Relationships Between Leaf Morphology and Efficiency of Foliar Application of Nutrients in Guava (*Psidium guajava* L.).

Fabiola Vitti Môro [1], William Natale [2] and Carlos F. Damiao Filho [1]
[1] Dep. of Applied Biology - email: fabiola@fcav.unesp.br / [2] Dep. of Soil and Fertilizer
FCAV/UNESP, 14870 - 000 Jaboticabal - SP, Brazil. Fax: 016- 3224275.

Abstract

Foliar application to supply micro- and macronutrients is a common practice in several crops. However, in guava (*Psidium guajava* L.) efficiency of this procedure has been low. An anatomical approach was made to understand this problem by light and scanning electron microscopy of guava's leaves, which revealed: (a) the hypodermis under the adaxial epidermis is formed by three layers of cells with thickened cell walls; (b) well developed palisade parenchyma; (c) high density of stomata and trichomes at the abaxial epidermis; (d) absence of stomata on the adaxial surface. Such pattern reveals a typical water saving mechanism, which probably interferes with the absorption of nutrients applied by foliar spraying.

Keywords: leaf morphology, SEM, guava, foliar absorption.

Resumen

La suplementación de micro y macronutrientes por pulverización de la hoja es una práctica común en varias cosechas. Sin embargo, en guayaba (*Psidium guajava* L.) la eficacia de este procedimiento ha sido baja. Un estudio anatómico fue hecho para entender este problema a traves de microscopía ótica y de barrido de las hojas de guayaba, que revelaron: (a) la hipodermis bajo la epidermis adaxial esta formada por tres capas de células con paredes de la célula espesadas; (b) un parenquima en empalizada bien desarrollado; (c) una alta densidad de estomas y pelos en la epidermis abaxial; (d) la ausencia de estomas en la epidermis adaxial. Este modelo revela un mecanismo economizador de agua típico, que probablemente interfiere con la absorción de nutrientes aplicados en las hojas.

Introduction

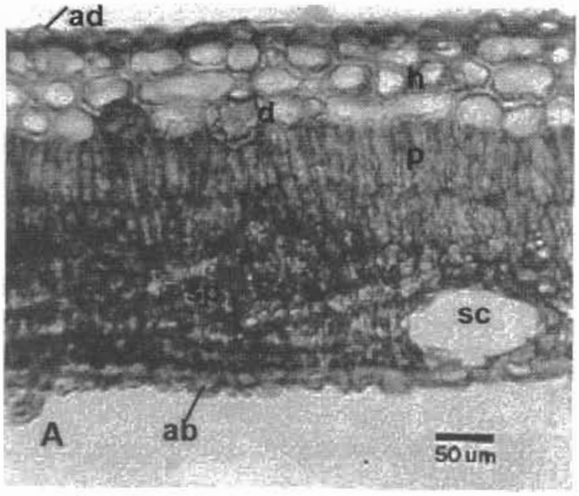
The culture of guava (*Psidium guajava* L.) a tropical fruit to be consumed *in natura* or processed, is expanding in Brazil. Phosphorus fertilizers applied to the soil have little impact on fruiting perennial plants (Natale *et al.*, 1999). Spraying with chemicals to control diseases and pests is a common practice and as in several other crops, addition of nutrients has been considered. The phosphorus applied in leaves is rapidly absorbed and metabolized (Boyton, 1954; Barel & Black, 1979). However, studies made with ^{32}P showed that only 12% of the applied P were absorbed by guava's leaves, and of this 20% of which were redistributed to the younger parts (Natale *et al.*,1999). When N, P, K were applied in guava's leaves, only the N effect was observed (Arora & Singh, 1970).

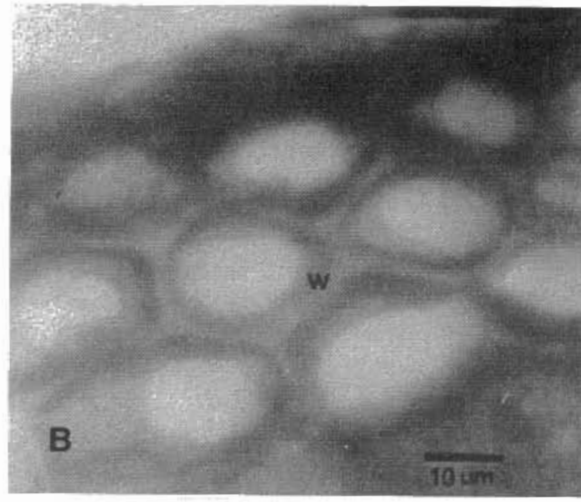
As a comparison, in bean leaves, 52% of the applied phosphorus was absorbed in 24 h (Boaretto *et al.*, 1984), and in sugarcane, 53.8% are absorbed in 2 days (Boaretto & Muraoka, 1989). In cotton, ^{32}P sprayed in leaves was absorbed and redistributed in 5 days (Laca-Buendia, 1989), and in coffee, the spraying of triple superphosphate in leaves was as efficient as the simple superphosphate applied on the projection of the cup (Barros *et al.*, 1984).

In xerophytic *Helianthus* species water consumption and dry matter production are highly linked and related to foliar structures (Blanchet & Gelfi, 1980).

Sprayed P in pineapple was more efficient absorbed by the leaves than by the roots or the axilary buds (Bader, 1970). The observation of pineapples leaves revealed the presence of stomata and trichomes only in abaxial epidermis (Giacomelli, 1982).

A possible cause for the constraint in P absorption may be linked to the foliar anatomy. This possibility was analyzed by light (LM) and scanning microscopy (SEM).





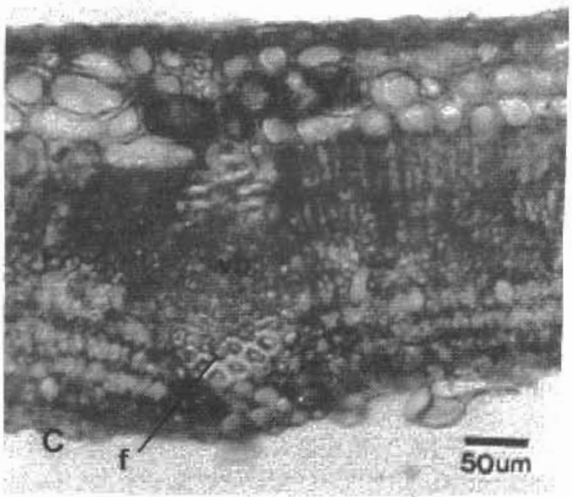


Fig. 1: A: *Cross section of leaf laminae of* P. guajava *showing the abaxial (ab) and adaxial epidermis (ad), the hypodermis (h), the palisade parenchyma (p), the spongy parenchyma (sp), a druse (d) and a secretory cavity (sc).* **B:** *Detail of the hypodermics cells with thickened secondary walls (w).* **C:** *Vascular bundle (vb) and fibres (f).*

Material and Methods

Light microscopy

For LM, twenty full developed cv.' Paluma' guava leaves (thirty pair below the shoot apex) were fixed in formaldehyde - acetic acid - ethanol (FAA) for 24 h at room temperature and transversally cut by hand, mounted in slides with water-glycerol (1:1), protected by a cover slip, examined and photographed in a Docuval Photomicroscope.

Scanning Electron Microscopy

For SEM, leaves were fixed in 3% glutaraldeyde in 0.05 M potassium phosphate buffer pH 7.4, for 48 h at 10°C, post-fixed with 1% OsO_4 in the same buffer and temperature for 24 h, dehydrated in graded ethanol series, critical point dried with CO_2, mounted in stubs, and sputter-coated with gold-palladium (Santos, 1995). Examinations were made in a JEOL JSM 25 SII microscope using 12.5 kV as accelerating voltage.

Results

Cross sections of the leaf lamina showed below the adaxial epidermis a hypodermis formed by three layers of cells with thickened cell walls and containing occasional druses. The adaxial and the abaxial epidermis have only a single compact layer of tabular cells devoid of intercellular spaces and covered by a thick cuticle. Mesophyll is composed by several layers of palisade parenchyma below the hypodermis, with few layers of spongy parenchyma. Essential oil cavities are present near the abaxial epidermis (Fig. 1 A, B). Xylem and phloem are arranged in collateral bundles with several fibers with thickened secondary cell walls (Fig. 1C). This anatomical pattern is according to that described by Accorsi *et al.* 1960.

SEM examination of the guava's leaves surfaces indicated a high density of stomata in abaxial epidermis (Fig 2 B-D), while the adaxial epidermis is completely devoid of stomata or trichomes (Fig. A). These stomata were of paracytic type, with kidney-shaped guard cells, elevated in relation to the ordinary epidermal cells (Fig. 2 D). A simple unicellular non-flattened hairs covers the abaxial surface of the guava's leaf (Fig. 2 B, C).

Pubescence is positively associated with harsh moisture regimes. Plants of deserts, steppes and alpine tundra show a high incidence of pubescence.

Plant hairs have been linked either directly or indirectly to increased water use efficiency. In some cases trichomes may retard transpiration through a boundary layer effect while in others they may increase it by participating as an additional evaporative surface (Johnson, 1975).

The structural characteristics of guava leaves are typical from xerophytes to adapt guava plants for conditions of high temperature and drought. Such water economy mechanism possibly contribute to reduce the efficiency of the absorption of nutrients by foliar application. As the phosphorus was applied in the adaxial surface of the guava's leaves the stomata absence, thick cuticle, hypodermis with thickened cell walls and several layers of palisade parenchyma, possibly contribute to the low P absorption observed in guava's leaves.

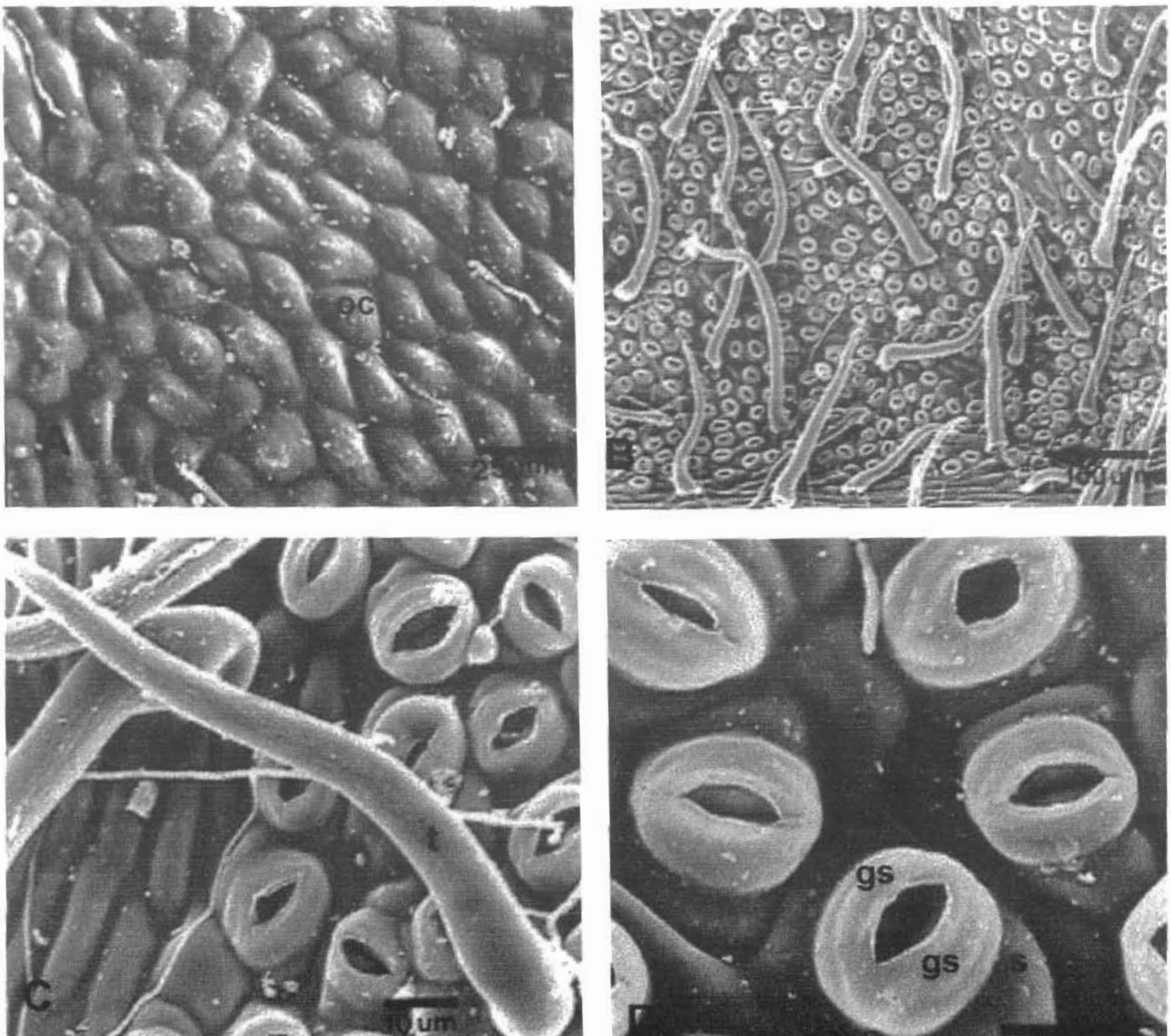


Fig. 2: *Electron micrographs of leaf surface of* P. guajava. **A:** *Adaxial surface showing ordinary cells (oc).* **B:** *Abaxial epidermis with high density of stomata and trichomes.* **C:** *Detail of a trichome (t).* **D:** *Stomatal apparatus: guard cells (gs) and subsidiary cells (s).*

References

Arora, J.S. & Singh, J.R. (1970) Effect of nitrogen, phosphorus and potassium sprays on guava (*Psidium guajava* L.). Jour. Japan. Soc. Hort. Sci.,39(1):55-62.

Bader, J.C. (1970) Ananazeiro- Alguns aspectos da sua utilização. Gazeta Agrícola de Angola, 15(12): 873-875.

Barel, D. & Black, C.A. (1979) Foliar application of P. I. Screening of various inorganic and organic P compounds. Agronomy Journal, 71:15-21.

Barros, V.V., Santinato, R. Figueiredo, J.P., Silva, O.A. (1984). Modo de adubação e fornecimento de fósforo ao cafeeiro em produção. In: Congresso Brasileiro de Pesquisas Cafeeiras. 11°. Londrina, p. 98-100.

Boaretto, A. E., Muraoka, T. (1989). Absorção e translocação de fósforo (^{32}P) aplicado via foliar em cana-de-açúcar (*Saccharum officinarum* L.). Científica, 17(1):35-42

Boaretto, A. E., Muraoka, T., Rosa, J .P. P. (1984). Absorção foliar de fósforo pelo feijoeiro: Efeito de fontes e doses de uréia e sacarose. In: Seminário Regional Sobre Técnicas Nucleares na Produção de Plantas Agrícolas, Piracicaba, Anais, p.125-131.

Boyton, D. (1954) Nutrition by foliar application. A. Rev. Pl. Phisiol., 5:31-54.

Giacomelli, J. (1982) Expansão da abacaxicultura no Brasil Campinas, Fundação Cargill.

79p.

Laca-Buendia, J.P. (1989) Adubação foliar em algodão. In: Simpósio brasileiro de adubação foliar. 2°, Botucatu, SP, p.417-497.

Natale, W., Boareto, A.E., Muraoka, T. (1999). Absorption et redistribution de ^{32}P appliqué sur feuille de goyavier. Fruits, v. 54(1), p. 23-29.

Santos, J.M. (1995) Microscopia Eletrônica de Varredura Aplicada às Ciências Biológicas. Jaboticabal: FUNEP, 27 p. (Mimeogr.)