TRATAMIENTOS Y TECNOLOGÍAS POSTCOSECHA PARA LA FRUTA FRESCA

La calidad como punto de partida: prácticas precosecha

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- **La calidad** final de un **fruto** se prepara en **el campo** donde, durante todo el período vegetativo, está sometido a una serie de factores intrínsecos y extrínsecos que lo afectan de distinta manera, según el momento en que se producen y la forma como actúan.

- Las tecnologías postcosecha son las técnicas de conservación orientadas a frenar el deterioro de los productos hortofrutícolas con el fin de mantener su calidad durante el tiempo deseado, pero la respuesta a estas tecnologías depende en gran medida de la calidad inicial del fruto, asociada a los diferentes **tratamientos precosecha.**

- **La calidad y el estado general de los productos frescos no pueden mejorarse después de la cosecha.**

- El valor final potencial de mercado del producto dependen de las decisiones del agricultor sobre qué y cuándo plantar y de los procedimientos de cultivo y de recolección subsiguientes.

- La adopción tras la cosecha de las prácticas adecuadas pueden prolongar la vida útil de las frutas y las hortalizas, pero sólo en la medida en que lo permitan su calidad y su estado en el momento de ser recolectadas.

Factores precosecha que inciden en la calidad de los productos hortofrutícolas

- Son muy diversos e interrelacionados. Unos dependen intrínsecamente de la propia planta y consisten en la integración del **flujo de energía**, **agua** y **nutrientes** y otros son de tipo **genético**, **ambiental** y de **cultivo**.

- El interés científico y las repercusiones económicas sobre el sector agroalimentario han motivado que se dedicara una especial atención al estudio de los **factores precosecha** que **afectan a la calidad** y su repercusión sobre la **conservación de frutas y hortalizas**.

- A pesar de la amplia bibliografía que se dispone, los **resultados son contradictorios**, tal vez debido a la complejidad y a los **múltiples factores que inciden sobre la composición química del fruto**.

Composición química del fruto

- Determina su **calidad sensorial y nutricional**
- **Comportamiento del fruto durante la postrecolección.**
- Regula el **desarrollo de desórdenes fisiológicos** durante la conservación frigorífica

↓

Calidad, y a la **vida comercial útil**.

Factores genéticos

El **genoma** es responsable del **funcionamiento de la planta** en relación con las **condiciones medioambientales.** Obtener frutos de calidad depende en definitiva del comportamiento de **una variedad en un medio externo determinado**

la **selección varietal** es esencial, ya que la obtención de un fruto de calidad dependerá de su potencial genético y de las condiciones ambientales y de cultivo.

Las técnicas de **biología molecular** se han convertido en una alternativa, complementaria a la genética clásica, para mejorar los atributos de calidad y prolongar la vida comercial útil en poscosecha

La variabilidad genética de un cultivar, dentro de una misma especie, es relativamente amplia, por lo que la **selección** de la más apropiada es de vital importancia para la calidad del producto final.

Factores Fisiológicos

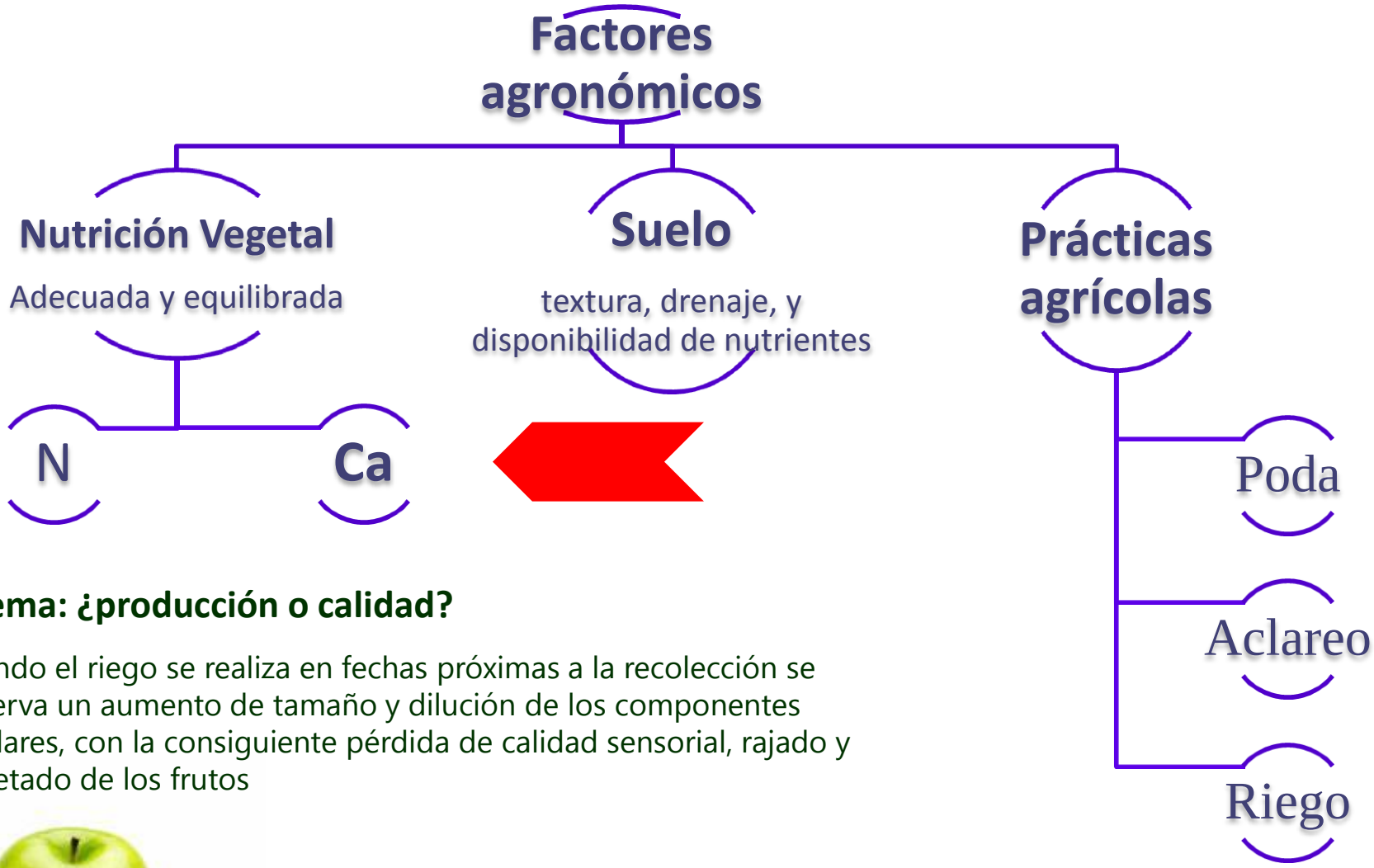
El **estado de madurez** tiene un papel esencial en la composición química del fruto y en sus atributos de calidad.

Frutos Climatéricos mayor potencial para su regulación y posibilidad de continuar el proceso una vez recolectados, siempre y cuando hayan adquirido la "capacidad para madurar".

En la mayoría de los frutos, **no** se han podido establecer

"**índices de madurez**" que permitan determinar el momento de recolección.

Frutos no climatéricos la posibilidad de actuación es muy limitada, ya que carecen de esta capacidad y deben recolectarse cuando han alcanzado su calidad de consumo.



Dilema: ¿producción o calidad?

Cuando el riego se realiza en fechas próximas a la recolección se observa un aumento de tamaño y dilución de los componentes celulares, con la consiguiente pérdida de calidad sensorial, rajado y agrietado de los frutos

Factores ambientales

Luz

Intensidad y calidad

Temperatura

Tª alta precosecha

CO_2

ambiental

El cambio climático

- **Aumento de las temperaturas**, variable en función de reducción de gases de efecto invernadero.
- Irregularidad de las **precipitaciones**, las áreas tropicales tendrán más lluvia pero las latitudes medias menos.
- Reducción de las capas de **hielo** en glaciares continentales y Ártico.
- Subida generalizada del **nivel del mar**, será severa en el Atlántico Norte.

- En **España** se prevén una **disminución de las precipitaciones**, **olas de calor, sequías y progresivo aumento de las temperaturas**

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Impact of Climate Change and Globalisation on Safety of Fresh Produce
Governing a Supply Chain of Uncompromised Food Sovereignty

Alertas en seguridad alimentaria, pero

¿cual es o será su influencia en la producción y en su calidad?

Respecto a la producción de fruta los riesgos del Cambio Climático Global comprenden alteraciones en:

- Requisitos de frío invernal
- Fechas de floración
- Riesgo de heladas
- Duración de la estación de cultivo
- Estado de maduración y fechas de recolección
- Necesidades hídricas
- Susceptibilidad al ataque y transmisión de patógenos

Será preciso adaptar las prácticas culturales:

- Selección de nuevos cultivares y carga de cosecha
- Elección de las parcelas de cultivo en terrenos más altos
- Tasas y procedimientos de fertilización
- Sistemas y tasas de riego
- **Preparar el fruto, durante su desarrollo, para su adecuada madurez y mejor vida postcosecha (nutricional y sanitaria).**

Ca

¿Por qué el Calcio?

¿por qué en aplicación foliar en *sspp* leñosas?

Algunos ejemplos…

Importancia del calcio en la nutrición de frutales

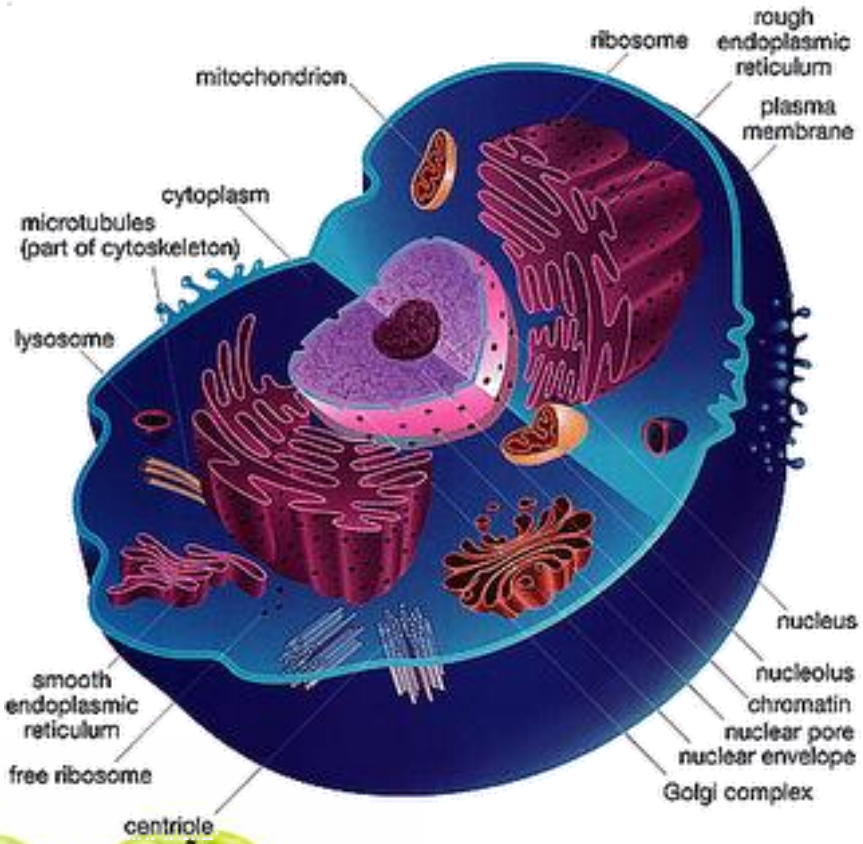
- Las aspersiones de Ca, especialmente como cloruro o nitrato, se recomiendan y aplican en todo el mundo como medida de protección rutinaria para evitar la deficiencia localizada de Ca en el fruto y mejorar así su calidad.

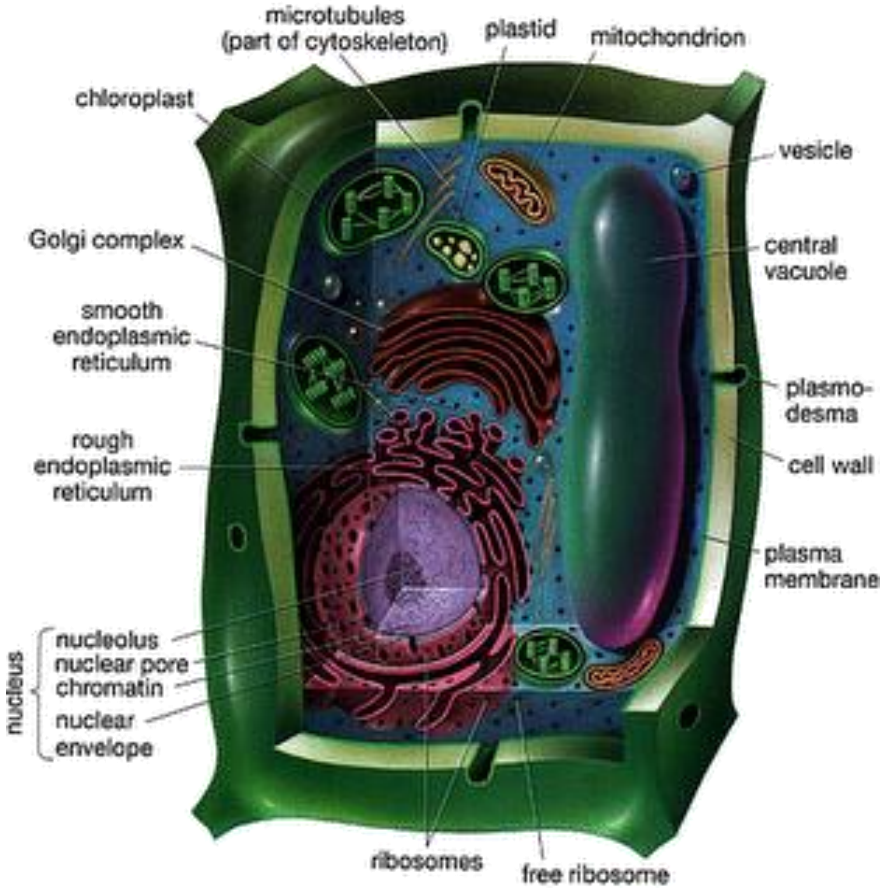
- El Ca aplicado a las hojas no se transporta al fruto y, por lo tanto, no contribuye a un aumento apreciable del Ca en este órgano (Kohl, 1966).

- Es preciso aplicar el Ca directamente a la superficie del fruto.

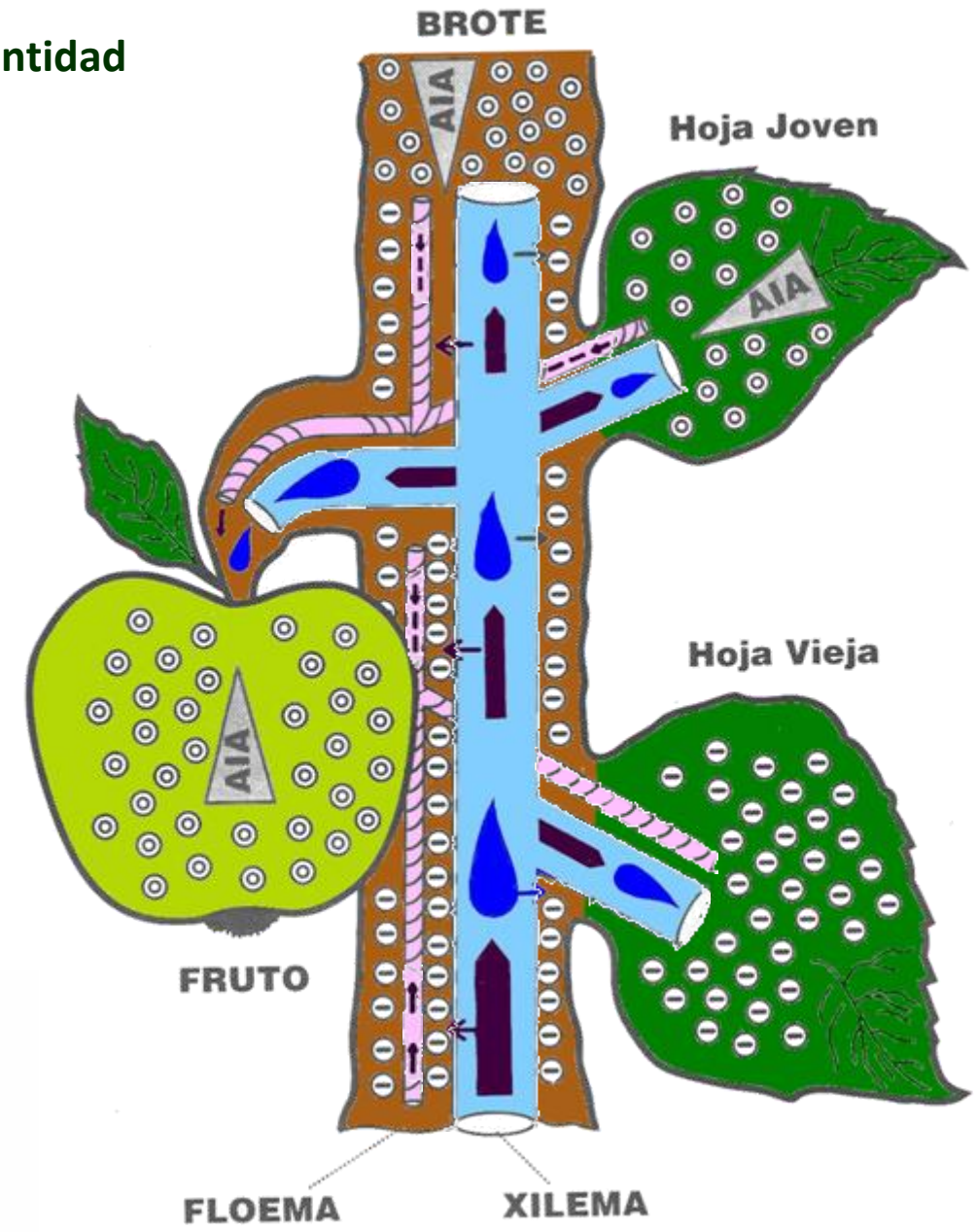
¿Por qué es importante el Calcio?

- Active role in cell growth and integrity of cell wall and plasma membranes.
- Cell division and new cells structures.
- Acts as cofactor and modulator in a high number of enzymatic reactions.
- Alleviates stress and protects against ROS.
- Gives consistency and quality to fruits through “protopectine” helping conservation along storage processes.
- It becomes human food on fruits.
- Makes easier other nutrients absorption and regulates nitrogen uptake allowing sugars and proteins movement within the plant.
- Regulates water flow.
- Correct acidity on the soil improving its properties (structure, labour, irrigation, etc).
- Corrects salinity on certain sort of soils (saline-sodic).


mitochondrion
ribosome
rough endoplasmic reticulum
plasma membrane
cytoplasm
microtubules (part of cytoskeleton)
lysosome
nucleus
nucleolus
chromatin
nuclear pore
nuclear envelope
Golgi complex
smooth endoplasmic reticulum
free ribosome
centriole


microtubules (part of cytoskeleton)
plastid
mitochondrion
chloroplast
vesicle
Golgi complex
central vacuole
smooth endoplasmic reticulum
plasmo-desma
rough endoplasmic reticulum
cell wall
plasma membrane
nucleus
nucleolus
nuclear pore
chromatin
nuclear envelope
ribosomes
free ribosome

El fruto recibe una cantidad mínima de Ca



Ca

Ca

Ca

Calcio y calidad de fruto

Year 1975

36

Calcium Related Physiological Disorders of Fruits and Vegetables

Calcium-related Disorders of Fruits and Vegetables[1]

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C. B. Shear

Calcium is the fifth most abundant element in the earth's crust, accounting for more than 3% of its composition. The exchangeable Ca content of a "normal" soil ranges from 65 to 85% of its total exchange capacity (12). Leaves of dicotyledonous plants generally contain from 0.5 to 5.5% Ca on a dry weight basis (44). The aboveground woody portions of trees in a 36-year-old apple orchard (35 trees per acre) contain about 200 lb. of Ca/acre as compared to about 175 lb. of all other nutrient elements combined (98). Recognizable foliar symptoms of Ca deficiency are seldom observed on field-grown fruit or vegetable crops. Despite these facts, serious economic losses occur annually from physiological disorders resulting from an inadequate level of Ca in the fruits, storage roots, or tubers of many plants or to the heart leaves of cabbage, lettuce, and other compact leafy vegetables.

Bitter pit (BP) of apples, blackheart of celery, and blossom-end rot (BER) of tomatoes have been recognized as physiological disorders since the middle of the 19th century, but only in 1936 for BP (14), 1944 for BER (74), and 1954 for blackheart of celery (26) was an inadequate level of Ca in affected parts implicated in any of these diseases.

The list of disorders now recognized as associated with a localized inadequacy of Ca includes BP (14, 17), cork spot (81), cracking (80), internal breakdown (5, 69), Jonathan spot (4), lenticel blotch (69, 75), lenticel breakdown (69), low temperature breakdown (101), senescent breakdown (54, 69), and watercore (69) of apples; end spot of avocados (35); hypocotyl necrosis of beans (79); internal browning of Brussels sprouts (56, 65); internal tipburn of cabbage (58) and of chinese cabbage (41); cavity spot and cracking of carrots (59); blackheart of celery (26); cracking of cherries (10, 92); blackheart and tipburn of chicory (97); brownheart (57) and tipburn of escarole (57); tipburn of lettuce (90); soft nose of mango (104); cavity spot of parsnips (33); poor filling of peanuts (7); cork spot of pears (102); blossom-end rot of peppers (36, 62); sprout failure (94) and tipburn (48) of potatoes; cracking of prunes (13); leaf tipburn of strawberry (53); black seed (20), blossom-end rot (21, 55, 64, 74), and cracking (15) of tomatoes; and blossom-end rot of watermelons (95).

Insufficient knowledge of factors affecting uptake and translocation of Ca by plants and of specific functions of Ca in metabolism have slowed progress towards understanding and controlling these and perhaps in recognizing other Ca-related disorders. Over the years, almost every environmental component and cultural practice has been shown to either aggravate or ameliorate these disorders. A chronology of the accumulation of these apparently unrelated bits of information and the eventual demonstration that each can be related in some way to Ca nutrition of affected tissue presents a unique example of interpretive synthesis in the unraveling of an intricate problem. As with any problem, the answer, once in hand, seems obvious.

I first will discuss those conditions that have been considered causes of, or agents in, the development of one or more of these Ca-related disorders. Then I will show how each condition is related to some aspect of Ca nutrition and assign each a logical position in the etiology of the disorders.

CONDITIONS INFLUENCING THE DISORDERS

Moisture

The first-described apple-spot disease now classified as a corking disorder was probably BP which, though probably recognized much earlier, was scientifically discussed as "Stippen" by Wortman in 1892 (103). He attributed the disease to abnormal transpiration. Later, McAlpine (60) thought the disease was produced by a shortage of water in the affected tissue as a result of either excessive transpiration or of too rapid growth. In 1918, Brooks and Fisher (9) reported cork spot (York spot), BP, Jonathan spot, and drought spot (probably B deficiency) all associated with irregular water supply. They concluded that late-season irrigation over-stimulated fruit growth, thus increasing susceptibility to pitting. Much work, both before and after that of Brooks and Fisher implicated excess moisture in the development of corking, though the evidence favored the drought theory (22, 31).

Low soil moisture was long considered the most important factor in the development of BER of tomatoes (89) though Stout (88) demonstrated that excessive watering also could promote its incidence. He concluded that over-watered plants were suffering from water stress induced by poor aeration. Similar conclusions were reached as to the effects of moisture fluctuations on blackheart of celery (11, 34), tipburn of lettuce (91), and internal browning in Brussels sprouts (56).

Other ambient conditions that affect the water relations within the plant have been shown to influence these disorders. Gerard and Hipp (30) showed that vapor-pressure deficits above 14-15 mm of Hg induced BER in 'Chico' tomatoes. McAlpine (61) considered excessive transpiration to be responsible for the greater prevalence of BP in arid Australia than in humid England. Geraldson (26) suggested that high temperatures, through their effects of increasing transpiration, might be partially responsible for the high incidence of blackheart in greenhouse-grown celery. Tibbitts and Rao (91) cited several investigations that have implicated high temperatures in the induction to tipburn of lettuce.

Light

Light intensity also has been related to the incidence and severity of these disorders. Wallace (93) reported higher incidence of BP in apples grown in exposed positions on the tree. Jackson et al. (42) showed that artificially imposed shade reduced the incidence of BP on 'Cox's Orange Pippin' apples. Tibbitts and Rao (91) increased the severity of lettuce tipburn with increased light intensities and/or extended light duration. Wedgeworth et al. (96) reported reduced BER of tomatoes with shading.

Solution concentration

Increasing the osmotic concn of the nutrient solution induced BER of tomatoes (76). Fruit on plants grown in solutions having an osmotic pressure of 0.08 atm was free of BER, but 80% of the fruit on plants grown at concn above 1.70 atm developed the disorder. Hori et al. (41) reported this effect of high salt concn on the incidence of blackheart of cabbage also.

[1] Received for publication February 18, 1975.
[2] Fruit Laboratory, Agricultural Research Service, Beltsville, MD 20705.

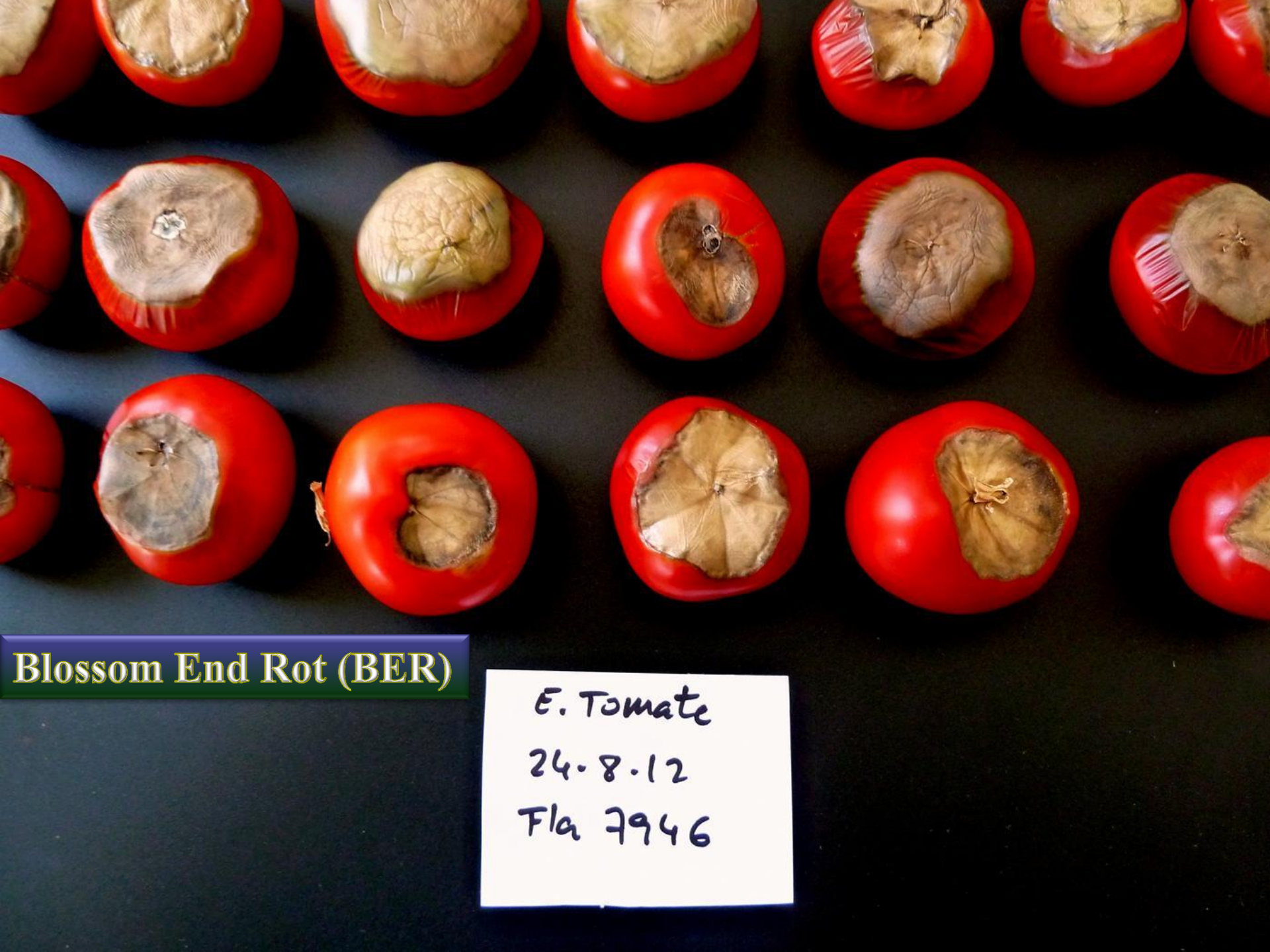
Alteraciones fisiológicas relacionadas con Ca

- Even with a good calcium content in the soil it can be blocked for the absorption by the plant, or once inside the plant may not be used correctly
- It’s an element with low mobility (passive transport) depending on transpiration gradient and photosynthetic activity
- Calcium plays a very important role in membrane structure
- When there is a severe change in temperature, humidity, light conditions or any other sort of stress, transpiration process is more difficult and calcium is not transported to all the places where it is needed.

Alteraciones fisiológicas relacionadas con Calcio

Tipburn

Blossom End Rot (BER)



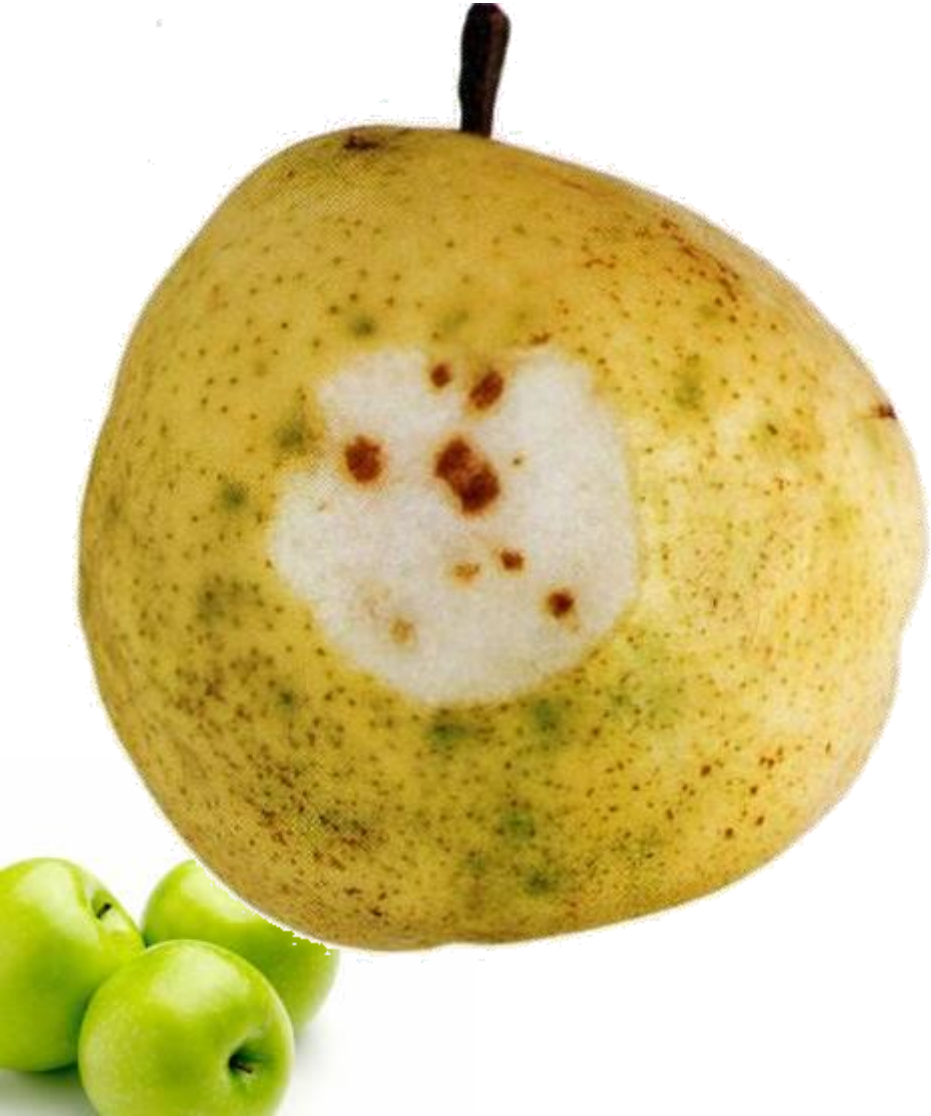
Blossom End Rot (BER)

Blossom End Rot (BER)

Blossom End Rot

Blossom end rot

Bitter pit o corky spot en peras



Plara

Síntomas. Manchas más o menos redondeadas situadas en el entorno de una lenticela, con dimensiones inferiores a 5 mm, deprimidas y localizadas, fundamentalmente en la zona calicina. Bordes perfectamente contrastados por el color marrón de la mancha. La lesión puede penetrar unos 3 mm con una textura seca y de color parduzco.

Causa. Desequilibrios de transpiración, aunque también se produce cuando el contenido de calcio en la piel del fruto es bajo.

Frecuencia. Característico en manzanas B. de Roma, Starking, King Davis y Golden Suprema. La anomalía se incrementa si después de periodos secos se producen lluvias abundantes.

Posible confusión. Con Bitter pit.

3 - plara
(Característico del Grupo
Red Delicious)

4 - plara intensa

Jonathan Spot

Mancha Vitrescente

Fisiopatías más habituales (Calciopatías)

- Blossom end rot (Tomato, Pepper, …)
- Vitrescencia (Melon, Apple, …)
- Tip Burn (Lettuce)
- Bitter pit (Apple)
- Cracking in Stone Fruit (Peach, Cherry, …) and citrus
- “Black Heart” in celery
- Senescency in flowers
- Vitrescent dark spot in peaches

- **La aparición de fisiopatías, como las descritas, deterioran la calidad organoléptica y estética del fruto y provocan graves mermas en la producción.**

- **El calcio es el elemento clave implicado en el desarrollo de este tipo de fisiopatías y, en general, en la calidad del fruto.**

- **Los tejidos vegetales con altos niveles de calcio entran más tarde en senescencia y son más resistentes, no solo a la incidencia de manchas corchosas, sino también al ataque de patógenos.**

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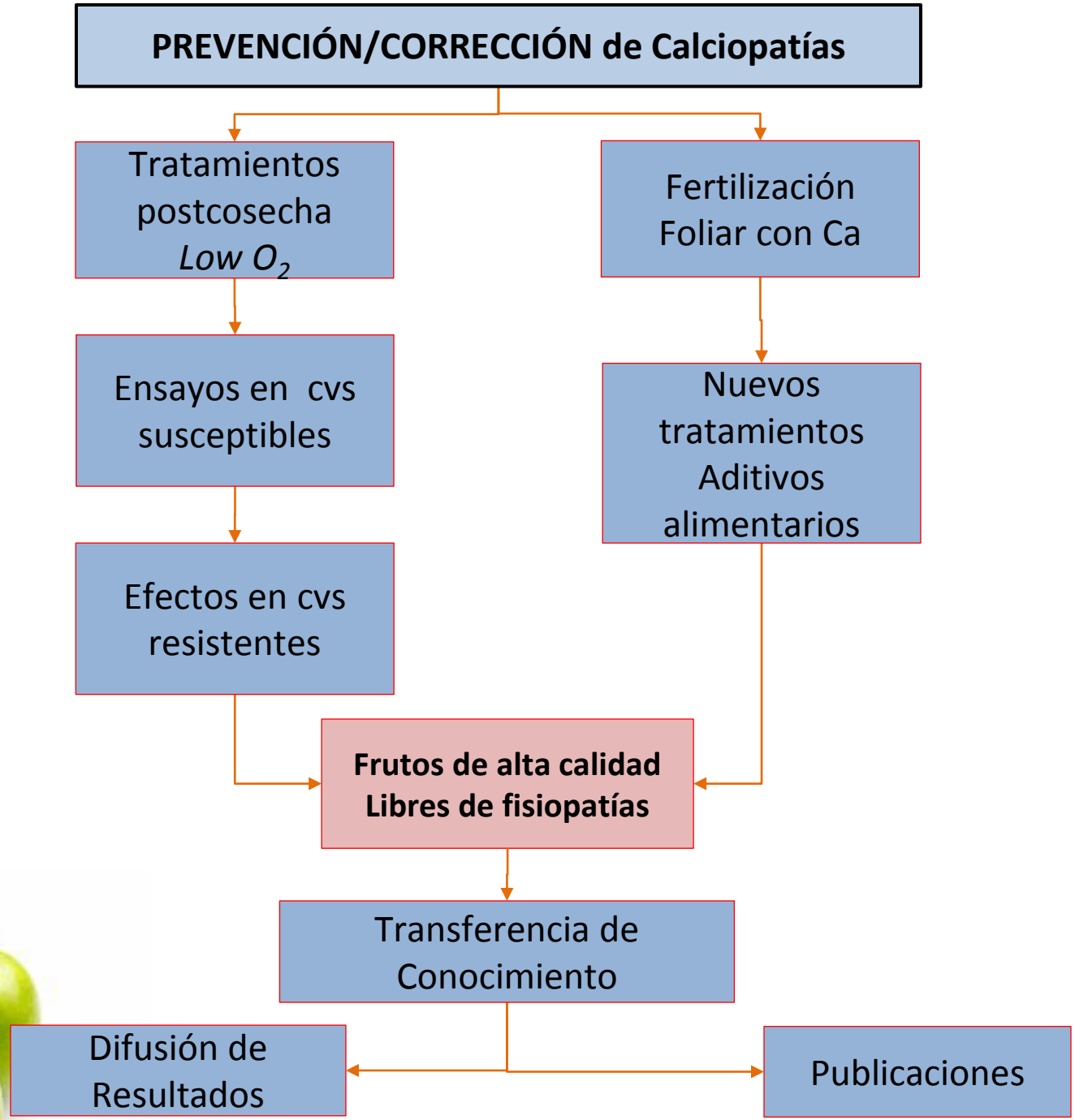
Nuevas estrategias para la fertilización cálcica de frutales

- ✓ We have developed procedures for modeling bitter pit development (i.e. Mg infiltration & oxalate injection)
- ✓ We have optimize methods for bitter pit prognosis
- ✓ We discovered a differentiated new population of starch grains
- ✓ We discovered a new 18 kDa protein in bitter pit tissues
- ✓ A novel method to reveal Calcium distribution in fruit has been published and patented
- ✓ **But, to be effective in apples, Calcium has to be applied at high rates (≥ 0.5%) which is phytotoxic**

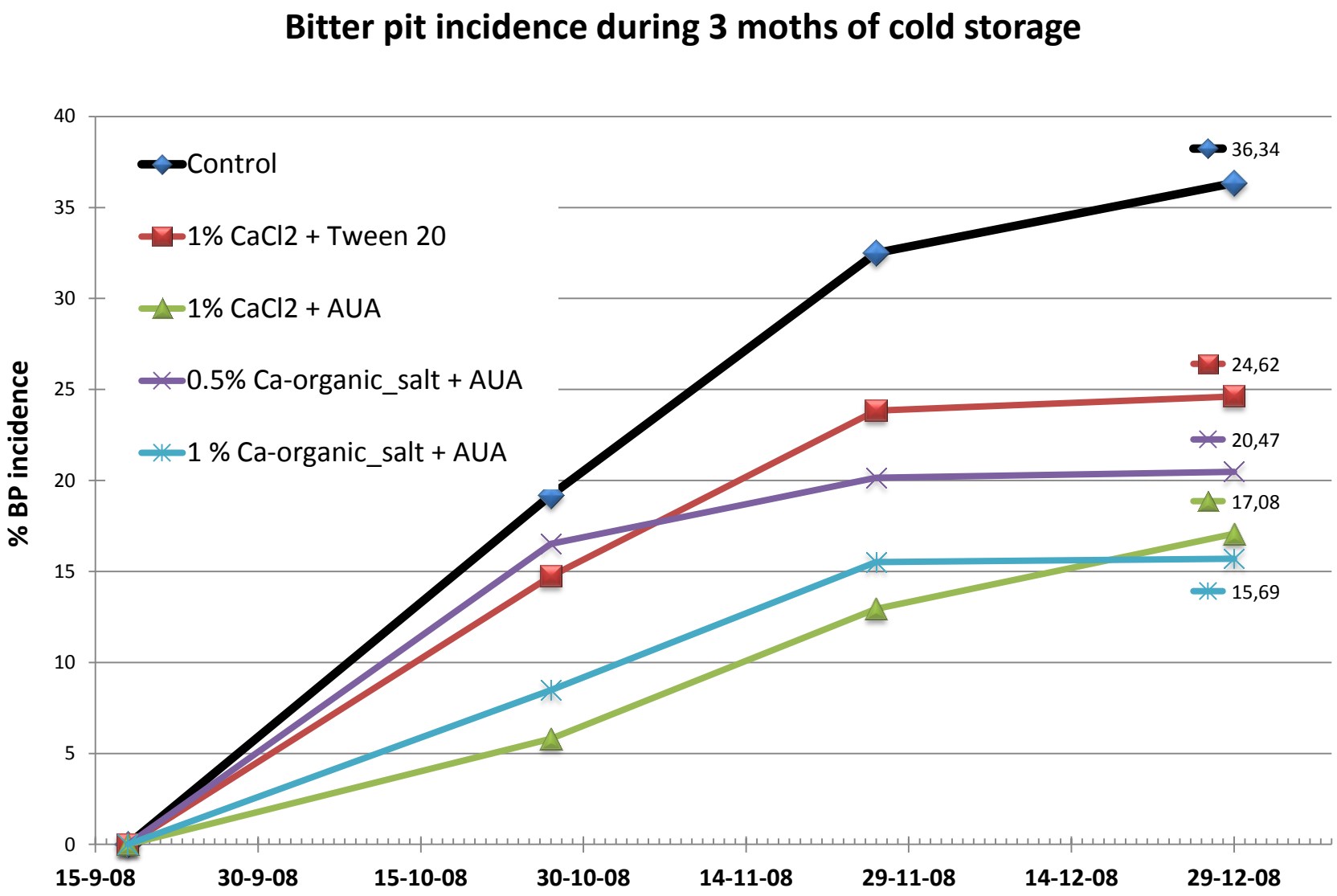
In summary:

- ✓ **It is a tough task to deal with Ca-related physiological disorders:**
- ✓ However, novel treatments with Polysaccharide food additives (**AUA**) plus **Ca**, seem promising in alleviating Ca-toxicity and permitting Ca-treatments increase fruit quality (patent pending procedures)


PREVENCIÓN/CORRECCIÓN de Calciopatías
Tratamientos postcosecha *Low* O_2
Fertilización Foliar con Ca
Ensayos en cvs susceptibles
Nuevos tratamientos Aditivos alimentarios
Efectos en cvs resistentes
Frutos de alta calidad Libres de fisiopatías
Transferencia de Conocimiento
Difusión de Resultados
Publicaciones

Nueva fertilización foliar con Calcio en manzano

Factor Clave: aditivos/coadyvantes


Bitter pit incidence during 3 moths of cold storage
% BP incidence
40
35
30
25
20
15
10
5
0
Control
1% CaCl2 + Tween 20
1% CaCl2 + AUA
0.5% Ca-organic_salt + AUA
1 % Ca-organic_salt + AUA
36,34
24,62
20,47
17,08
15,69
15-9-08
30-9-08
15-10-08
30-10-08
14-11-08
29-11-08
14-12-08
29-12-08

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Improving the performance of calcium-containing spray formulations to limit the incidence of bitter pit in apple (*Malus x domestica* Borkh.)

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ABSTRACT

Laboratory and field experiments were carried out with apples (*Malus x domestica* Borkh.) cv. 'Golden Reinders', to assess the efficacy of sodium salt of carboxymethyl ether of cellulose (0.5%, CMC) as an adjuvant for Ca spray formulations containing either Ca-chloride or Ca-propionate as active ingredient (120 or 250 mM Ca). This additive significantly increased the retention of Ca-containing solutions by the apple skin and prolonged the process of drying of the solution at room temperature. Four days after immersion of apples in 0.5% CMC plus $CaCl_2$ or Ca-propionate solutions (120 and 250 mM Ca) significant Ca increases were recorded in the peel and cortex of treated fruits. Application to apple trees of in-season sprays containing 250 mM $CaCl_2$ plus 0.05% Tween 20, Ca-propionate (120 and 250 mM Ca) plus 0.5% CMC or 250 mM $CaCl_2$ plus 0.5% CMC had no impact on fruit yield and quality, but significantly limited the rate of bitter pit incidence during the following 3-month cold-storage period. Evidence is provided that addition of appropriate adjuvants to Ca sprays can favour the distribution of Ca into the apple fruit and helps to reduce the incidence of Ca-related disorders over the postharvest cold-storage period.

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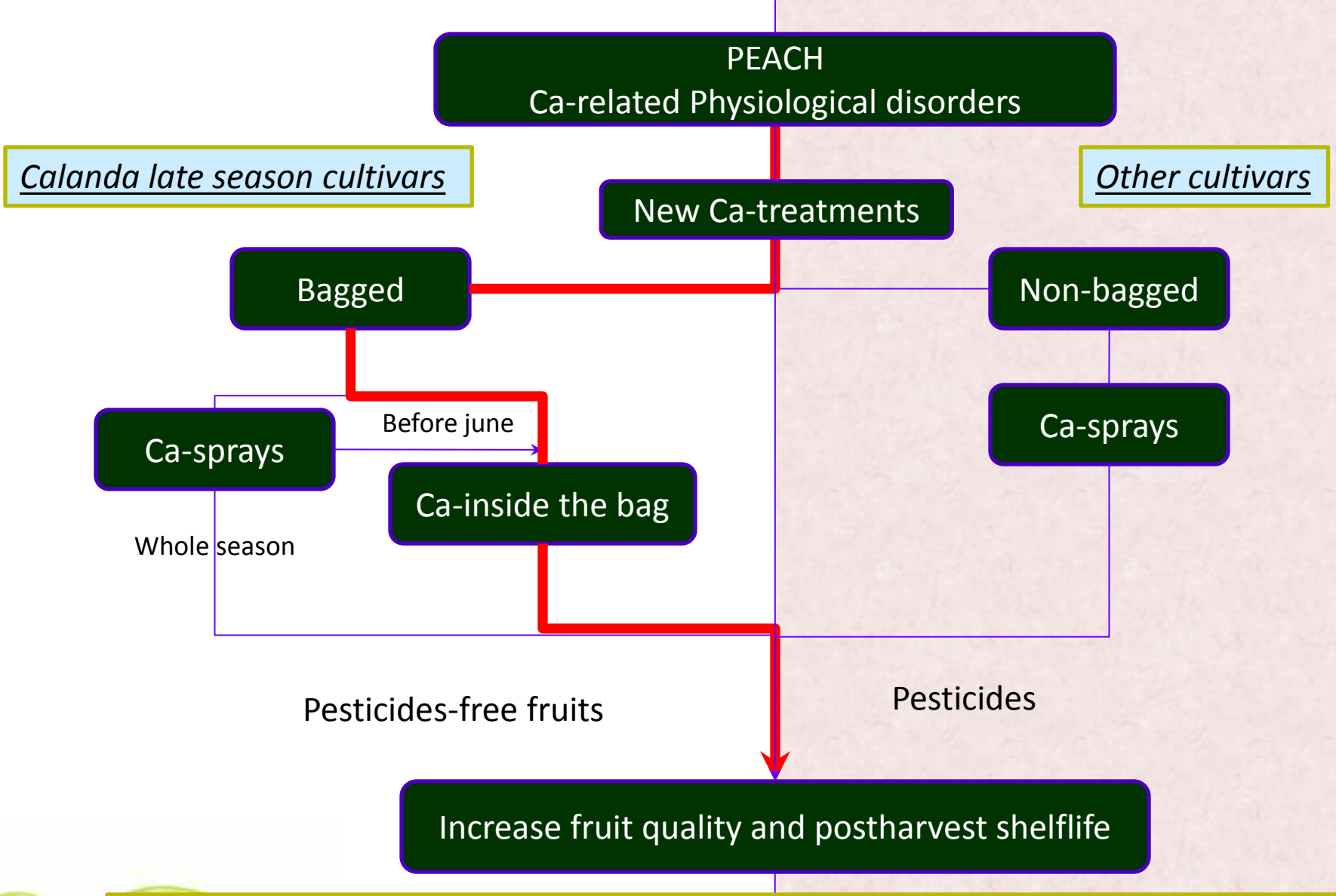
1. Introduction

Bitter pit remains as one of the main problems for apple growing industry around the world, particularly in areas where climatic conditions are generally dry. Such physiological disorder which develops during the period of fruit growth (Ferguson et al., 1999), has generally been related to calcium (Ca) deficiency in the fruit

The effects of in-season spraying and/or post-harvest dipping of apple fruits in Ca solutions have been evaluated in various studies in terms of e.g., bitter pit development, Ca content increase and improved fruit firmness. However, inconsistent results have been often reported (van Goor, 1971; Lidster and Porritt, 1978; Hewett and Watkins, 1991; Neilsen et al., 2005; Lötze and Theron, 2006; Lötze et al., 2008; Val et al., 2008). Recently, Val et al. (2008) showed

Tratamientos de Ca en *sspp* Hueso



Our Experience

- To be effective Calcium has to be applied at high rates (≥ 0.5%) which is phytotoxic.
- Polysaccharide food additives (AUA) plus Ca, alleviate Ca-toxicity and permit Ca-treatments increase fruit quality (patent pending procedures)
- New procedures have been developed both for pestice-free bagged fruits and traditionally cultured peach cvs.

Research Article

SCI

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Surface application of calcium-containing gels to improve quality of late maturing peach cultivars

Victoria Fernández, Azahara Díaz, Álvaro Blanco and Jesús Val*

Abstract

BACKGROUND: A strategy to supply Ca directly to fruits as a tool for improving peach quality has been devised and tested under field conditions. Since peaches in the area of study (Calanda, Spain) are routinely bagged shortly after thinning, a method based on the application of Ca gels to the fruit surface was introduced. The effect of surface treatments was assessed in terms of quality, nutrient balance and surface deposition.

RESULTS: Application of Ca-containing formulations increased mesocarp and exocarp Ca concentrations, providing evidence for the penetration of Ca through the peach skin. Surface Ca treatments had a particular mode of deposition and in some instances improved the shelf life of fruits without affecting their quality.

CONCLUSION: Surface treatment with Ca-containing gels appears to be a viable approach to increase fruit Ca, quality and storability of bagged peach cultivars and should be optimised in future studies.
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Keywords: adjuvants; calcium formulations; fruit quality; fruit surface; *Prunus persica* L. Batsch; surface treatments

D PROOFS

APLICACIONES DE CALCIO PARA ALIVIAR LOS DAÑOS POR FRÍO Y LA MANCHA VITRESCENTE

Table 5.- Evaluation of damages (vitrescent dark spot or browing) developing in 'Calrico' peaches after two weeks of cold-storage (0ºC). Trees were treated with multiple sprays of $CaCl_2$ and Ca propionate (0.5 % Ca) plus 0.05% Tween20, 0.05% Break Thru or 0.5% CMC during the growing season (2009). Values were averaged over Ca-treatment, Ca-compound and adjuvant levels. For each factor, means followed by different letters are significantly different (Duncan's multiple range test, $P \leq 0.05$, N= 40).

	Vitrescence		Browning	
Ca treatments	%	Index	%	Index
Untreated	74.38 a	41.10 a	43.75 b	15.0 b
Ca-treated	59.23 a	29.71 a	22.08 a	8.59 a
Ca- compound				
Ca-Propionate	67.28 a	34.13 a	23.75 a	10.63 b
$CaCl_2$	51.17 a	25.29 a	20.42 a	6.56 a
Adjuvant				
Tween20	64.40 a	35.09 b	32.50 b	13.28 b
CMC	51.81 a	21.84 a	19.38 ab	7.34 a
Break Thru	61.46 a	32.20 b	14.38 a	5.16 a

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In-season calcium-spray formulations improve calcium balance and fruit quality traits of peach

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Abstract

Experiments to evaluate the effect of in-season calcium (Ca) sprays on late-season peach (*Prunus persica* L. Batsch cv. Calrico) were carried out for a 2-year period. Calcium formulations (0.5% and 1.0% in 2008 and only 0.5% tested in 2009) supplied either as $CaCl_2$ or Ca propionate in combination with two or three adjuvants (0.05% of the nonionic surfactants Tween 20 and Break Thru, and 0.5% carboxymethylcellulose, CMC) were sprayed four to five times over the growing season. Peach mesocarp and endocarp Ca concentrations were determined on a 15-day basis from the beginning of May until the end of June. Further tissue analyses were performed at harvest. A decreasing trend in fruit Ca concentrations over the growing season was always observed regardless of the Ca treatments. Both in 2008 and 2009, significant tissue Ca increments associated with the application of Ca-containing sprays in combination with adjuvants were only observed in June, which may be coincident with the period of pit hardening. In 2008, both at harvest and after cold storage, the total soluble-solids concentration (° Brix) of fruits supplied with Ca propionate (0.5% and 1.0% Ca) was always lower as compared to the rest of treatments. The application of multiple Ca-containing sprays increased firmness at harvest and after cold storage, especially when $CaCl_2$ was the active ingredient used. Supplying the adjuvants Tween 20 and CMC increased fruit acidity both at harvest and after cold storage. Evaluation of the development of physiological disorders after cold storage (2 weeks at 0°C) indicated a lower susceptibility of Ca-treated fruits to internal browning. Fruits treated with multiple $CaCl_2$-, CMC-, and Break Thru®-containing sprays during the growing season were significantly less prone to the development of chilling injuries as compared to untreated peaches.

Key words: *Prunus persica* (L.) Batsch / fruit storage / physiological disorders / physiological calcium deficiency / foliar sprays

Accepted January 27, 2011

Nuevos tratamientos de calcio para mejorar las propiedades físicas y organolépticas del melocotón protegido bajo la denominación de origen «Melocotón de Calanda»

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Palabras clave
Análisis mineral, calcio, calidad de fruto, embolsado, goma tara, mancha vitrescente, microscopía electrónica, *prunus persica*.

The Effects of Ca Applications on Peach Fruit Mineral Content and Quality

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Keywords: calcium, Ca absorption, fruit physiopathologies, fruit quality, peach, *Prunus persica*

Abstract

Late season peach cultivars are usually cold stored for a few weeks to extend the marketing season, but physiological disorders related to calcium deficiency are now emerging. To study the absorption of Ca by the peach fruit, mature trees of two late-maturing cultivars: 'Miraflores' and 'Jesca' were treated with Ca applied in two different ways: either as foliar sprays of Ca water solutions, or rubbed on the fruit with a Tara gum gel containing the Ca solution. In both cases, the Ca source was $CaCl_2$. Repeated foliar sprays along the growing season, of aqueous solutions of Ca concentrations ranging from 0.25 to 1% Ca did not affect the concentration of Ca in the peach skin or fruit flesh. Similarly, no effects on the fruit quality traits were observed at harvest. In a second experiment, fruits were rubbed with a calcium containing gel. A great increase in Ca concentration was found both on skin and flesh of fruits treated with 1% Ca. However, fruits treated with 1% Ca resulted in lower flesh firmness and were flat-shaped and exhibited an increased rate in fruit drop.

INTRODUCTION

Late season peach (*Prunus persica* (L.) Batsch.) cultivars are becoming increasingly profitable in Spain. Thus, the marketing period is being expanded for several weeks, by storing the fruits under cold conditions. In certain areas like the "Bajo Aragón" (Teruel, Spain), these cultivars are grown in bags. This technique implies placing the fruits inside bags, usually in June, after fruit thinning, and leaving the fruits inside paper bags until harvest, for which the crops are sold as pesticide free.

Fruit physiological disorders are now emerging in late maturing cultivars, which deteriorate the quality of fruits, and economic losses are beginning to occur. The main disorder that appears, is vitrescent dark spot, and has rarely been described (Val, 2007). In short, areas of the fruit mesocarp become translucent, and this is accompanied by a darkening of the area, with no external symptoms which only become visible after fruit harvest.

The vitrescent dark spot observed in peaches is somehow similar to bitter pit, lenticel blotch pit and other physiological disorders of apples and other horticultural species, which have been related to calcium deficiency. In apple, Ca sprays have long been recommended to prevent the development of bitter pit and other disorders (Ferguson and Watkins, 1989; Saure, 2005) by increasing the concentration of Ca in the fruit flesh. However, little success has been achieved when spraying Ca to apple fruits and this has been recently related to the small, if any, absorption of Ca through the apple skin (Val et al., 2008).

Recent work has shown that the low efficacy of Ca applications may be due to difficulties of the chemicals in passing through the fruit cuticle. The penetration of Ca-salts is dependent upon its point of deliquescence (POD) (Schönherr, 2001). $CaCl_2$ is a Ca formulation with very low POD, for which is one of the best candidates to test the performance of Ca-treatments on peach fruits. Besides, Ca absorption is closely related to air humidity conditions, and these are usually very low under the Middle Ebro Valley

El mundo de los pelos del melocotón

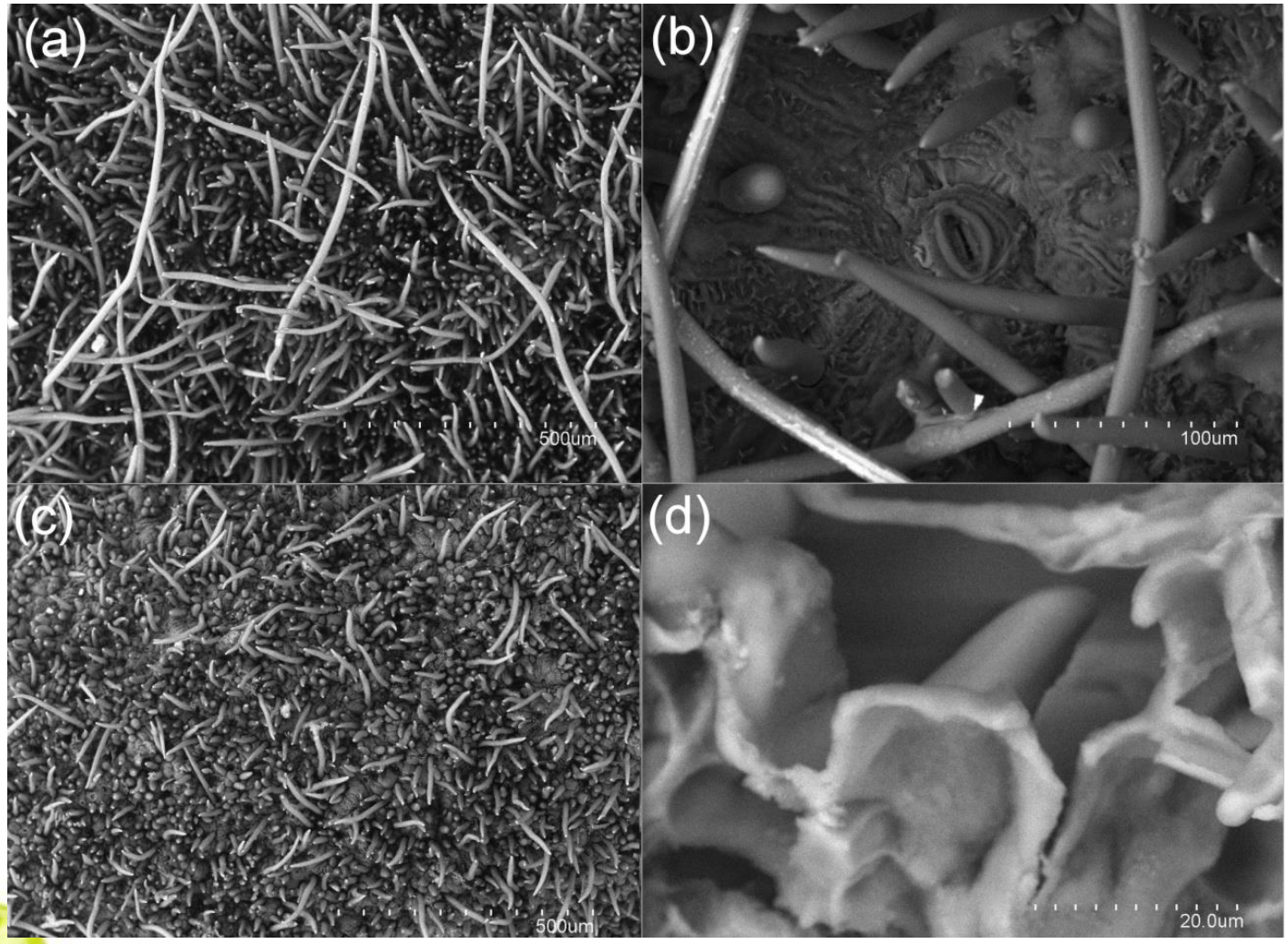

Fig Scanning electron micrographs of peach intact surfaces (a, b) and isolated cuticles. (a) intact peach surface (x100). (b) Stoma observed in an intact surface after the mechanical removal of trichomes (x450). (c) Upper surface of an isolated cuticle (x100). (d) Lower surface of an isolated cuticle (x2000).

Plant Physiology 2011

New Insights into the Properties of Pubescent Surfaces: Peach Fruit as a Model[1][OA]

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The surface of peach (*Prunus persica* 'Calrico') is covered by a dense indumentum, which may serve various protective purposes. With the aim of relating structure to function, the chemical composition, morphology, and hydrophobicity of the peach skin was assessed as a model for a pubescent plant surface. Distinct physicochemical features were observed for trichomes versus isolated cuticles. Peach cuticles were composed of 53% cutan, 27% waxes, 23% cutin, and 1% hydroxycinnamic acid derivatives (mainly ferulic and *p*-coumaric acids). Trichomes were covered by a thin cuticular layer containing 15% waxes and 19% cutin and were filled by polysaccharide material (63%) containing hydroxycinnamic acid derivatives and flavonoids. The surface free energy, polarity, and work of adhesion of intact and shaved peach surfaces were calculated from contact angle measurements of water, glycerol, and diiodomethane. The removal of the trichomes from the surface increased polarity from 3.8% (intact surface) to 23.6% and decreased the total surface free energy chiefly due to a decrease on its nonpolar component. The extraction of waxes and the removal of trichomes led to higher fruit dehydration rates. However, trichomes were found to have a higher water sorption capacity as compared with isolated cuticles. The results show that the peach surface is composed of two different materials that establish a polarity gradient: the trichome network, which has a higher surface free energy and a higher dispersive component, and the cuticle underneath, which has a lower surface free energy and higher surface polarity. The significance of the data concerning water-plant surface interactions is discussed within a physiological context.

Plant surfaces have a key role in the protection against abiotic stress factors, such as water losses, high densities of UV and visible radiation, or temperature extremes, but they are also crucial as a defense barrier against biotic threats, such as the attack of pathogens or herbivores (Jeffree, 2006; Stavrianakou et al., 2010; Xia et al., 2010).

The cuticle can be considered a cutinized cell wall, emphasizing the composite and heterogeneous nature of this layer and the physiologically crucial interaction between it and the cell wall underneath (Domínguez et al., 2011). This extracellular layer is composed of a polymer matrix with waxes embedded into (intracuticular) or deposited onto (epicuticular) the surface (Heredia, 2003). On the inner side of the cuticle, cutin is mixed with polysaccharide material from the epidermal cell wall (Domínguez et al., 2011). The cuticle matrix is commonly made of a biopolyester known as cutin, which is constituted by a network of cross-esterified, hydroxy C_{16} and/or C_{18} fatty acids (Kolattukudy, 1980; Domínguez et al., 2011). Cuticles from some species may

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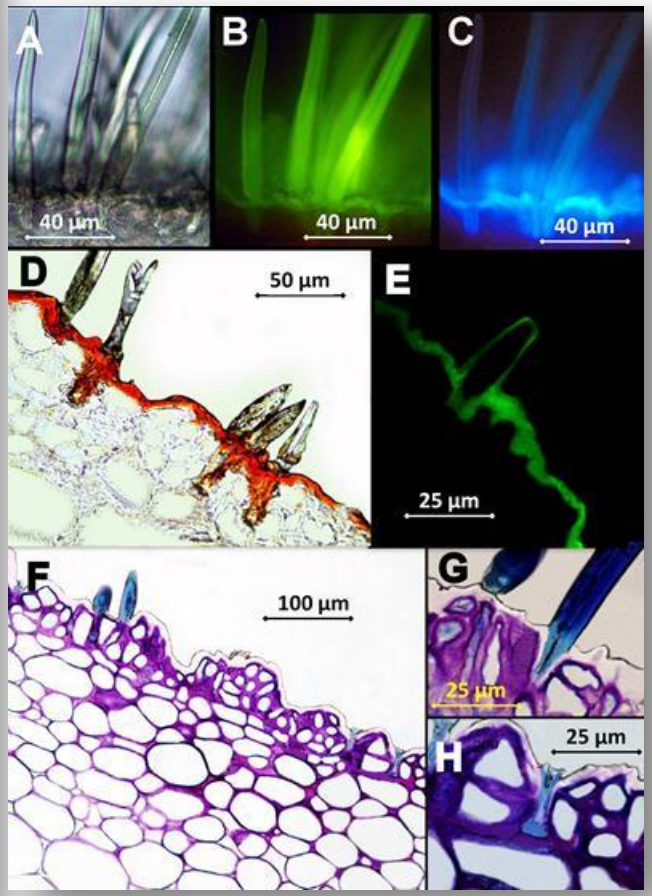

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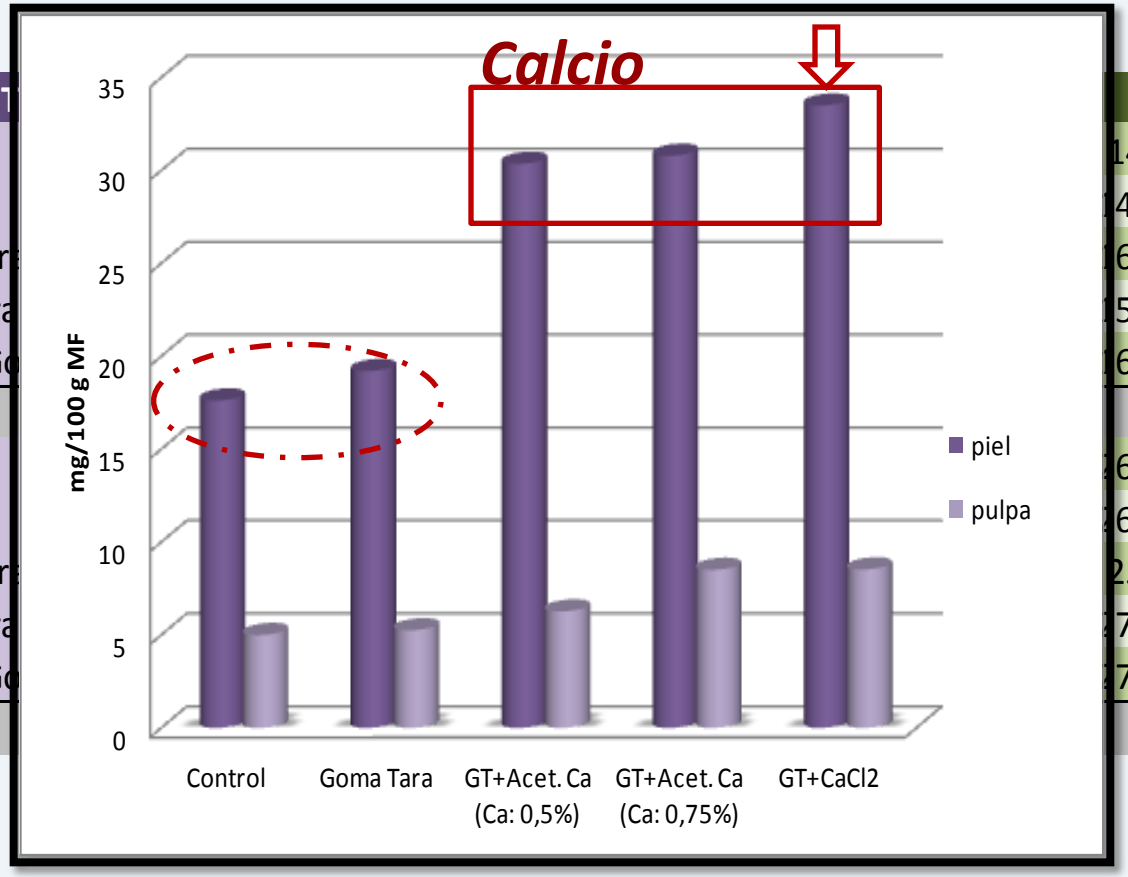

T	K
Goma Tar	146,46±6,55
Goma Tara	143,84±12,58
Go	169,16±40,72
	156,58±13,13
	167,88±11,03
	n.s.
Goma Tar	269,44±21,43
Goma Tara	264,86±30,88
Go	258,83±8,79
	275,45±14,83
	271,38±11,78
	n.s.

Aplicación Tratamientos con Calcio

Aumento concentración Calcio

CLORURO de Ca

Mayor firmeza

Mayor incidencia cracking

ACETATO de Ca

No aumento firmeza

Descenso “índice cracking”

Tratamientos físicos postcosecha para mejorar la calidad de la manzana Golden

M. Pérez[2], A. Diaz[1], A. Blanco[1], S. Remón[2] y J. Val[1]

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(www.interscience.wiley.com) DOI 10.1002/jsfa.3837

Low oxygen treatment prior to cold storage decreases the incidence of bitter pit in 'Golden Reinders' apples

Jesús Val,[a*] Victoria Fernández,[a] Paola López,[a] Jose María Peiró[b] and Alvaro Blanco[a]

Abstract

BACKGROUND: The effect of subjecting 'Golden Reinders' apples to a low O_2 pre-treatment (LOT; 1–2% O_2) was evaluated as a strategy to decrease the rate of bitter pit (BP) incidence after standard cold storage (ST). Immediately after harvest, apples were stored for 10 days at 20 °C under low O_2. Thereafter, apples were cold-stored (0–4 °C) for 4 months and changes were monitored in terms of BP incidence, fruit quality traits and mineral element concentrations.

RESULTS: After 4 months cold storage, LOT apples presented a 2.6-fold decrease in the rate of BP incidence (14%) *versus* the values obtained for standard cold-stored fruits (37% BP incidence). LOT increased flesh firmness, total soluble solids and titratable acidity as compared to the quality traits determined for cold-stored fruits. Lower cortex Ca and Mg concentrations as compared to ST apples were determined in association with LOT, 2 months after cold storage.

CONCLUSION: Application of a LOT prior to cold storage may be a promising strategy to reduce the incidence of BP and preserve fruit quality, which should be further investigated.
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Keywords: apple; bitter pit; calcium-related disorders; fruit quality; low oxygen; storage

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Bajo oxígeno, 20ºC, 10 días. (*Val et al., 2010)*

Smoothee Golden Delicious

- Se reduce el % de frutos afectados por bitter pit.
- Firmeza más alta, tras 4 meses de conservación en frio convencional.
- Coloración más brillante y amarilla
- Más alto su contenido en sólidos solubles.

De estos datos estos autores concluyeron que el pretratamiento a 20ºC y bajo oxígeno confirió a los frutos unas **características organolépticas y de calidad excepcionales.**

20/01/2009
Cold storage

Initial short term 20ºC + low oxygen treatment

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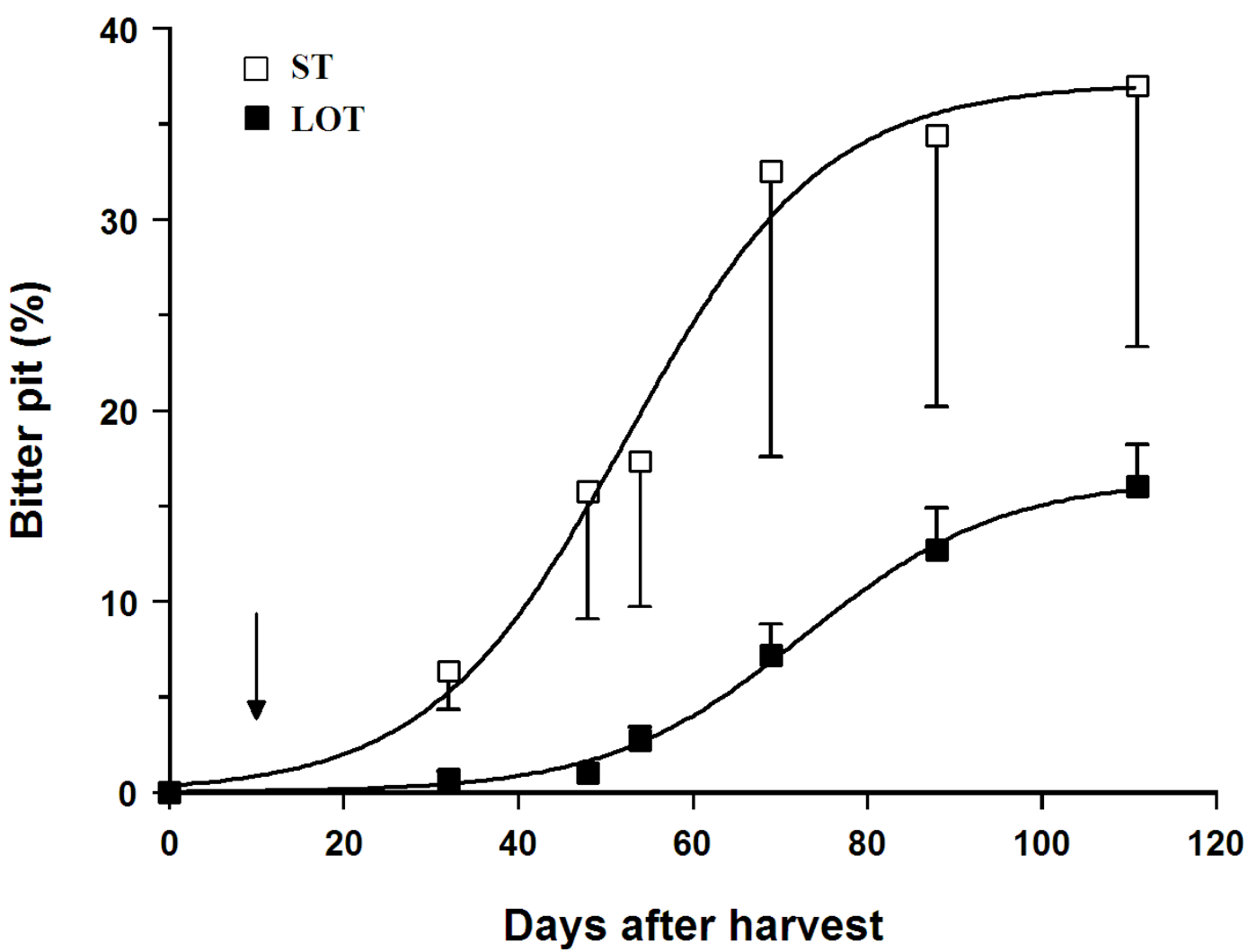

Figure 1. BP incidence during the cold storage period of 'Golden Reinders' apples. Fruits were either pre-treated at low O_2 and 20 °C for 10 days (LOT; end of treatment indicated by the arrow) or directly cold-stored (ST). Vertical bars are means ± SE.

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MATERIAL Y METODOS

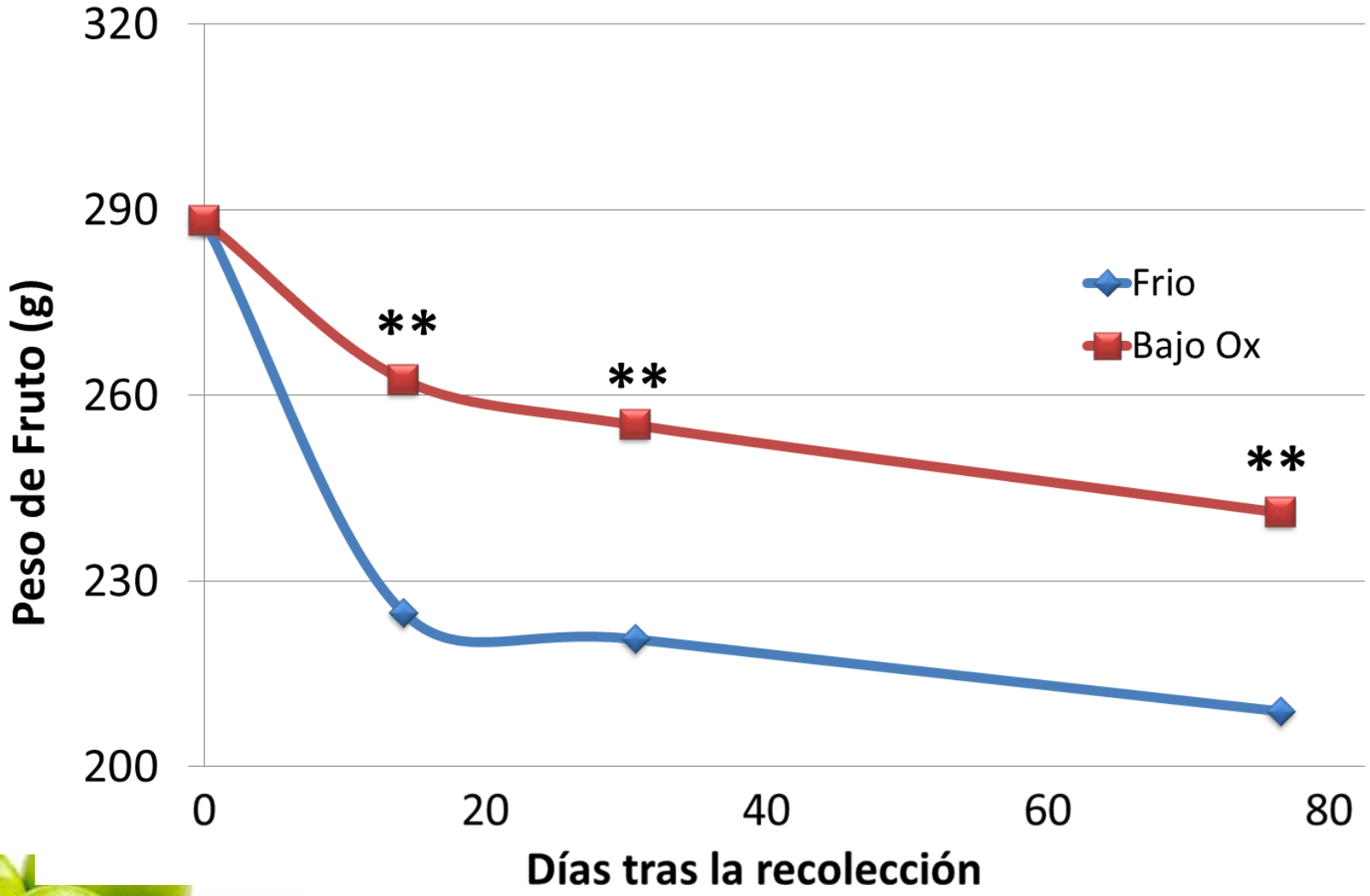
- Las manzanas fueron proporcionadas por Frutasgil (La Almunia de Doña Godina, Zaragoza). Variedades: **Reineta Gris, Fuji y Pink Lady**. (solo mostró síntomas la **Reineta**)

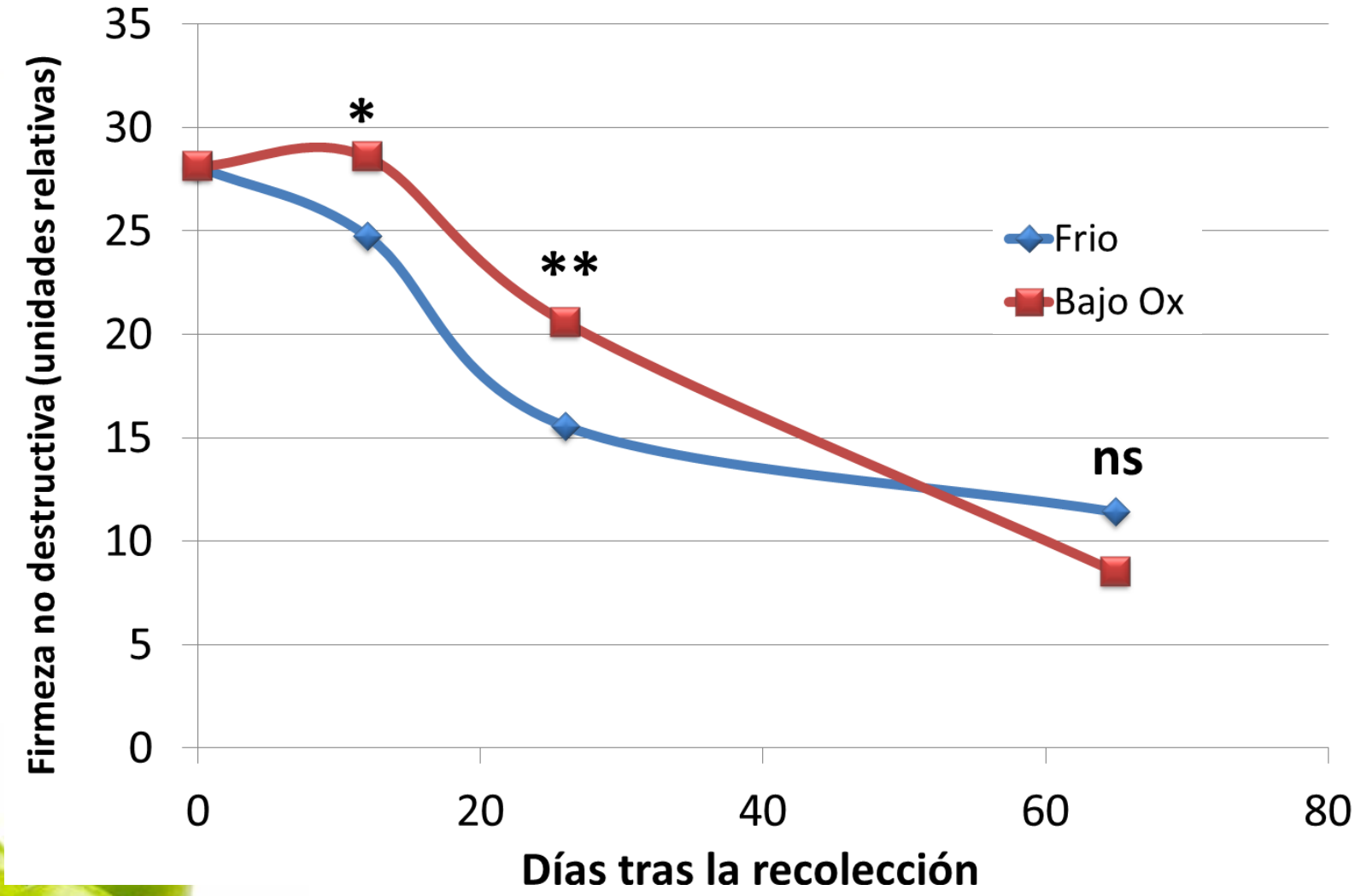
- El mismo día de la recolección se aplicó el tratamiento (**LOT**) que consistió en mantener las frutas durante 10 días a una temperatura de 20ºC en una atmósfera exenta de oxigeno y otros gases, mediante **purga con N_2** gas en cabinas experimentales TECNIDEX sistema CONTROL-TEC CAM Research Tecnidex (Valencia, España).

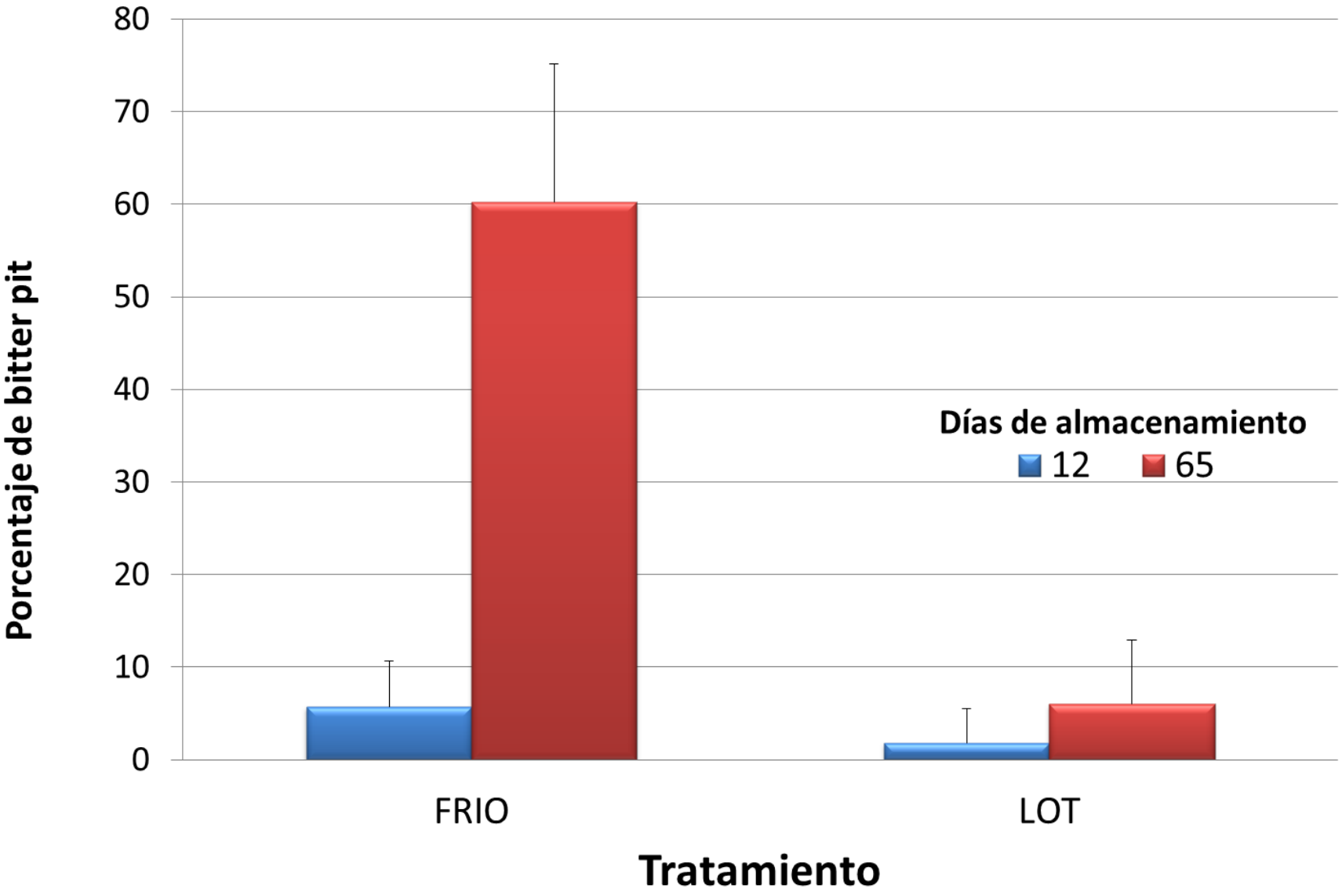
- El día 11, los frutos se traspasaron a una cámara de almacenamiento en frío convencional (0-4ºC), sin control de atmósfera.

- Los testigos se almacenaron en frío convencional el mismo día de la recolección.

- Por cada tratamiento y variedad se usaron 4 barquillas que contenían cada una 30 frutos exentos de fisiopatías.


320
290
260
230
200
Peso de Fruto (g)
0
20
40
60
80
Días tras la recolección
Frio
Bajo Ox
**
**
**


35
30
25
20
15
10
5
0
Firmeza no destructiva (unidades relativas)
*
**
ns
Frio
Bajo Ox
0
20
40
60
80
Días tras la recolección


80
70
60
50
40
30
20
10
0
Porcentaje de bitter pit
Días de almacenamiento
12
65
FRIO
LOT
Tratamiento

Frío convencional

Bajo oxígeno

Tabla 1. Evolución de la actividad respiratoria y producción de etileno en sistema cerrado (mg/h/kg).

	Etileno			O_2			CO_2		
DTA	Bajo O_2	Frío	sign	Bajo O_2	Frío	sign	Bajo O_2	Frío	sign
13	**2,74**	**35,59**	***	15,89	9,40	***	9,00	7,09	*
27	**11,03**	**44,99**	***	8,57	8,85	ns	4,09	7,21	*
69	64,79	70,42	ns	14,87	14,79	ns	10,26	12,87	*

DTA=días tras el almacenamiento. El tratamiento se realizó entre los días 1-10.

CONCLUSIONES

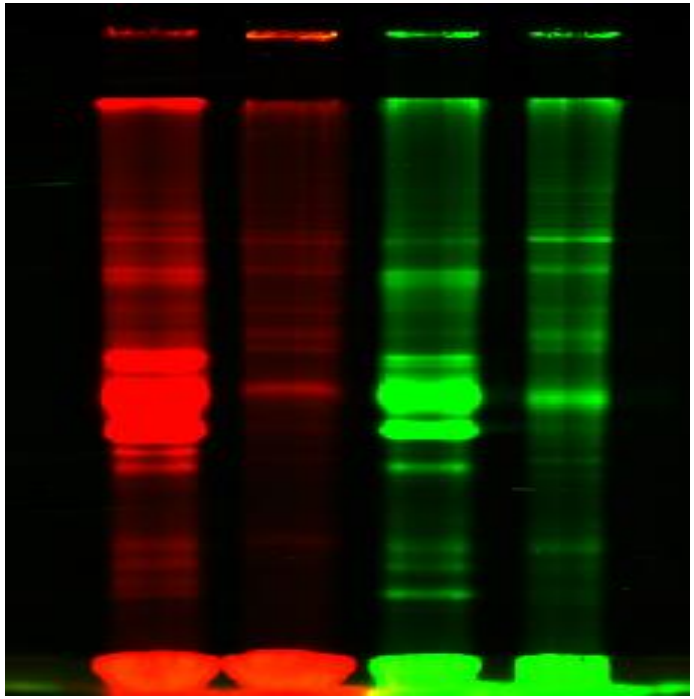
- El tratamiento con bajo oxígeno y 20ºC durante 10 días induce en manzanas Golden (Val et al., 2010) y Reineta Gris, una notable mejora de los parámetros de calidad concomitante con una reducción de la incidencia de bitter pit.

- Esta metodología es útil para aliviar el bitter pit en variedades susceptibles a esta calciopatía como las del grupo Golden y Reinetas.

- Este estudio merece ser continuado en otras variedades de manzana descritas como susceptibles al bitter pit y otras alteraciones fisiológicas relacionadas.

Protein/electrophoresis

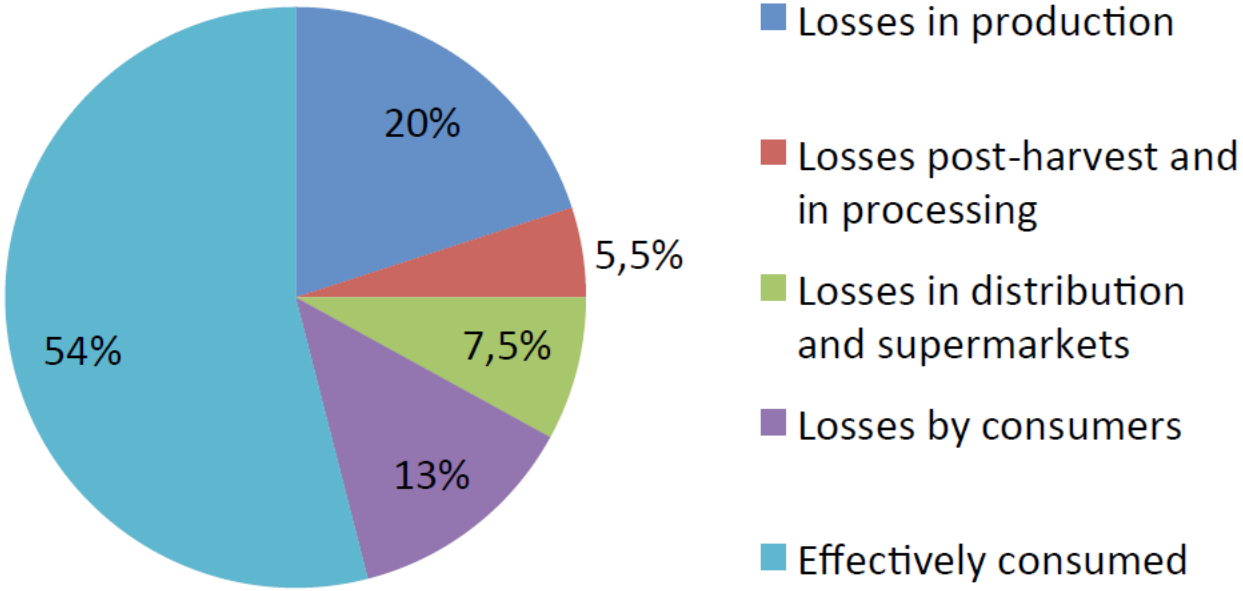
- Protein patterns obtained by electrophoresis are generally highly specific, and can be used for the analytical differentiation of species and cultivars.



Current Studies

- 2D/DIGE Gel Analysis
  - Protein Identification
- Proteomic profile
  - Apple Genome (59,000 genes)
  - Peptidic Data (318,000 EST; 6-Frame ORF)
- Bitter Pit information
  - Genetic and Proteomic
    - Sequence
    - location

Losses in the European fresh produce chain: 46% is not being consumed



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Nuestros deseos

El Grupo **Nutrición de Cultivos Frutales** de la **EEAD-CSIC** está dedicado a consolidarse como uno de los grupos de referencia en Investigación Agronómica, específicamente, en **Nutrición Foliar de Frutales** y en **Alteraciones Fisiológicas del Fruto** en los ambientes semiáridos mediterráneos.

En resumen, el grupo NFC pretende:

- **Alcanzar la máxima calidad en su investigación.**
- **Potenciar la transferencia de conocimiento al sector privado.**
- **Contribuir a crear una percepción positiva de la Investigación en Agricultura en nuestra sociedad**

Muchas gracias por
Su atención