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Quality of Banana Fruit Produced in Different Locations (Greenhouse and Open Air) of the Canary Islands

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ABSTRACT

This work aimed to evaluate fruit quality and nutrient content of Cavendish banana cultivars produced under different greenhouse covers in Tenerife Island (Spain) and compare them with other bananas production regions in the island. Observation on fruit quality under greenhouse were carried out in the experimental station of Pajalillos of ICIA - Instituto Canario de Investigaciones Agrarias on a plot planted with *in vitro* plants of two cultivars ('Grand Nain' and 'Gruesa') in their fifth crop cycle, cultivated under four greenhouse covers: Celloclim (thermic plastic), 20 × 10 mesh, white mesh and 16 × 10 mesh. Data were also collected in open air cultivation in 3 different locations of Tenerife: Cueva del Polvo, Hoya Meleque and Canaria Forestal. Nutrients levels in the dry mass of 'Gruesa' and 'Grand Nain' banana leaf did not show differences between cultivars nor among different greenhouse covers. The parameters analysed related to fruit quality were not also influenced by covers or cultivars and nor relevant differences were also detected between open air condition and greenhouse cultivation.

Keywords: cultivars, *Musa* sp., nutrients, post harvest, protected cultivation

INTRODUCTION

The major banana (*Musa* spp.) growing areas are situated between the Equator latitudes 20°N and 20°S, where climatic conditions are mainly tropical, with relatively small temperature fluctuations from day to night and from summer to winter (Robinson 1996). Since banana plants show wide adaptability to a range of environments, they can also be grown in subtropical areas like New South Wales, Western Australia, South Queensland, South Africa, Israel, Taiwan, Spain (the Canary Islands), Egypt, Morocco, and parts of Brazil, where banana plantations are situated between latitudes 20°S and 30°S (Galán Saúco 1992).

In recent years protected cultivation became popular for many fruits, including tropical and subtropical fruits, particularly in the case of banana (Galán Saúco 2002), with protected cultivation starting in the Canary Islands during the 1970's (Galán Saúco *et al*. 1992). Nowadays banana protected cultivation occurs in many subtropical countries, such as Morocco, Israel, Crete, Korea, South Africa, and Turkey. The world's largest banana producer countries using greenhouse cultivation are Morocco and Spain (the Canary Islands) with 4,460 and 3,000 ha, respectively (Galán Saúco *et al*. 2004; Gubbuk and Pekmezci 2004). Although these figures did not changed much in the last 4 years – with 3,173 ha under protected cultivation (from a total of 9,579) in the Canaries (www.gobiernodecanarias.org) and around 4,000 ha in Marroco – an important increase in protected cultivation of banana did occur in Israel moving from 100 ha in 2003 till 1,000 ha in 2008 (Galán Saúco 2008) and in Turkey, nowadays with 2500 ha (H. Gubbuk 2009, pers. comm.).

The main practical advantage of protected cultivation, particularly under subtropical conditions, is an increase in yield and quality, but there are many other advantages in protected cultivation compared to open-field cultivation: plant cycle reduction; water economy, extended duration of temperatures above 20°C and higher photosynthetic rate; protection against wind and other unfavorable weather conditions (Galán Saúco 1992, 2002; Galan Saúco *et al*. 2004; Galán Saúco 2008).

The main cultivars grown in the Canary Islands are 'Dwarf Cavendish' (approximately 4,500 ha), 'Grand Nain' (around 3,000 ha) and about 2,000 ha of 'Gruesa', with assorted Cavendish subgroup cultivars making up the rest. 'Gruesa', presently the favourite cultivar for new plantings in the region, originated as a field mutation of 'Dwarf Cavendish' was first observed in several plantations on the island of La Palma (Canary Islands) and is now commercially propagated through tissue culture by CULTESA (Cultivos Vegetales in Vitro de Tenerife S.A.). Besides high yield, the popularity of this selection is mainly due to its short stature and small finger length. This last characteristic is particularly attractive to growers who sell their bananas in the Spain mainland market which demand shorter fruits clearly differentiated from the larger fruit typically produced by the multinational brands, without renouncing to the high yields of 'Grand Nain'. 'Gruesa' due to its shorter height and very thick peudostem - to which their name is due, 'gruesa' means thick in Spanish - is less sensitive to wind damage and cultural practices are easier (Cabrera Cabrera and Galán Saúco 2005).

Although many phenological, morphological and production aspects has been so far studied for protected cultivated bananas in the Canary Islands (Galán Saúco *et al.* 1992, 1998; Cabrera Cabrera and Galán Saúco 2005), there are many aspects regarding quality of fruits or suitability of covering materials for different conditions that are still to be discerned. To contribute to clarify some of these unknown aspects our study aimed to compare the fruit quality of two

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Table 1 Characterization of covers (% of radiation transmitted).

P.A.R.* (400-700 nm)				U.V. RADIATION (300-390 nm)*			
Celloclim	**Net of 20 × 10**	**White net**	**Net of 16 × 10**	**Celloclim**	**Net of 20 × 10**	**White net**	**Net of 16 × 10**
72	80	55	85	18	64	32	75

* P.A.R. = Photosynthetic Active Radiation, measured with spectroradiometer (W m^{-2}). nm = nanometers

Table 2 Results of chemical analysis of the soils. Pajalillos ICIA Experimental Station.

Cultivar*: Covers	pH $CaCl_2$	C.E. dS m^{-1}	Ca	Mg	Na	K	P	Fe	Mn	Zn	Cu	M.O. %
			meq l^{-1}				ppm					
GR: Celloclim	7.38	5.26	14.12	17.65	13.32	10.86	197.68	7.96	12.05	5.77	3.13	8.50
GR: Net of 20 × 10	5.80	7.25	35.49	21.47	21.50	5.06	239.46	31.94	27.03	6.86	3.45	7.25
GR: White net	6.91	5.32	20.19	18.97	12.51	7.57	182.58	8.70	11.78	5.37	7.86	5.43
GR: Net of 16 × 10	7.30	2.72	7.35	8.43	8.45	5.65	264.62	12.07	8.38	8.66	3.23	8.75
GN: Celloclim	7.14	5.25	19.71	19.79	12.40	6.83	171.89	6.89	10.76	4.84	3.63	5.97
GN: Net of 20 × 10	6.35	4.40	20.04	12.88	13.59	4.46	219.02	25.83	24.03	7.86	3.63	10.32
GN: White net	7.54	2.21	3.22	4.81	11.53	4.63	192.64	9.45	10.34	9.26	2.23	8.89
GN: Net of 16 × 10	7.15	3.05	10.91	9.09	10.57	1.97	195.16	8.92	8.30	6.47	2.73	4.78

* GR: Gruesa; GN: Grand Nain

cultivars 'Gruesa' and 'Grand Nain' under four different covering materials in the north of Tenerife Island. As a reference, fruit quality data from bananas cultivated in other locations of the island of Tenerife are also reported in this paper.

MATERIALS AND METHODS

Fruit quality studies were carried out at the Laboratories of the Department of Tropical Fruits and Soil and Irrigation of ICIA (Instituto Canario de Investigaciones Agrarias), according to the following protocol:

Three fruits of the 2nd hand of every harvested bunch (when the fruits of the 2nd hand reached a diameter of 34 mm) were analyzed in each location (1 to 4) mentioned below to evaluate chemical characteristics (pH, acidity, soluble solids and starch). The fruits were peeled and crushed to determine pH, which was measured in aqueous extract, prepared with 10 g of fresh material and diluted in 100 ml of distilled water (IAL 1985). Acidity (g 100 g^{-1}) was measured with NaOH 0.1 N in the same aqueous extract prepared for the pH (IAL 1985). Soluble solids (°Brix) were determined with a refractometer type ABBE, as recommended by A.O.A.C. (1970). For starch analysis fruits were cut and peeled in slices of 3 cm thick and immersed in a solution of iodine during 30 sec. After dried, they were photographed for later analysis of tinted area, which represents the percentage of starch contained in fruit (Blakenship *et al.* 1993). The experimental design was completely randomized in a factorial scheme 2 × 4 (cultivars × covers) with 5 replications and 3 fruits per plot. Data were submitted to variance analysis and compared by Tukey's Test at the 5% probability level.

Leaf samples were also collected – only in location 1 – at the beginning of blooming (bunch emergence) to determine the levels of nitrogen, phosphorus, potassium, calcium, magnesium, sodium, iron, manganese, zinc and copper following the recommended international standard analysis (Martin-Prével 1984).

The locations, all of them in the island of Tenerife, where these quality studies were undertaken include:

1) Pajalillos ICIA Experimental Station, located in Valle Guerra on the northwest coast of the island with an average altitude of 90 m. The climatic conditions of the area are: annual average rainfall of 213 mm, annual average temperature of 19.8°C, with extremes of 10.1 and 31.1°C and average relative humidity of 71%, with extremes of 35 and 89% (Pérez 2008). Data were taken in a parcel currently devoted to trials for the ICIA Project RTA05-0208-C02-01. This parcel was a five year old planting of *in vitro* plants of the cultivars 'Grand Nain' (GN) and 'Gruesa' (GR), at a spacing of 1.67 × 5.0 m and two plants per hole (2400 plants ha^{-1}), under a completely randomized factorial scheme 2 × 4 (cultivars × covers), with 5 replications, under protected cultivation with four different green house covers: Celloclim (termic plastic), net of 20 × 10 mesh, white net and net of 16 × 10 mesh. Characteristics of the different covers as studied previously by Cabrera Cabrera and Galán Saúco (2003) are presented in **Table 1**.

The soil of each treatment was analyzed during the time of this study at the Soil and Irrigation Department of ICIA and its chemical characteristics are shown in **Table 2**.

Currently applied fertilization consisted on incorporation of 80 m^3 ha^{-1} of organic compost and fertirrigation with 2 ton ha^{-1} $year^{-1}$ of calcium nitrate, 1.2 ton ha^{-1} $year^{-1}$ of potassium sulphate and 157 kg ha^{-1} $year^{-1}$ of phosphoric acid. Drip irrigation was also currently applied at a rate of 12,080 m^3 ha^{-1} $year^{-1}$ of water.

2) Cueva del Polvo ICIA Experimental Station, located in Guía de Isora (on the southwest coast of the island with an average altitude of 50 m The climatic conditions of the area are: annual average rainfall of 197 mm, annual average temperature of 20.2°C, with extremes of 10 and 31.3°C and average relative humidity of 65%, with extremes of 32 and 82% (Pérez 2008). It was planted with cultivars 'Grand Nain' and 'Gruesa', cultivated under conventional management at plant spacing of 1.67 × 5.0 m, with two plants per hole.

3) Hoya Meleque Farm, located in Puerto de la Cruz on the north coast of the island with an average altitude of 60 m. The climatic conditions of the area are: annual average rainfall of 314 mm, annual average temperature of 19.9°C, with extremes of 10.5 and 29.9°C and average relative humidity of 74%, with extremes of 45 and 91% (Pérez 2008). It was planted with the cultivar 'Laja', another local selection of Dwarf Cavendish (Cabrera Cabrera and Galán Saúco 2006), cultivated under conventional management at an inter-plant spacing of 1.3 × 3.0 m, with one plant per hole.

4) Canaria Forestal Farm: located in Guía de Isora (Tenerife, Spain) on the southwest coast of the island with an average altitude of 400 m. The climatic conditions of the area are: annual average rainfall of 238 mm, annual average temperature of 18.3°C, with extremes of 7.4 and 37.6°C and average relative humidity of 68%, with extremes of 24 and 89% (Pérez 2008). It was planted with the cultivar 'Gruesa' cultivated under organic system at plant spacing of 2.0 × 5.0 m, with two plants per hole.

RESULTS AND DISCUSSION

Foliar nutrient levels at blooming

No significant differences were found among covers in both cultivars studied at the experimental station of Pajalillos (see **Table 3**).

There are no published studies comparing nutrition of bananas plants cultivated under greenhouse. Leaf nutrient concentration at bunch emergence was K > N > Ca > Mg > P (21.3 > 19.5 > 15.8 > 4.9 > 1.6 g kg^{-1}). This concentration sequence was the same found by Damatto Junior *et al.* (2006), for open air cultivation of banana 'Prata-anã' under organic management. Nutrients presented, however, lower levels than those obtained by the same author: 23 > 22 > 11 > 4.6 > 1.6 g kg^{-1}, respectively to K, N, Ca, Mg and P. Leaf levels of nitrogen, phosphorus and potassium were lower

Table 3 Macronutrients levels in the dry mass of 'Gruesa' and 'Grand Nain' banana leaf under different greenhouses covers.

Cultivars	Covers	N	P	K	Ca	Mg
		---------- $g\ kg^{-1}$ ----------				
	Celloclim	18.0 a	1.5 a	20.0 a	16.0 a	5.7 a
Grand	Net of 20 × 10	20.0 a	1.5 a	26.0 a	14.0 a	5.3 a
Nain	White net	22.0 a	1.7 a	24.0 a	12.0 a	4.2 a
	Net of 16 × 10	20.0 a	1.7 a	18.0 a	20.0 a	6.0 a
	Average	20.0 A	1.6 A	22.0 A	15.5 A	5.3 A
	Celloclim	20.0 a	1.6 a	18.0 a	18.0 a	4.8 a
Gruesa	Net of 20 × 10	20.0 a	1.9 a	20.0 a	16.0 a	4.7 a
	White net	18.0 a	1.5 a	24.0 a	14.0 a	3.9 a
	Net of 16 × 10	18.0 a	1.6 a	20.0 a	16.0 a	4.7 a
	Average	19.0 A	1.6 A	20.5 A	16.0 A	4.5 A
	CV (%)	16.22	23.64	28.75	23.30	95.30

Averages followed by different lowercase letters in the columns differ by Tukey test at 5% of probability for the greenhouse covers and different capital letters in the columns differ by Tukey test at 5% probability for the cultivars.

Table 4 Micronutrients levels in the dry mass of 'Gruesa' and 'Grand Nain' banana leaf under different greenhouses covers.

Cultivars	Covers	Na	Fe	Mn	Zn	Cu
		---------- $mg\ kg^{-1}$ ----------				
	Celloclim	66 a	52 a	409 a	17 a	3 a
Grand	Net of 20 × 10	102 a	56 a	487 a	15 a	2 a
Nain	White net	74 a	75 a	480 a	16 a	4 a
	Net of 16 × 10	84 a	56 a	517 a	13 a	2 a
	Average	82 A	60 A	473 A	15 A	3 A
	Celloclim	80 a	56 a	396 a	17 a	4 a
Gruesa	Net of 20 × 10	116 a	97 b	411 a	15 a	6 a
	White net	61 a	53 a	807 a	16 a	2 a
	Net of 16 × 10	86 a	49 a	587 a	15 a	2 a
	Average	86 A	64 A	550 A	16 A	4 A
	CV (%)	56.33	27.33	61.44	21.11	72.43

Averages followed by different lowercase letters in the columns differ by Tukey's test at 5% of probability for the greenhouse covers and different capital letters in the columns differ by Tukey's test at 5% probability for the cultivars.

and nutrient levels of calcium higher than the nutritional standards recommended for Cavendish banana in the State of São Paulo by Raij *et al.* (1997) (27-36; 1.8-2.7; 35-54; 3-12 g kg^{-1}, respectively. Greenhouse plants did not show symptoms of deficiency.

As can be seem in **Table 3**, leaf nutrient levels obtained for both cultivars ('Gruesa' and 'Grand Nain') are lower than the recommended standards for Cavendish banana in the State of São Paulo by Raij *et al.* (1997). The excellent yields obtained in the Canary Islands (Galán Saúco *et al* 1992) clearly confirm the well known fact that nutrient standards may, to a certain extent, vary from one location to another.

No significant differences were found in any plot regarding micronutrient leaf contents (see **Table 4**). The order of concentration was Mn > Na > Fe > Zn > Cu (512 > 84 > 62 > 16 > 3 ppm) indicating no influence of greenhouse covers or the cultivars in these tenors.

Fruit quality parameters

Results of chemical analysis of fruit (see **Table 5**) in location 1 did not show any significant difference, with little variability among the different plots, which also seem to indicate the scarce influence of different covers and cultivars on these characteristics. The same occurs in fruits of cultivars 'Gruesa', 'Grand Nain' and 'Laja' analysed in different region of Tenerife Island (see **Table 6**). In another experiment, Damatto Junior (2005) working with 'Prata-anã' did not find differences between organic compost rates in banana's quality. Results for the studied parameters for fruit quality seem to indicate that differences on them are relatively independent of cultural practices and may be more linked to cultivar genetical background, as observed by Damatto Junior (2005) working in cultivar 'Prata-anã' under organic management and by Barbosa (2008), evaluating irrigation and sewage sludge rates to banana 'Nanicão' cultivar.

Starch levels determined at harvest time in the experi-

Table 5 Post harvest characterization of bananas 'Grand Nain' and 'Gruesa' under different greenhouses covers.

Cultivars	Covers	Starch (%)	Soluble solids (ºBrix)	pH	Acidity (g 100 g^{-1})
	Celloclim	30.32 a	2.44 a	5.56 a	0.10 a
Grand	Net of 20 × 10	41.12 a	2.52 a	5.53 a	0.10 a
Nain	White net	43.76 a	2.28 a	5.54 a	0.11 a
	Net of 16 × 10	36.40 a	2.56 a	5.53 a	0.10 a
	Average	37.90 A	2.45 A	5.54 A	0.10 A
	CV (%)	13.00	25.32	2.16	9.59
	Celloclim	34.70 a	2.12 a	5.63 a	0.09 a
Gruesa	Net of 20 × 10	41.44 a	2.12 a	5.54 a	0.09 a
	White net	45.34 a	2.72 a	5.45 a	0.10 a
	Net of 16 × 10	44.06 a	2.64 a	5.46 a	0.10 a
	Average	41.38 A	2.40 A	5.52 A	0.09 A
	CV (%)	9.99	25.32	4.50	15.88

Averages followed by different lowercase letters in the columns differ by Tukey's test at 5% of probability for the greenhouse covers and different caps letters in the columns differ by Tukey's test at 5% probability for the cultivars.

Table 6 Post harvest characterization of bananas produced in different region of Tenerife Island.

Area (cultivar)	**Starch (%)**	**Soluble Solids (ºBrix)**	**pH**	**Acidity (g 100 g^{-1})**
C. Forestal (Gruesa)	37.02	2.72	5.82	0.12
C. Polvo (Grand Nain)	42.46	2.72	5.63	0.10
C. Polvo (Gruesa)	33.12	2.36	5.74	0.08
H. Melleque (Laja)	44.00	1.66	5.87	0.09
Average	39.15	2.36	5.76	0.10

mental station of Pajalillos (location 1) shows an average of 37.90% for 'Grand Nain' and 41.38% for 'Gruesa', and although 'Gruesa' showed higher values than 'Grand Nain' in all covers no significant differences were found among cultivars and covers. These results were in the same range than those determined for the other locations (see **Table 6**). Fruits produced in location 1 did not show statistical differences regarding soluble solids tenors with very close average values for both cultivars (2.45 ºBrix for 'Grand Nain' and 2.40 º Brix for 'Gruesa'). The level of soluble solids found in this location was also close to those determined in the other plots (2.72 ºBrix for 'Gruesa' in Canaria Forestal and for 'Grand Nain' in Cueva del Polvo; 2.36 ºBrix for 'Gruesa' in Cueva del Polvo). The higher levels of starch at harvest are logical since banana is not harvested completely mature, and in the maturation process the starch is converted to sugars remaining starch level between 1 and 2% This also explains the very low levels of soluble solids at harvest that increase considerably at maturity (Chitarra and Chitarra 1990).

Average pH values of the fruits produced in location 1 also did not show statistical differences with very close average values for both cultivars (5.54 for 'Grand Nain' and 5.52 for 'Gruesa'). Fruits produced in the other locations exhibit pH somewhat higher, but all between 5.5 and 6.0 on the average (**Table 6**). Results are also very similar to values obtained by Damatto Junior (2005) that found pH of 5.61, for cultivar 'Prata-anã' under organic management. All of them were, however, higher than those found by Soto Ballestero (1992), which says that pH in fruits of banana ranges from 4.2 to 4.8 for Cavendish cultivars in open air cultivation. As in the case of starch and sugar levels pH differences may be more influenced by the stage of maturity than for differences between cultivars (Chitarra and Chitarra 1990).

Very scarce differences exists between all the locations studied regarding average acidity, in the order of 0.10 g × 100 g^{-1}, also very close to those values found by Damatto Junior (2005), for cultivar 'Prata-anã' under organic management.

CONCLUSIONS

Most nutrients levels in the dry mass of 'Gruesa' and 'Grand Nain' banana leaf did not show differences between cultivars nor among different greenhouse covers. Fruit quality was neither influenced by the covers employed nor by cultivars.

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REFERENCES

A.O.A.C. (Association of Official Analytical Chemists) (1970) *Official Methods of Analysis of the Association of official Analytical Chemists* (15th Edn), Vol 1

Barbosa RD (2008) Avaliação do crescimento e da produção de bananeira manejadas com irrigação e aplicação de biossólido. PhD thesis, Faculdade de Ciências Agronômicas, Universidade Estadual Paulista, Botucatu, 122 pp

Blankkenship SMM, Ellsworth D, Powell L (1993) A ripening index for banana fruit based on starch contents. *HortTechnology* **3**, 338-339

Cabrera Cabrera J, Galán Saúco V (2003) Crecimiento y desarrollo de la platanera. (*Musa acuminata* Colla AAA) bajo distintos tipos de cubierta. Avance de resultados. *Actas de Horticultura* **39**, 257-259

Cabrera Cabrera J, Galán Saúco V (2005) Evaluation of the banana cultivars Zelig, Grand Naine and Gruesa under different environmental conditions in the Canary Islands. *Fruits* **60**, 357-369

Cabrera Cabrera J, Galán Saúco V (2006) Evaluación de selecciones locales de 'Pequeña Enana' (*Musa acuminata* Colla AAA, subgrupo Cavendish) en las Islas Canarias. In: *Proceedings of XVII Reunião Internacional de ACORBAT*, 15-20/10/2006, Joinville, Brasil, pp 468-471

Chitarra MI, Chitarra AB (1990) *Pós-Colheita de Frutos e Hortaliças: Fisiologia e Manuseio*, Lavras, ESAL/FAEPE, 320 pp

Damatto Junior ER (2005) Efeitos da adubação com composto orgânico na fertilidade do solo, desenvolvimento, produção e qualidade de frutos de bananeira 'Prata-anã' (Musa AAB). MSc thesis, Faculdade de Ciências Agronômicas, Universidade Estadual Paulista, Botucatu, 70 pp

Damatto Junior ER, Villas Bôas RL, Leonel S, Fernandes DM (2006) Avaliação nutricional em folhas de bananeira 'prata anã' adubadas com composto orgânico. *Revista Brasileira de Fruticultura* **28 (1)**, 109-112

Galán Saúco V (1992) *Los Frutales Tropicales en los Subtrópicos II*. El plátano, Madrid, Mundi-Prensa, 173 pp

Galán Saúco V (2002) Greenhouse cultivation of tropical fruits. *Acta Horticulturae* **575**, 727-735

Galán Saúco V (2008) Cultivo de la platanera (*Musa acuminata Colla* AAA) bajo invernadero: La experiencia española y su comparación con las experiencias de otras zonas subtropicales del mundo. Palestras. In: *I Workshop sobre Inovaçôes Tecnológicas em Bananicultura*. Faculdade de Ciências Agronômicas. Universidade Estadual Paulista. (CD), 19 pp

Galán Saúco V, Cabrera Cabrera J, Hernández Delgado PM (1992) Phenological and production differences between greenhouse and open-air banana (*Musa accuminata* Colla AAA cv. Dwarf Cavendish) in Canary Islands. *Acta Horticulturae* **296**, 97-112

Galán Saúco V, Cabrera Cabrera J, Hernández Delgado PM, Rodríguez Pastor MC (1998) Comparison of protected and open-air cultivation of Grand Naine and Dwarf Cavendish bananas. *Acta Horticulturae* **490**, 247-259

Galán Saúco V, Ait-Oubahou A, Abdelhaq H (2004) Greenhouse cultivation of bananas. *Crónica Horticulturae* **44 (2)**, 35-37

Gobierno de Canarias. Available online: www.gobiernodecanarias.org

Gubbuk H, Pekmezci M (2004) Comparison of open-field and protected cultivation of banana (*Musa* spp. AAA) in the coastal area of Turkey. *New Zealand Journal of Crop and Horticultural Science* **32**, 375-378

I.A.L. (Instituto Adolfo Lutz) (1985) *Normas Analíticas: Métodos Químicos e Físicos Para a Análise de Alimentos* (2nd Edn), São Paulo, 371 pp

Martin-Prével P (1984) Bananier. In: Martin-Prével P, Gagnard J, Gautier P (Eds) *L'Analyse Végétale Dans le Contrôle de l'Atation des Plantes Tempérées et Tropicales*, Tec & Doc, Paris, pp 715-751

Pérez LMS (2008) Análisis climático de Año 2006. Available online: http://www.agrocabildo.com

Raij B Van, Cantarella H, Quaggio JÁ, Furlani AMC (Eds) (1997) *Recomendações de Adubação e Calagem para o Estado de São Paulo* (2nd Edn), Campinas, Instituto Agronômico/Fundação IAC, 285 pp

Robinson JC (1996) *Bananas and Plantains*, CAB International, 238 pp

Soto Ballestero M (1992) *Banano – Cultivo y Comercialización* (2nd Edn), San José, Litografia e Imprensa LIL, 674 pp