergency of *M. glazoviana*.

**Keywords:** sexual propagation, *Myrtaceae*, germination.

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## Soils cationic balance in Brazilian guava orchards

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Soil and plant testing methods are used to rebalance guava (*Psidium guajava* L) soils with appropriate fertilization and liming. Cationic species are expressed on a soil volume or weight basis or as saturation of the cation exchange capacity (CEC). Recent development in compositional data analysis showed that dual ratios as well as base saturation ratios are inherently not normally distributed and biased. The isometric log-ratio (ilr) transformation can compress 4 components into 3 ratios using orthogonal balances between groups of components and thus avoiding redundancy and scale dependency among cationic expressions (hence spurious correlations). Our objective was to test a scheme of cationic balances arranged to facilitate the management of K fertilizers and Ca-Mg liming materials in Brazilian guava orchards. We sampled surface layers (0.00-0.20 and 0.20-0.40 m) in two guava orchards newly established on Oxisol and Ultisol and receiving increasing rates of N and K fertilizers during three consecutive years. Seasonal changes in the cationic balance in surface soil layers of Oxisols and Ultisols were driven by added N that acidified the soil and by added K that competed with Ca, Mg and exchangeable acidity for negative charges on CEC. We computed the balances between soil K and other cationic species (Ca, Mg, acidity) to assess the effectiveness of applied K under actual acid-base conditions, for Ca and Mg against acidity to determine lime requirement, and between Ca and Mg to select the proper liming material. Highest fruit yields were obtained in the Ultisol ( $\text{pH}_{\text{CaCl}_2}$  of 5.3) despite lower soil test K and Ca compared to the Oxisol ( $\text{pH}_{\text{CaCl}_2}$  of 5.8). We determined critical ilr values. The K nutrient budget must be equilibrated to maintain adequate cationic balance in the soil on the short run while the acidification effect of N fertilizers can be curtailed by liming materials on the long-run. To conclude, the ilr is an unbiased index of cationic balance in soils that can be manipulated soundly by K fertilization and liming materials in Brazilian guava orchards soils.

**Keywords:** Compositional data analysis, isometric log ratios (ilr), soil fertility, soil cationic balance, Aitchison geometry.

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## Delimitation of guava water productivity in the Brazilian Northeast

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The intensification of agricultural crops in the Brazilian Northeast results in a change of natural vegetation, making important the quantification and evaluation of the additional water use. Applications of a Geographic Information System (GIS) are presented in this paper to estimate guava water productivity at the large scale. Long term weather data were used together with simple regression models involving crop coefficient ( $K_c$ ), reference evapotranspiration ( $ET_o$ ) and accumulated degree days ( $DD_{ac}$ ) to quantify the guava water requirement (GWR) in the commercial production States of the Brazilian Northeast, considering growing season of six months and the cv. Paluma as reference. Coupling GWR data with total precipitation for a growing season it was possible to quantify the guava water deficit (GWD) giving an approach about irrigation needs. Considering the whole region, the variation of the averaged GWD values varied from 75 mm for pruning dates in December to 430 mm, with pruning in May. Associating the average GWR values with yield data for 2010 from the Brazilian Geographical and Statistical Institute (IBGE), the average bio-physical and economic values of guava water productivity were estimated for each guava producer state. The bio-physical values are between 0.86 and 4.95 kg m<sup>-3</sup> for pruning dates in July and January in Rio Grande do Norte and Pernambuco states, respectively, while the economic ones were from 0.40 to 3.18 R\$ m<sup>-3</sup> for the same pruning periods, however with the lowest averaged value being for Paraíba state. Highlights are for the States of Pernambuco, Bahia and Piauí, which present both, bio-physical and economic values of guava water productivity. The analyses spatially presented, can subsidize programs for expansion of rain fed guava crop as well as water allocation criterions under irrigation conditions, when aiming improvements on water resources use in the Brazilian Northeast.

**Keywords:** degree days, crop coefficient, evapotranspiration.

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## Up scaling guava water balance in the Petrolina-Juazeiro growing area, Northeast Brazil

Antônio Heriberto de C. Teixeira<sup>1</sup>, Fernando B.T. Hernandez<sup>2</sup>

The modeling of crop water variables at large scales is important when aiming a sustainable development, while insuring water availability for different users. Weather data for 2011, from a net of 15 automatic agrometeorological stations and field energy balance results from previous experiments, were used together with regression models to quantify the guava water requirement (GWR) in the growing area of Petrolina (Pernambuco state)-Juazeiro (Bahia state), Brazil, considering a 6.5 months average growing season (GS). GWRGS joined with precipitation, allowed the acquirement of the regional water balance by developing and applying a guava water indicator (GWIGS) being the ratio of the total precipitation during a growing season (PGS) to GWRGS. The analyses made possible the characterization of areas with different natural humidity conditions for guava production, comprising two pruning periods. The variation of the averaged GWRGS values for the Petrolina municipality was from  $750 \pm 6.9$  mm to  $950 \pm 10.5$  mm, for pruning in January and June, respectively, the wetter and dryer GS, while for the Juazeiro municipal district the respective ranges were from  $730 \pm 6.2$  mm to  $900 \pm 9.2$  mm. Considering the GWIGS indicator, the values for both municipalities were similar, around 0.40 and 0.08 for pruning in January and June, respectively. Quantifying the differences between PGS and GWRGS, the need of irrigation could also be quantified, being evident the highest water amounts to be applied when the prunes are done in June, with the largest rates between September and October, from 160 to 174 mm month<sup>-1</sup>. Additional data from IBGE (Brazilian Geographical and Statistical Institute) allowed the inspection of the guava water productivity (GWP) at the municipal level. The GWP values for Petrolina were 4.1 and 3.3 kg m<sup>-3</sup>, while for Juazeiro they were 1.8 and 1.5 kg m<sup>-3</sup>, for pruning in January and June, respectively. The higher GWP values for pruning in January are explained by the coupled effect of higher PGS and lower GWRGS rates. On the other hand, as the both municipalities had similar GWIGS ranges, it could be concluded that the lower GWP values for Juazeiro should be a poorer crop management, resulting in lower

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yield, evidencing ample room for water productivity improvements. The analyses spatially presented, can subsidize water allocation and irrigation management criteria, when aiming improvements on guava water productivity and yet, avoiding environmental damage by fast climate and land use changes in the Brazilian semi-arid areas.

**Keywords:** water requirements, water productivity, crop coefficient.

**Acknowledgement:** To FACEPE for financial support.

## Guava tree nitrogen reserves during spring/summer growing season

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The nitrogen fertilization and pruning management promote the vegetative growth and it can occur at different times of the year. This study aimed to evaluate the nitrogen reserves of the 'Paluma' guava tree, fertilized with nitrogen, during the spring/summer season. The experiment was conducted in Vista Alegre do Alto, SP, Brazil under Cwa subtropical climate, with short winter, mild and dry, hot and rainy summer, and two distinct seasons (Köppen). The 8 years old irrigated orchard was pruned in September/2010. The experimental design was a randomized block, with three blocks, in a split plot, represented by four nitrogen rates (0, 0.5, 1 and 2 kg N plant<sup>-1</sup>) and the subplot of four sampling times. There were evaluated, each two months, the levels of total nitrogen in the leaves, stems and roots. The first assessment was carried out during flowering; the second when the fruits had an average length of 4.24 cm; the third at harvest and the last assessment in the post-harvest period, prior to the next pruning. Total N content of roots were not affected by nitrogen fertilization but it was influenced by the seasons ( $p < 0.01$ ). The N root content was 8.80, 9.57, 8.13 and 7.76 g.kg<sup>-1</sup>, respectively for each stage analyzed. The linear equation was adjusted to  $y = -0.46x + 9.71$  ( $R^2 = 0.55$ ), being x represented by 1 (the first evaluation) to 4 (last evaluation). Stem N content was not affected by the applied nitrogen at 5% probability. However, the values were 2.00, 2.18, 2.52 and 2.54 g.kg<sup>-1</sup>, respectively, for each N dosage, showing a trend of increasing on the N reserves of the stems, as a function of nitrogen application. On the other hand, the levels of N in the stems were influenced by the time of the year and the values observed were 2.46, 2.43, 2.11 and 2.25 g.kg<sup>-1</sup>, respectively for each stage analyzed. It was noted a decreasing in the N levels until harvesting with later addition, being adjusted by the cubic equation  $y = 0.12x^3 - 0.88x^2 + 1.47$  ( $R^2 = 1$ ). Nitrogen fertilization and the time of the year had influenced the foliar concentrations of N ( $p < 0.01$ ). Thus, foliar concentrations varied as a function of nitrogen, according to the

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equation  $y = -3.06x^2 + 9.40x + 13.80$  ( $R^2 = 0.91$ ) and the time of the year according to the equation  $y = 1.12x^2 - 6.53x + 25.01$  ( $R^2 = 0.94$ ).

**Keywords:** *Psidium guajava* L., nitrogen fertilization.

Acknowledgement: FAPEMIG, CNPq, Indústria de Polpas e Conservas VAL Ltda, technicians of the FCAV/Unesp/Jaboticabal plant analysis laboratory.

## **Influence of nitrogen and potassium fertilization on nutrient content of the guava "Paluma" fruit**

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The mineral fertilization consists in the delivery of nutrients to the soil, which promotes, in general, an increase on plant productivity. On the other hand, nutrients are exported from orchards through fruit removing. This study aimed to evaluate the effect of N and K fertilizations on the nutrient content of guava fruits from trees managed according to an intensive production system. The experiment was carried out at Vista Alegre do Alto, SP, Brazil in an irrigated seven years old guava orchard, cultivated on dystrophic Acrisol and managed by pruning during three consecutive producing cycles. The experimental design was randomized blocks, with three replications, in a factorial design with four doses of nitrogen (0, 0.5, 1.0 and 2.0 kg N plant<sup>-1</sup>) and four of potassium (0; 0.55, 1.1 and 2.2 kg K<sub>2</sub>O plant<sup>-1</sup>). It was used urea and potassium chloride, split into four equal applications. Fertilization was complemented with superphosphate, boric acid and zinc sulfate. The samples consisted of 18 fruits per plot, which were oven-dried at 70°C and analyzed to determine the levels of nutrients. In the evaluations of the first production cycle it was found that nitrogen fertilization increased N, K, Cu and Mn in the fruit. This effect was represented by quadratic regression equations, and linear increments in S. In the second production cycle, it was verified that nitrogen fertilization increased the N contents in the fruits, and the effect was represented by the quadratic equation, and linear increments of Mn. There was also observed that the levels of P, Ca and Zn decreased with the nitrogen fertilization, represented by quadratic equations, while the B concentration decreased linearly. It was detected for these two cycles, no effect of potassium fertilization and no N x K interaction on the concentration of elements in the fruits. On the other hand, assessments of the third harvest showed significant effects of nitrogen fertilization on the nutrient content of fruits; N and Mn increased linearly while P and Mg decreased, here represented by quadratic

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equations. Different from the first and second harvests, the third showed that the potassium fertilizer affected the nutrient levels, and promoted the linear increase of K and the linear decrease in the levels of B on fruits, as well as, a significant interaction of N x N for the elements K , P, S and B.

**Keywords:** *Psidium guajava* L, macronutrients, micronutrients.

**Acknowledgement:** FAPESP, FAPEMIG, CNPq, Indústria de Polpas e Conservas VAL Ltda, technicians of the FCAV/Unesp/Jaboticabal plant analysis laboratory.

## Effects of organic fertilizer and the use and management on soil moisture and density of a Hapludults cultivated with guava fruit

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The systems use and management of soils cause major changes in the mass-volume relationships of the soil, affecting the behavior of water and nutrients available to plants and influencing crop yields. This work aimed to study the effects of use and soil management in the mass-volume relationships of soil cultivated with guava, sugar cane and occupied by native forest. The experiment was conducted in a Hapludults and the experimental design was completely randomized with four replications in plots. The factor levels were six main land use systems and soil management (application of residue processing industry in the orchard of guava in guava fruit 'Paluma'; mineral fertilization in guava 'Paluma'; application of residue dry weight of guava processing industry in guava fruit 'Paluma'; mineral fertilization in guava fruit 'Pedro Sato'; mineral fertilizers in sugar cane and native forest). The secondary factor levels were two sampling sites (canopy projection line of traffic and machinery). The applications of the products were held for five years from 2006 to 2010, the same period which saw the cultivation of guava 'Pedro Sato' and cane sugar. The use of mineral fertilizers, as well as the application of dry weight processing industry guava, ground or unground, the cultivate Paluma provided soil moisture and bulk density similar to that observed in native forest. The cultivate Pedro Sato resembled the cultivation of cane sugar, considering the variables studied. Considering the sampling position, it was found that the line traffic machine had a higher density, reducing the space available for the free passage of water and storage. This behavior is confirmed by correlation analysis between soil density and moisture measurements, which showed negative correlation ( $R = -0.8187$ ), linear and significant ( $Y = -0.0003 + 0.8499 \times R^2 = 0.67^{**}$ ).

**Keywords:** *Psidium guajava*, residue, soil density.

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### Software CND-Goiaba 1.0 for guava (*Psidium guajava* L.) to cultivate Paluma in Brazil

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Computer programs enable with practice the transformation of data into necessary information for decision making. In particular for the production of guava that has highlighted, with Brazil being the largest producer of red guavas. The objective of this study was to present the CND-Goiaba 1.0 software (C Sharp) as a tool to perform the mathematical calculations involved in the determination of diagnosis compositional nutrient (CND) indexes for the guava crop. A database was created, based on 205 leaf samples collected in commercial plots (sampling units) of cultivate Paluma (*Psidium guajava* L.), with ages between 5 and 20 years, during the 2009/2010 and 2010/2011 growing seasons. For the production variable data were normally distributed by Shapiro-Wilk  $W = 0.988$ ;  $p = 0.11$ . The software makes possible to diagnose that 63% of the orchards evaluated need adequacy on their nutritional status. The CND method showed severe nutritional imbalances in the Mg and Zn rates from the orchards.

**Keywords:** computer program, leaf analysis, diagnosis.

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## Purple-fruited Pitanga: Antioxidant Levels and Flavors of Mature Fruits Vary Considerably Among Closely-Related Cultivars

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Pitanga (*Eugenia uniflora* L.) has been produced on a small scale in Brazil for many years, and several food items such as juices, jellies, candies and drinks as well as cosmetic products such as shampoos, soaps and perfumes are available in the Brazilian marketplace. Some frozen fruit pulp has been exported to Europe. Seeds of red-fruited pitanga have been widely distributed throughout the tropics and the seedling plants can be found in many countries. However, the fruit is scarcely cultivated as a commercial fruit crop outside of Brazil. There is a small fruit production industry in Hawaii and the plants themselves are popular ornamental hedge plants in Southern Florida and many other places. Until recently, purple-fruited selections of pitanga have not been widely known or grown. It has been determined that purple-fruited pitanga has substantially higher levels of certain antioxidants than the common red-fruited types. Our chemical analysis by HPLC of freeze-dried purple pitanga pulp for anthocyanin pigments and carotenoids as well as analysis of mineral nutrients by ICP-MS show that concentrations of these materials are quite variable and highly dependent upon cultivar and fruit maturity. For example, lycopene concentrations varied by a factor of 10, as did lutein. Quercetin varied by a factor of 4 among purple fruits harvested at the same times from sibling plants grown side-by-side in Hawaii. Purple fruits harvested from selected mature pitanga siblings planted in both Hawaii and Florida had rather widely divergent flavor profiles and both fruit size and actual fruit color at maturity were quite variable. Chemical analysis of purple fruits of unknown heritage may not be representative of levels of antioxidants found in purple fruits harvested from specific cultivars. Our selection and characterization of purple-fruited pitanga cultivars with both high levels of desirable antioxidants and pleasing flavor profiles is in progress.

**Keywords:** *Eugenia*, *uniflora*, *myrtaceae*.

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### Morphometric variability of guava plants (*Psidium guajava* L.) conducted in trellis

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The guava (*Psidium guajava* L.) is a fruit tree that presents a consolidated technology for commercial exploitation. Normally, the guava tree orchard is made up of plants conducted with only one stem as far as the height of 60 cm when the terminal bud is removed, leaving 4 branches opposed 2 to 2 and oriented towards the cardinal points for canopy formation. The work evaluated the morphometric evaluation of a training system developed by the producer Roberto Losque, Jundiá, São Paulo, Brazil, Brazil, whose characteristic is the placement (conduction) of plant branches in trellis. The morphometric characters evaluated in 129 plants were: measures of stem diameter above the junction between stem and root systems, height, horizontal length and bud number. The data were processed using descriptive statistics (Me = mean, Mo = mode, Md = median, S<sup>2</sup> = standard deviation, Min = minimum, Max = maximum, Amp = range, Curt = kurtosis, A = asymmetry). The parameters obtained were: a) Diameter: Me = 2.45 cm, Mo = 2.3 cm, Md = 2.5 cm, S<sup>2</sup> = 0.29 cm, Min = 1.3 cm, Max = 3.5 cm, Amp = 2.2 cm, Curt = 2.984, A = 0.094; b) Height: Me = 73.61 cm, Mo = 75, Md = 75 cm, S<sup>2</sup> = 9.3 cm, Min = 48 cm, Max = 95 cm, Amp = 47 cm, Curt = -0.024, A = -0.341; c) Length: Me = 276 cm, Mo = 300 cm, Md = 278 cm, S<sup>2</sup> = 3.2 cm, Min = 130 cm, Max = 370 cm, Amp = 240 cm, Curt = 3.158, A = -0.581; d) Number of buds: Me = 84.4, Mo = 80, Md = 85, S<sup>2</sup> = 15.97, Min = 12, Max = 115, Amp = 103 cm, Curt = 2.56, A = -0.91. It follows that the current form of conduction produces a morphometric variability which can be decreased with the practice of uniformity of the plants through both pruning and farming practices. The management on trellis supports the farming practices, both the pruning and mechanization in steep areas.

**Keywords:** fruit crop, training systems, crop management.

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### Formation of rootstocks of guava "Pedro Sato" in hydroponic and conventional systems

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Guava (*Psidium guajava* L.) belongs to the Myrtaceae family, and it stands out as an alternative income to small farmers. In Brazil, due to the expansion of guava orchards, studies related to the propagation of guava are necessary. In this context, this study aimed to evaluate the production of rootstock of the cultivar Pedro Sato in hydroponics and conventional systems. The experimental design was a completely randomized. Five seeds were sown in containers, with vermiculite in hydroponics tubes. In the conventional system the seeds were sown in polyethylene bags with 7 liters capacity, containing substrate composed of 3 subsoil parts, one sand part, plus one pound of lime and one pound of simple superphosphate/m<sup>3</sup> of substrate, totaling 270 containers for each system studied. The hydroponic tubes were kept under five inches of water till the thinning point, when from the same nutrient solution was introduced CHALFUN & FAQUIN (2010, patent: PI0802792-7a2). In the conventional system daily irrigations were performed. They were evaluated: the time for the plants reached the thinning point (three pairs of leaves), the transplanting point (15cm) and the grafting point (diameter equal to or greater than 0.6 mm). From the thinning, the height of the plants was evaluated and from the transplanting point, the diameter at the grafting point, both measured weekly till 51% of the seedlings were apt for grafting. In hydroponics, the plants reached the thinning, transplanting and grafting points at 36 DAS (days after sowing), 121 DAS and 220 DAS, respectively. In conventional system, the plants reached the thinning, transplanting and grafting points at 77 DAS, 212 DAS, 348 DAS respectively. At the grafting point, the average height in hydroponic system was 58.5 cm with coefficient of variation (CV) of 37.9% while in the conventional system it was of 80.5 cm with CV of 25.6%. Viability of the hydroponic system for production of guava rootstocks "Pedro Sato" was found, since it enabled faster growth than in the conventional system.

**Keywords:** *Psidium guajava*, seedling production, rootstock.

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### Economic level of nitrogen application in guava 'Paluma'

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The potential of production of guava 'Paluma' is directly related to nitrogen fertilization. The high cost of this fertilizer and the variation that occurs in the commercialization of guavas, are important factors to define the most appropriate doses of N for this fruit tree. The study aimed to establish the most economic dose of nitrogen fertilizer in orchards of guava 'Paluma' intensively managed. The experiment was carried out in Vista Alegre do Alto, SP, Brazil, in an orchard with seven-year-old irrigated plants, spaced by 7 x 5 meters, managed with pruning during three consecutive cycles of production. The soil is dystrophic Acrisol. The experimental design was a factorial consisting of four nitrogen levels (0, 0.5, 1.0 and 2.0 kg N plant<sup>-1</sup>) and four of potassium (0, 0.55, 1.1 and 2.2 kg K<sub>2</sub>O plant<sup>-1</sup>) in a randomized block design with three replications. It was used urea and potassium chloride, split into four equal applications. The process of fertilizing was supplemented with superphosphate, boric acid and zinc sulfate. Fruit yield was influenced by nitrogen fertilization ( $p < 0.01$ ) in the three production cycles. The most economic level was calculated based on the derived regression equation between yield and nitrogen rates, making it equal to the ratio of exchange. During the experimental period, prices of urea (45% N) ranged from R\$ 1.00 to 1.10 per kg of urea. The prices of commercialization of guava fruit to industry ranged from R\$ 0.25 to R\$ 0.30 / kg of fruit. Thus, it was stipulated two terms of trade price of N / price of guava. For the relation (2.22/0.30), considering the lower price of N and the highest amount paid during the period the most economical dosages would be 0.93, 1.04 and 1.06 kg N plant<sup>-1</sup> respectively for the first, second and third production cycle, which would provide yields of 64.6, 54.1 and 63.1 t.ha<sup>-1</sup>. On the other hand, applying the relation (2.44/0.25), using the highest N and lowest price of the guava, the most economical dosages were 0.80, 0.94 and 0.99 kg N plant<sup>-1</sup> reaching 63.5, 53.3 and 62.5 t.ha<sup>-1</sup> respectively in each cycle. Thus

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the economic analysis can be applied to establish the most appropriate dose of N to be applied in guava orchards allowing greater profitability for producers.

**Keywords:** productivity, guava, *Psidium guajava* L.

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### Effect of juvenility on root-cutts of *Psidium cattleianum*

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The Myrtaceae family has more than 4000 species and more than 70 genera, among them the genus *Psidium* represented by guava (*Psidium guajava* L.), the araçás, a common Portuguese name for many species of this genus. The culture of guava is susceptible to the root-knot nematode *Meloidogyne enterolobii* that can destroy orchards. It is thought that this problem can be overcome using resistant rootstocks like *Psidium cattleianum* Sabine (strawberry guava or cattley guava). This guava species is cultivated in home gardens, mainly in southern Brazil. It grows naturally in the Brazilian Atlantic Forest and initiates flowering and fruiting between September and March. Propagation is usually made by seeds, which can lead to segregation and genetic variability. This fact may increase the interest for use of this genotype as rootstock. This study aimed to evaluate the rooting of *Psidium cattleianum* with different ontogenetic ages (adult and juvenile plants) and the use of four concentrations of indol-butyric acid (0, 1000, 3000 and 5000 mgL<sup>-1</sup>). The experiment was conducted in a lathhouse at FCAV-UNESP, Jaboticabal, Brazil, from November to January 2011. Cuttings were taken from an adult plant (about 25 years old) and two-year-old plants of the Active Germplasm Bank of the FCAV. The cuttings were treated with indol butyric acid (IBA), packed in trays containing expanded vermiculite and maintained under intermittent nebulization. The experimental design was completely randomized with four treatments (IBA) and 4 replications with 10 cuttings each. The evaluations of rooting and survival percentage, length and number of roots were made 45 days after cuttings. There was no rooting on cuttings taken from adult plants, but it was observed 62.5% rooting on cuttings from juvenile plants, reaching the best results (75 and 77.5%) for the highest doses of IBA (3000 and 5000 mg.L<sup>-1</sup>). The average number of roots was superior at the highest dose with 11.8 roots per cutting, although it had a significant difference only between the controls. The survival percentage and root length did not

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differ significantly between treatments. It can be concluded that the propagation of this species by cuttings is viable when using 2 years old plants, treated with IBA at 3000 mg.L<sup>-1</sup>.

**Keywords:** Cattley Guava, Araçá, vegetative propagation, IBA.

Acknowledgement: CAPES.

### Grafting as a propagation method of *Eugenia stipitata*

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The *Eugenia stipitata* Mc Vaugh, is a small tree native of Amazonian dry forests. Its flowering happens from July to October and fruiting from December to May. The fruit tastes acidic, which limits its consumption as fresh fruit. However, the pulp is widely used to make juice, ice cream, jams and jellies. Its propagation is usually done by seeds, as it has a short period of juvenility, hence an early flowering. However, the propagation of seminiferous segregation leads to a larger genetic variability that reflects the non-uniformity of the orchards. This study aimed to evaluate the process of grafting as a method of propagation of *E. stipitata*. The experiment was conducted at the Department of Plant Production, Faculdade de Ciências Agrárias e Veterinárias - FCAV/UNESP - Jaboticabal, Brazil. The grafts were taken from a selected plant located in the Active Germplasm Bank of FCAV/UNESP, and the rootstocks, from seeds, preserved for approximately one year. The processes of grafting adopted were splice, whip and tongue and cleft graft, using plastic bag and narrow ribbon to tie and protect the local of grafting. The experimental design was completely randomized with three treatments (types of grafting) and four replications with ten plants each. At 40 days there were evaluated the percentage of grafting rates and the number of sprouts. Data were submitted to variance analysis and the averages compared by the Tukey test at 5% probability. There were not significant differences between grafting treatments for both percentage of grafting success (32.5%) and number of shoots (1.85). Therefore it is concluded that, at 40 days, the type of grafting did not affect the grafting success and number of shoots. Although the low percentage observed, it is possible to propagate *E. stipitata* by grafting.

**Keywords:** Araçá-Boi, vegetative propagation, types of graft.

**Acknowledgement:** CAPES.

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## Organic nutrient management protocol for cultivation of guava

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Organic Horticulture is gaining momentum across the world. Growing concerns on consumers' health and awareness on environmental issues have increased the demand on production of organic foods. Owing to high nutraceutical values of guava, there has been a growing consumers' preference, resulting in area expansion across the guava growing countries of the world. An investigation was conducted under sub-tropical condition (22.43° N latitude and 88.34° E longitude) of West Bengal, India, at the Horticultural Research Station of the university, to standardize the organic nutrient management protocol for guava. In this experiment, various organic sources {Farm yard manure (26 kg/tree/year), Poultry Manure (10 kg/tree/year), Vermicompost (19 kg/tree/year) and Neem Cake (9 kg/tree/year)} along with various biofertilizers combinations (*azotobacter*, *azospirillum*, phosphorous solubilizers and potash mobilizers each at 100g/tree/year) were tested on eight-years-old guava cv. Sardar to study its effect on growth, fruiting and yield. The different doses of organic manure were calculated based on the twenty-five percent of potash requirement of the recommended dose of guava for the region. The calculated dose along with biofertilizer was applied in two splits in January and August. The results obtained showed maximum fruit weight (230.5g and 224.8g) by application of neem cake and vermicompost + *azotobacter* + phosphorous solubilizers + potash mobilizers. Maximum number of fruits produced per tree (626.33fruits/tree) was found from tree fertilized with farm yard manure + *azotobacter* + phosphorous solubilizers + potash mobilizers and caused maximum yield of (114 kg/tree) as compared to 18.017 kg per tree in control. Treatment combinations with poultry manure + *azospirillum* + phosphorous solubilizers + potash mobilizers showed the highest total soluble solids (120 Brix) and maximum total sugar content of fruit (6.667 %), whereas the fruit acidity (0.448 %) and Vitamin C content (154.61 mg/100g pulp) were recorded maximum with farm yard manure + *azotobacter* + phosphorous solubilizers + potash mobilizers. Application of nutrients through organic along with biofertilizers improve soil health in terms

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of mean microbial population in the rhizosphere of root zone soil as compared to control. From the present study, it can be concluded that addition of biofertilizers along with organic manure was more effective than use of organic manure alone in enhancing fruit growth parameters in guava. Combined application of biofertilizers, P-solubilizers, potash mobilizers and N-fixers were found more effective in improving the fruit physico-chemical characteristics as compared to application of any biofertilizers alone. We conclude that for cultivation of guava cv. Sardar organically, application of farm yard manure at (26 kg/tree/year) + *azotobacter* (100g/tree) + phosphorous solubilizers (100g/tree) + potash mobilizers (100g/tree) in two splits is necessary.

**Keywords:** guava, biofertilizers, vermicompost, neem cake, poultry manure.

## Model to estimate individual leaf area on guava cultivars

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Knowledge of leaf area is essential to assess crop, and the use of mathematical equations to estimate leaf area is an affordable and non-destructive method for field use. This study aimed at determining equations to estimate the leaf area of five guava cultivars, using data from leaf length (C, cm) and width (L, cm). There were studied five guava cultivars (Pedro Sato, Paluma, Thailand, Sassaoka and XXI Century), located in the region of Vista Alegre do Alto, SP, Cwa subtropical climate with two different seasons (Köppen): winter and short, mild and dry, hot and rainy summer. It was randomly selected 10 guava trees per cultivar and in each one, was sampled 20 expanded leaves, located in the middle of the canopy of the third branches of plants and taken to the laboratory for measurements of length and width. Leaf area was determined using a leaf area meter (model LI-3000A). It was observed that the leaves of the four guava cultivars studied was almost symmetrical, and its geometric shape is approximately an ellipse. Thus, the leaf area (A, cm<sup>2</sup>) of the four guava cultivars can be estimated using the equation, where and. The Student t test was applied at 1% significance level. The leaf area measured by the integrator was considered the dependent variable. The results showed that there were no significant difference between leaf area measured by the integrator and leaf area measured using the obtained mathematical equation. It was concluded that the leaf area of guava tree can be predicted using the formula derived from data obtained in the field without the need of removing the leaf.

**Keywords:** *Psidium guajava*; mathematical model; leaf area.

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## Assessment of nutritional status of seedlings guavas trees using preliminary DRIS norms and sufficiency ranges

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Brazil is one of the largest producers of guava in the world, however, to maintain orchard productivity and longevity it is need to purchase plants healthy and well nourished. Whereas the charts with tracks sufficiency, or methods that help in assessing the most limiting nutrient (DRIS) could help in the management and consequently the production of quality seedlings, there is a need to establish standards and/or suitable levels for plants. Thus, the objective of this work was to propose preliminary DRIS norms and derive critical levels and nutrient sufficiency ranges in the leaves of guava plants in conditions of commercial nursery in the state of Sao Paulo - Brazil. Sixty-eight leaves samples were evaluated, from fertilization trials with seedlings. It was used Paluma guava seedlings, the most planted in Brazil, obtained from the vegetative propagation of selected matrices and pruned 70 days before the removal of herbaceous cuttings. The seedlings were conducted in a nursery covered with 30% shading screen, packed in polyethylene bags of 1.5 dm<sup>3</sup> of volume, containing a pine bark substrate and placed on benches with no spacing between the bags. The seedlings were evaluated when they were about 50 cm high, determining the nutrient content in leaves and dry matter. In the subpopulation of low productivity (84% of the population) the limiting nutrients by lacking in descending order, were: N > Cu > P = K > Mn > Fe = Zn > S > B = Mg > Ca, and limiting by excess in descending order, were: B > Ca > Fe > Mn > S > Mg > P > Zn > N = K. The ranges from the appropriate DRIS indices were: 24 to 28, 2.4 to 3.1, 21 to 29, 6 to 8, 1.9 to 2.9 and 1.9 to 2.3 (g kg<sup>-1</sup>) for macronutrients

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N, P, K, Ca, Mg and S, respectively, and 35 to 48, 4 to 15, 68 to 93, 31 to 60 and 180 to 245 ( $\text{mg kg}^{-1}$ ) for the micronutrients B, Cu, Fe, Mn and Zn, respectively. The dry matter production of guava seedlings was associated with nutritional status.

**Keywords:** *Psidium guajava*, nursery, leaf analysis.

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## Effects of application of guava processing residue on the nutrient content in guava fruit and post-harvest quality

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The use of residue from the guava industrial processing could partially replace mineral fertilizer, in view of the relatively high nutrient content contained in this product, reducing the environmental impacts of its accumulation and reducing the cost of fruit production areas. Given the scarcity of information in the literature and the importance of proper management of organic residues in agriculture, this work aimed to evaluate the effects of application of the residue in an Ultissol, determining the chemical changes induced in guava fruits and in their post-harvest attributes. The experimental design was randomized blocks with seven treatments and four replications: doses of the residue (grounded) equal to zero, 9, 18, 27 and 36 t ha<sup>-1</sup> (dry weight), dose of 18 t ha<sup>-1</sup> of non-grounded residue, and the recommendation of mineral fertilizers. Applications and evaluations were made in 2006, 2007, 2008, 2009 and 2010. The results indicated that increasing the doses there was an increasing N content and a decreasing Ca content in fruits. The residue doses did not influence the post-harvest attributes of guava.

**Keywords:** *Psidium guajava*, organic manure, by-product.

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### Productivity of *Eucalyptus grandis* x *Eucalyptus camaldulensis* hybrid in different plant spacing, at four year age, in the Chapada of Araripe, Pernambuco, Brazil

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The density of tree species is a very important variable for planning a forest enterprise. It may affect growth rate, plant survival, wood quality, cutting off age, thinning time, management practices and consequently the costs for forestry cropping system. The study aims to assess the effects of different planting spacing in wood productivity of the hybrid *Eucalyptus grandis* x *Eucalyptus camaldulensis* in the Chapada of Araripe. The trial was conducted at the Experimental Station of the Agronomic Institute of Pernambuco (IPA) in Araripina, Pernambuco State, Brazil (Latitude: 7°27'50"S, Longitude: 40°24'38"W, Altitude: 828m). The average annual rainfall in the region is 752.5 mm, concentrated in February, March and April, with average annual temperature of 24°C, evaporation of 1,127 mm.year<sup>-1</sup> and relative humidity annual average of 55.2%. Five spacing were used: 1) 3.0 x 2.0m, 2) 3.0 x 2.5m, 3) 3.0 x 3.0m, 4) 3.0 x 3.5m, 5) 3.0 x 4.0m. The experimental design was a randomized blocks with four replications. Before planting, the experimental area was submitted to plowing and harrowing, and sub soiling to 40 cm depth in the row, being incorporated into the soil 2.0 t.ha<sup>-1</sup> of lime. 150 g/tree of NPK (06:24:12.) were applied before planting. Each plot consisted of 64 plants, with areas varying from 216 to 432m<sup>2</sup>, totaling 11.520m<sup>2</sup>. As plants were four years old, it was found that the mean values of survival and height did not differ significantly from each other; means for the different spacing were 90% for survival and 13.9m for plant height. Diameter at breast height (DBH) in 3.0 X 4.0m spacing was 13.2m, being similar to 3.0 x 3.5m spacing and significantly superior from the others. The volume of wood production in 3.0 X 2.0m spacing (105,0 m<sup>3</sup>.ha<sup>-1</sup>) was significantly superior to 3.0 x 2.5m (86.3 m<sup>3</sup>.ha<sup>-1</sup>) and 3.0 x 3.0m (78.3 m<sup>3</sup>.ha<sup>-1</sup>) spacing. Average annual increment (AAI) increases inversely to planting density increases. It is concluded that planting density is an important variable for obtaining a higher productivity at the present plant development stage.

**Keywords:** Planting density, reforestation, forestry energy.

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**Productivity of *Eucalyptus brassiana* x *Eucalyptus urophylla* hybrid in different plant spacing, at four year age, in the Chapada of Araripe, Pernambuco, Brazil**

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The density of tree species is a very important variable for planning a forest enterprise. It may affect growth rate, plant survival, wood quality, cutting off age, thinning time, management practices and consequently the costs for forestry cropping system. The study aims to assess the effects of different planting spacing in wood productivity of the hybrid *Eucalyptus urophylla* x *E. brassiana* in the Chapada of Araripe. The trial was conducted at the Experimental Station of the Agronomic Institute of Pernambuco (IPA) in Araripina, Pernambuco State, Brazil (Latitude: 7°27'50"S, Longitude: 40°24'38"W, Altitude: 828m). The average annual rainfall in the region is 752.5 mm, concentrated in February, March and April, with average annual temperature of 24°C, evaporation of 1,127 mm.year<sup>-1</sup> and relative humidity annual average of 55.2%. Five spacing were used: 1) 3.0 x 2.0m, 2) 3.0 x 2.5m, 3) 3.0 x 3.0m, 4) 3.0 x 3.5m, 5) 3.0 x 4.0m. The experimental design was a randomized blocks with four replications. Before planting, the experimental area was submitted to plowing and harrowing, and sub soiling to 40 cm depth in the row, being incorporated into the soil 2.0 t.ha<sup>-1</sup> of lime. 150 g.tree<sup>-1</sup> of NPK (06:24:12.) were applied before planting. Each plot consisted of 64 plants, with areas varying from 216 to 432m<sup>2</sup>, totaling 11.520m<sup>2</sup>. As plants were four years old, it was found that mean values for survival (%), height (m), diameter at breast height - DBH (cm), volume of wood (m<sup>3</sup>.ha<sup>-1</sup>) and mean annual increment - MAI (m<sup>3</sup>/ha.ano<sup>-1</sup>) did not differ statistically among the different plant spacing. Average survival, that was 88%, ranged from 83 to 92% for the spacing 3.0 x 2.5m and 3.0 x 3.5m, respectively. The growth height, which average was 14.8m, was very uniform, varying from 14.2 to 15.0m. The DBH had an overall average of 12.3 cm, which ranged from 11.6 cm at lower plant spacing (2.0 x 2.0m) to 13.4 cm in the largest plant spacing (3.0 x

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4.0m). The volume of wood production in absolute values tended to be greater for smaller spacing (3.0 x 2.0m) with a volume of 116.1 m<sup>3</sup>.ha<sup>-1</sup>, equivalent to an average annual increase of 29.0 m<sup>3</sup>/ha.year<sup>-1</sup>, while in the wider spacing (3.0 x 4.0m) it was obtained 83.1 m<sup>3</sup>.ha<sup>-1</sup>, corresponding to an MAI 20.8 m<sup>3</sup>/ha.ano<sup>-1</sup>. It is concluded that the number of plants per area was not enough to increased productivity significantly, suggesting there was little competition between plants until the study period.

**Keywords:** Planting density, reforestation, energetic forests.

## Analysis of the guava price components in local market of Juazeiro, Northeast Brazil

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Guava (*Psidium guajava* L.) belongs to the Myrtaceae family and is originated from the Americas, finding in Brazil favorable cropping conditions. Northeast and Southeast regions are responsible to 93% of the Brazilian production, based on the 2001-2010 period. In the Southeast Brazil, the state of São Paulo is the largest producer. In the Northeast Brazil, the main producers are the States of Pernambuco and Bahia. The largest guava variety cropped is Paluma. However, São Paulo State produces mainly table fruit and the Pernambuco and Bahia States produce mainly for juice and pulp. This is an important factor on the price difference between these two regions, which is up to three times larger in the Southeast than in the Northeast, even considering that production costs are higher in the Southeast. Hence, this work aims to understand the behavior of the historical price series of guava trading at local market of Juazeiro, Bahia State, in the Lower Middle region of São Francisco River Valley. The data were deflated by IGP-DI and refer to the January 2005 to December 2011 period and are available at the website of the Secretariat of Agriculture, Irrigation and Land Reform (SEAGRI) of the State of Bahia. The component tendency, cycle, seasonality and volatility were analyzed based on estimations of the models ARIMA, ARCH and spectral density. The results of the log-linear regression against time indicate a price growth tendency around 1.8% per month. Analyzing the spectral density function cycles, only 6 and 7 month seasonal cycles were found, what was expected given the possibility of up to two crops within the period of 14 months. Regression using seasonal dummy variables showed that guava prices are much above their historical average in month 5 and below this average in month 8. As for volatility, conditional heteroskedasticity was found in the residues of the model ARIMA (3,1,3), used to describe the behavior of guava prices. Thus, several models of the ARCH family were estimated, and ARCH (1,0) was chosen and no high volatility was found in the series.

**Keywords:** Tendency, Cycle, Seasonality, Volatility, ARIMA, ARCH, Spectral Density.

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### **Characterization of production costs and economic feasibility of guava exploitation in the Lower-Middle San Francisco Valley**

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Guava (*Psidium guajava* L) is one of the most important fresh agricultural good produced and marketed in the Northeast of Brazil. The Lower Middle region of São Francisco Valley stands out today as the main guava producer area, which cultivation is performed basically by family farmers and small agricultural settlements inside some irrigation schemes established in this region. As the guava crop management is based on knowledge of technical practices, it is important to the growers a better understanding about the production costs and economical feasibility of guava exploitation. Hence, this study aims to make the identification and characterization of these information on the typical guava production system in this region. For the production costs analysis in a full developed guava orchard (commonly from the fifth year after planting), we used the partial budgeting model. The performance of economical exploitation was analyzed based on net income, leveling point, safety margin and the benefit / cost ratio. The analysis of profitability was based on net present value, internal rate of return, modified internal rate of return, profitability index, rate of return, annual net present value and discounted payback. Results revealed that service costs overcome the supply costs. Water is the most expensive item among inputs while mechanized chemical application and harvesting operations are the highest service expenses. Results also confirmed that this activity is profitable, based on the satisfactory index determined in this study.

**Keywords:** market, partial budgeting model, profitability index.

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