



## New Developments in Nutrition

David Marks

# Calcium and Soft fruit

- Calcium is an important nutrient that effects both yield and quality in soft fruit.
  - 1. complexes with cell wall and middle lamella pectin (Morris, 1980).
  - 2. Stabilises cell membrane (Piccioni, 1995).
  - 3. Increase cell turgor (Mignani, 1995).
  - Delays senescence (Rosea, 1989).



## Tip Burn

Caused by poor transport of calcium from roots to leaves and developing flowers and fruit.



**Botrytis cinerea**

## Effect on Disease

Calcium has been demonstrated to play an important role in reducing susceptibility to a variety of diseases on soft fruit.

Improved resistance is associated with preservation of cell wall and middle lamella structure (Lara, 2004).

**A review of the effect of calcium on fruit quality and susceptibility to rotting and on fungal growth and development**

Defra project OF0376

Objectives 6-8

David S Johnson and Dr Angela M Berrie



# Firmness

Strawberry has a short post harvest shelf-life, mainly due to rapid loss of firm texture

Cell wall thickness.

Strength.

Turgor.

Cell to cell adhesion (Pectate lysase).

All associated strongly with low levels of calcium (Lanauskas, 2006).

# But Inconsistent Response...

*Agronomy Research* 4(Special issue), 247–250, 2006

## **Effect of foliar and soil applied fertilizers on strawberry healthiness, yield and berry quality**

J. Lanauskas<sup>1</sup>, N. Uselis<sup>2</sup>, A. Valiuškaitė<sup>2</sup> and P. Viškelis<sup>2</sup>

<sup>1</sup>Lithuanian Institute of Horticulture, Kauno 30, LT–54333 Babtai, Kaunas distr., Lithuania;  
e-mail: j.lanauskas@lsdi.lt

<sup>2</sup>Lithuanian Institute of Horticulture, Kauno 30, LT–54333 Babtai, Kaunas distr., Lithuania;  
e-mail: institutas@lsdi.lt

Calcium applications have no effect on firmness and Tip Burn (Lanauskas, 2006).

# But Inconsistent Response...

Effective – Calcium chloride reduces *Botrytis cinerea* on strawberry (Cheow, 1990).

Not Effective – Calcium chloride has no effect on *Botrytis cinerea* on strawberry (Ellis, 1996).

## Why?



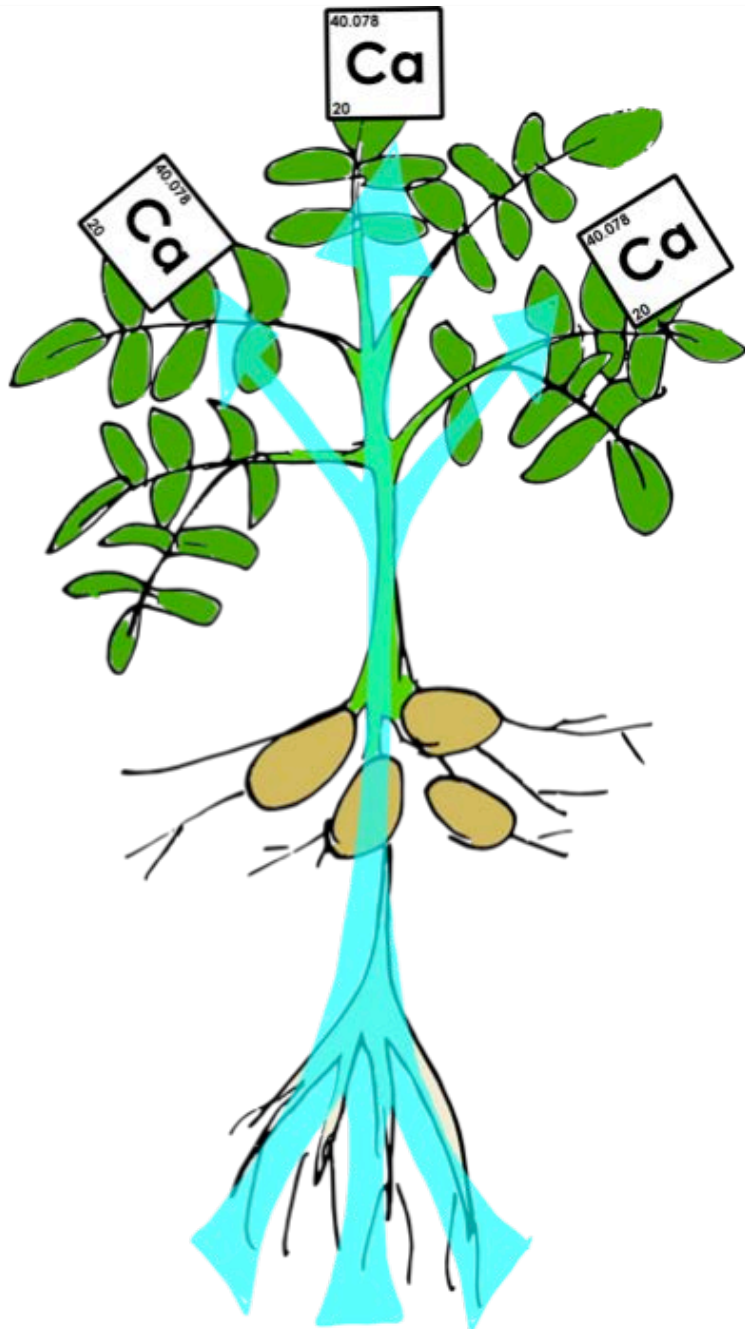
## Calcium – how is it used?

There are two factors that effect calcium levels in crops:

1. Transport
2. Absorption.

This talk will discuss the impact of both on soft fruit.





# Calcium Transport

Calcium is not phloem mobile

Moves with transpiration stream

Distribution is highest where water loss is highest.

Strongly affected by growing conditions.

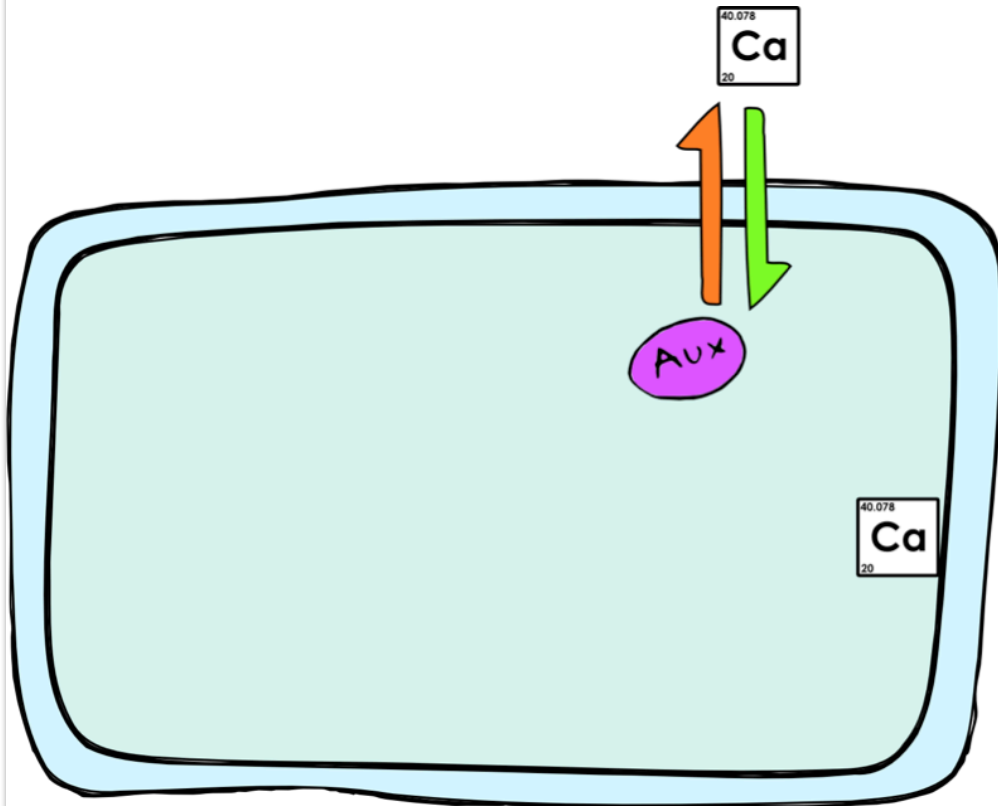
Effect of TIBA Pretreatment on Basipetal IAA and Acropetal Ca transport.

Treatment	IAA	Ca	H <sub>2</sub> O
Control	18	33	39
TIBA	12	18	38

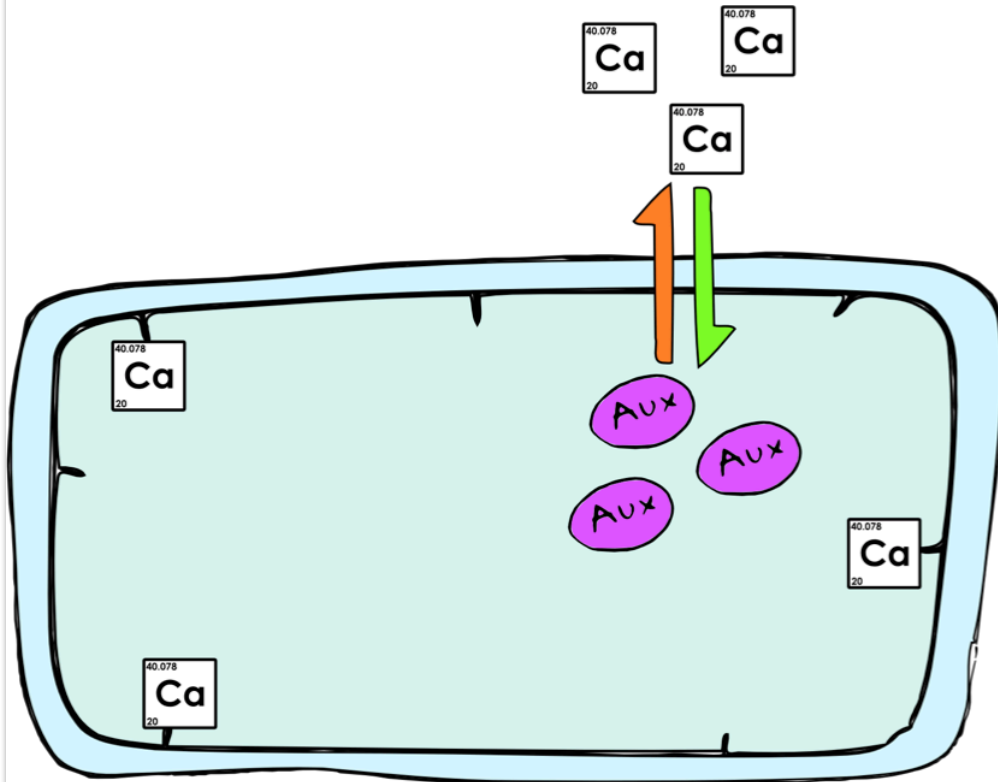
(Benuelos, 1987)

# Calcium Absorption

Calcium – Auxin counter  
transport pump



# Calcium Absorption



Auxin content of cells dictates ability of tissue to absorb Ca.

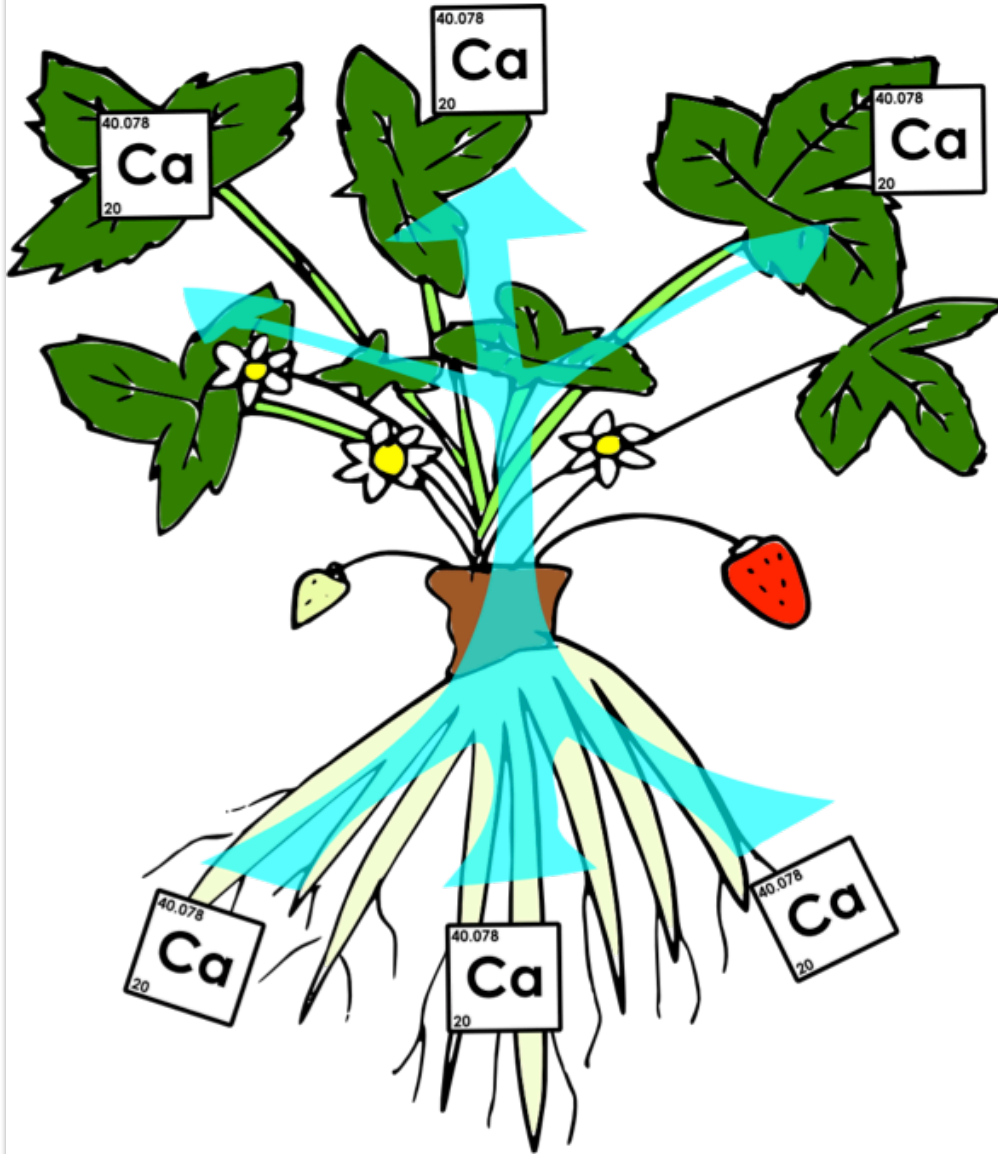
Low auxin tissue can not absorb Ca however much is available.



Cultivated in Europe since the 1400s, they have changed a lot since then.

## Highly varied production methods





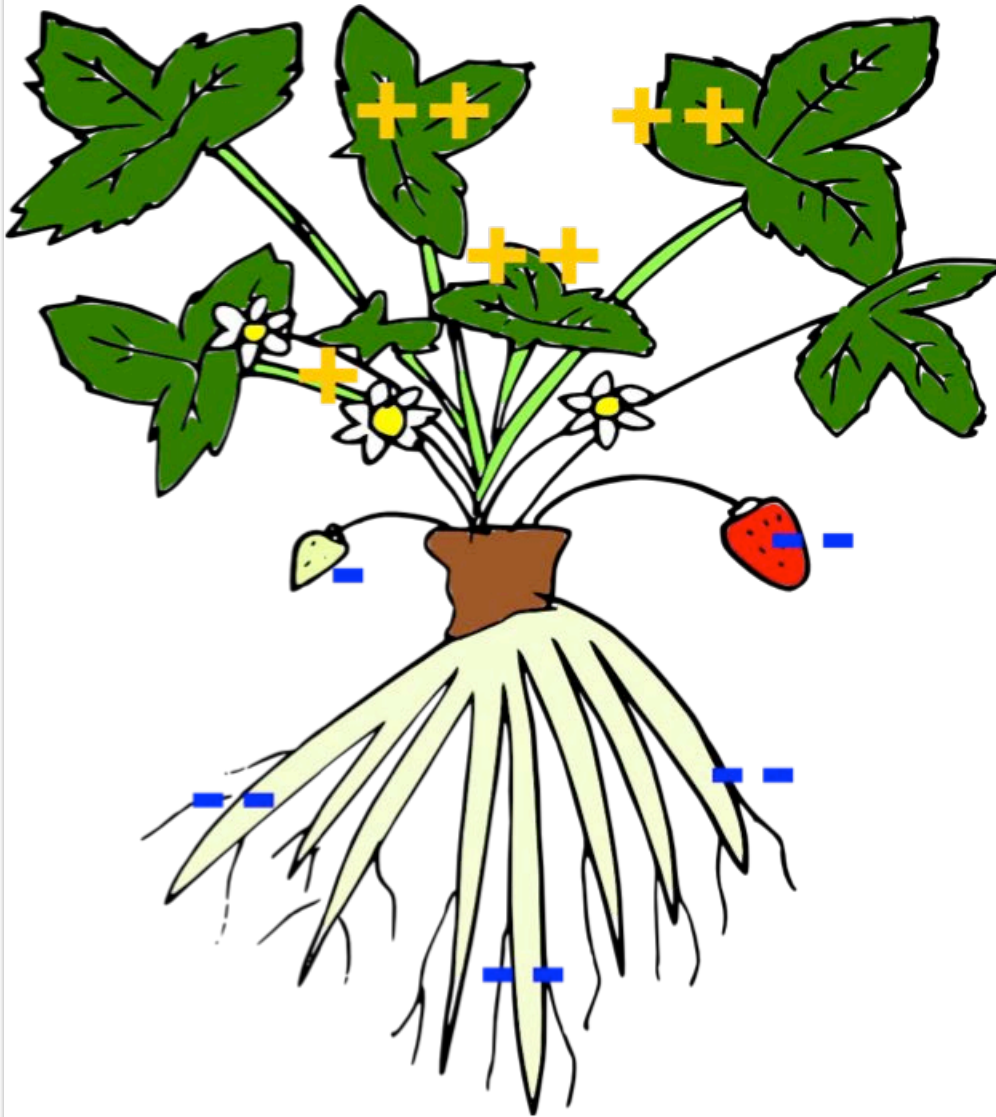
## Strawberry and Ca Transport

Fruit and flowers are low transpiration

Mature foliage gets highest Ca throughput.

Hot weather exacerbates this creating Tip Burn.

Wet or humid conditions reduce total Ca throughput creating Tip Burn

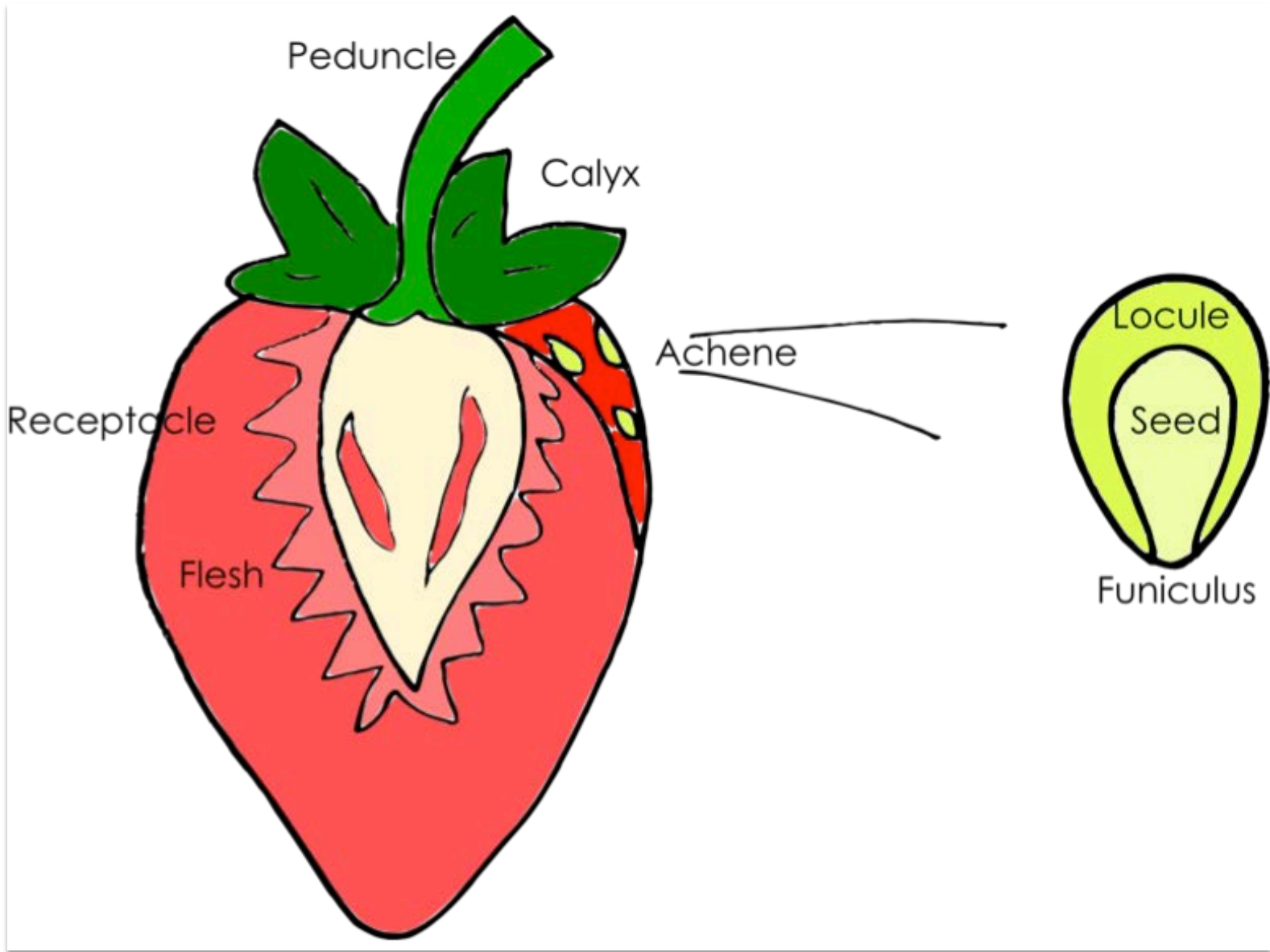


## Strawberry and Ca absorption

Foliage is the main site for auxin biosynthesis.

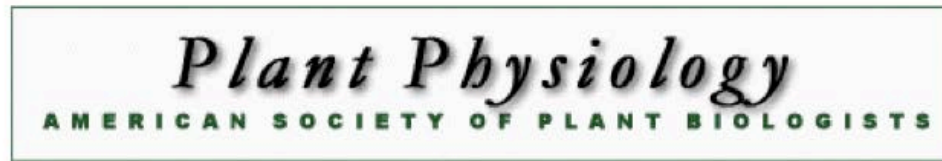
Fruit and roots are low auxin producers and have a low capacity to absorb Ca.





Achenes synthesise auxin and transport it to the receptacle via fibrovascular strands.

This changes as fruit develops.



Plant Physiol. 2008 Oct; 148(2): 730–750.

PMCID: PMC2556830

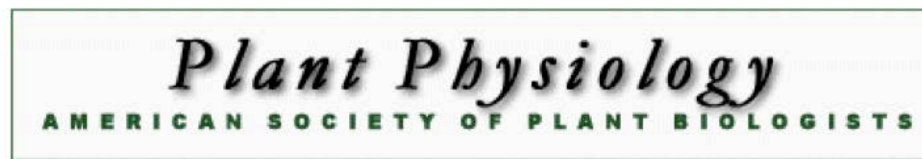
doi: [10.1104/pp.108.120691](https://doi.org/10.1104/pp.108.120691)

## Reconfiguration of the Achene and Receptacle Metabolic Networks during Strawberry Fruit Development<sup>1,[C][W]</sup>

[Aaron Fait](#)<sup>2,3,\*</sup>, [Kati Hanhineva](#)<sup>2</sup>, [Romina Beleggia](#), [Nir Dai](#), [Ilana Rogachev](#), [Victoria J. Nikiforova](#), [Alisdair R. Fernie](#)<sup>2</sup>, and [Asaph Aharoni](#)<sup>2</sup>

In strawberry ripening is triggered by a reduction in auxin transport from achenes to the receptacle (Fait, 2008).

Journal List Plant Physiol v.118(4); 1998 Dec PMC34746



Plant Physiol. 1998 Dec; 118(4): 1307–1316.

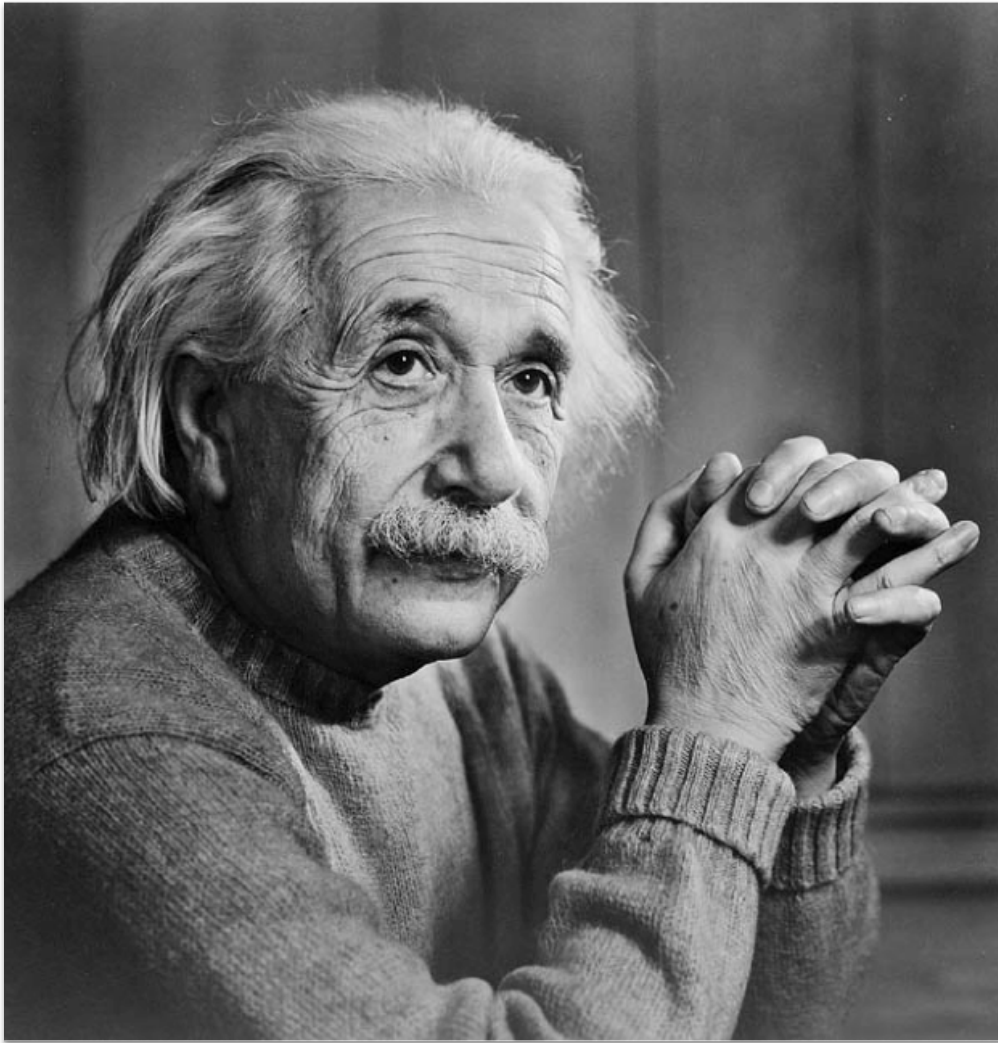
PMCID: PMC34746

## **Expression Analysis of a Ripening-Specific, Auxin-Repressed Endo-1,4- $\beta$ -Glucanase Gene in Strawberry**

Mark H. Harpster,\* David A. Brummell, and Pamela Dunsmuir

The receptacle can not ripen, whilst auxin levels are high (Harpster, 1998).

As fruit turns white auxin levels drop, and calcium absorption declines rapidly.



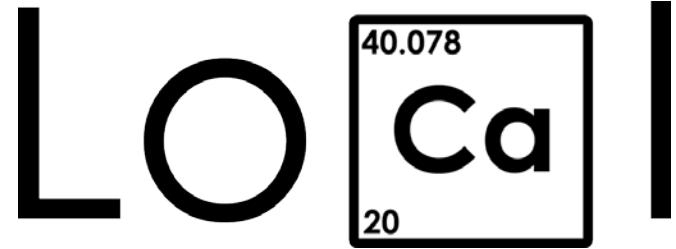
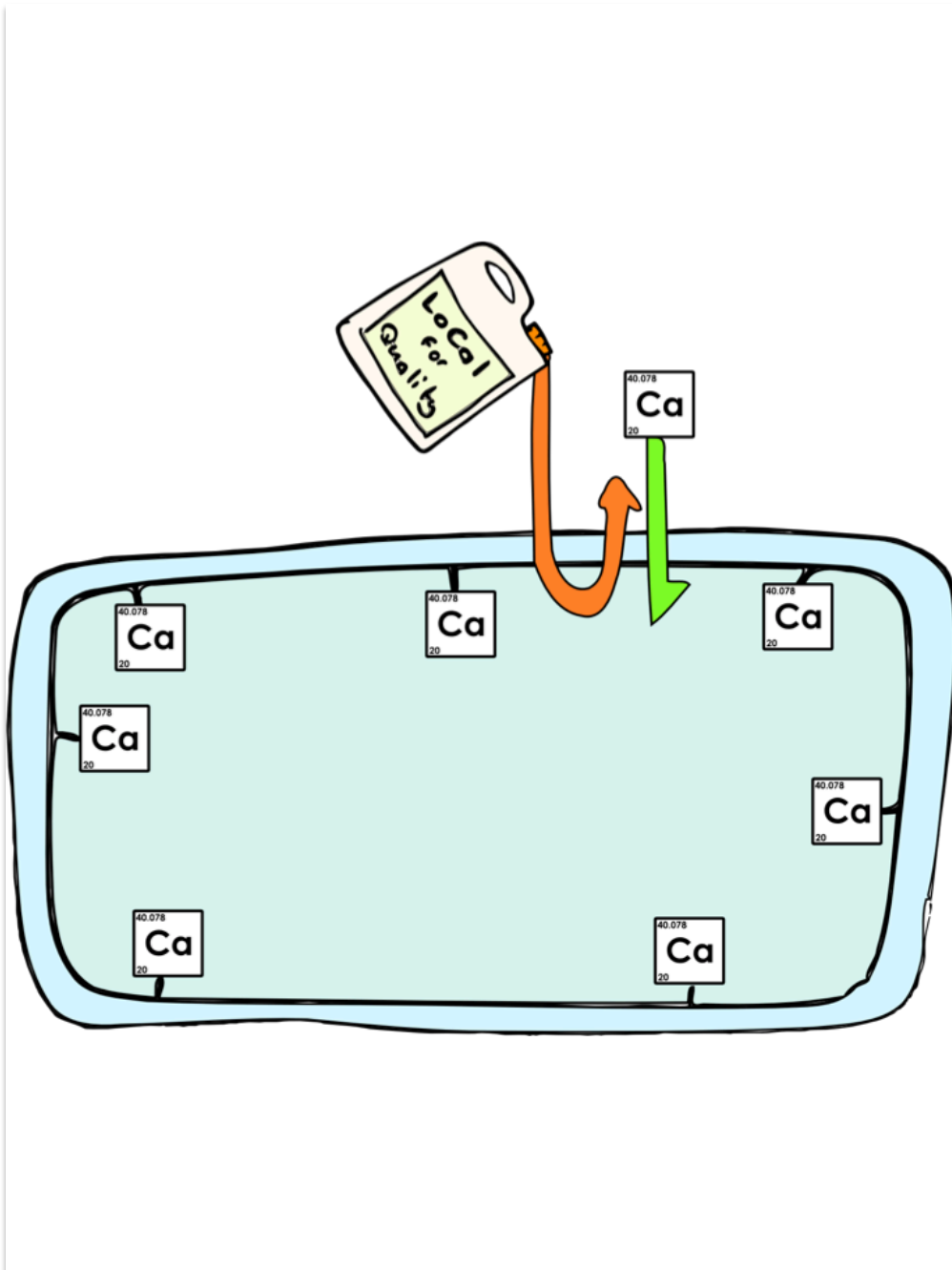
“Insanity is repeating the same thing over and over and expecting different results” – Albert Einstein

## What can we learn from this?

Root applied calcium can only access fruit if transpiration allows throughput.

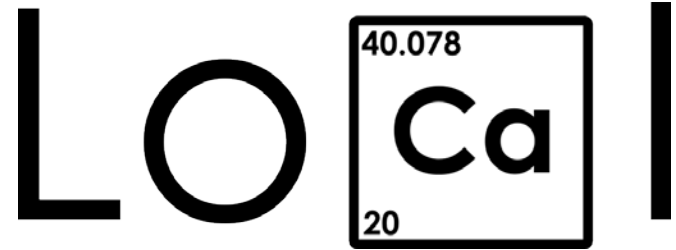
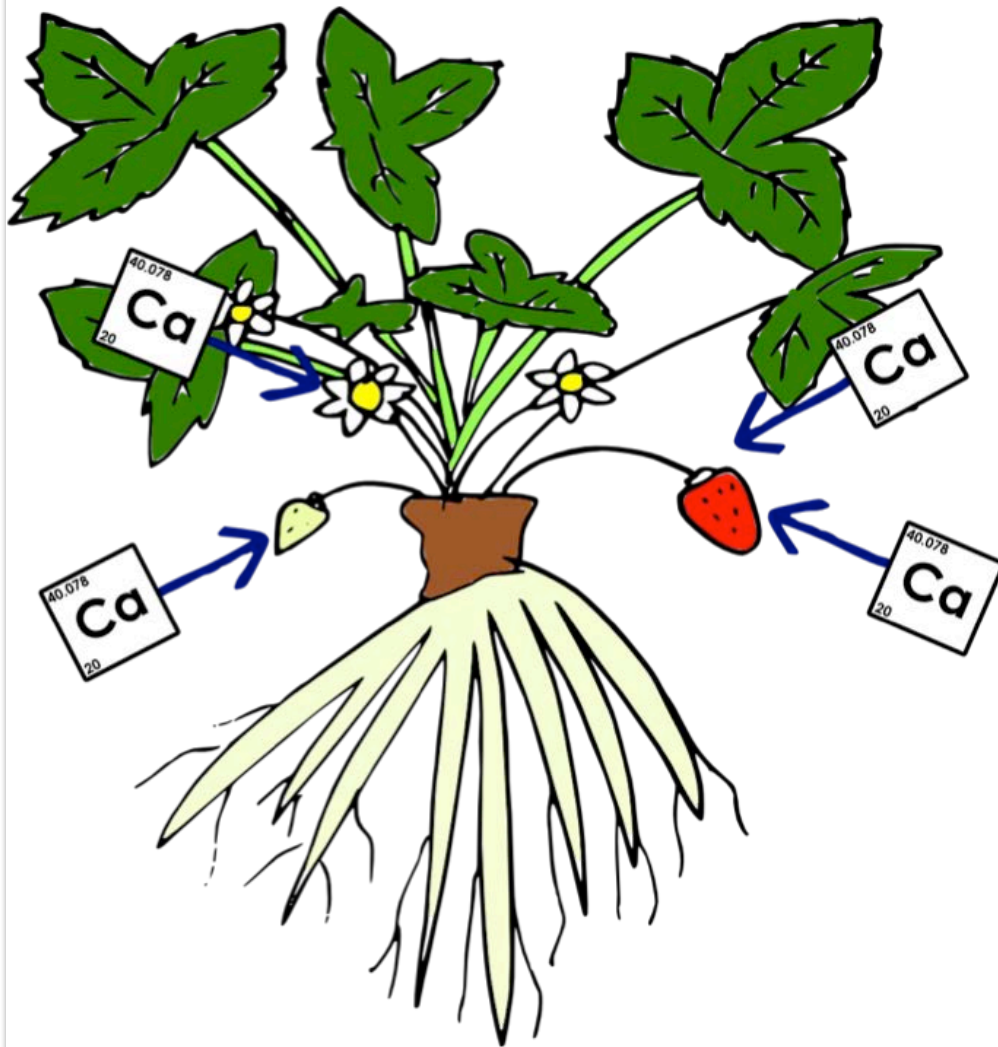
Maturing strawberry fruit can not absorb Ca.

Applying Ca is futile unless we address this.



Levity have developed chemistry that allows Ca to be absorbed in the absence of auxin.

This technology can be incorporated into Ca fertilisers to allow better performance.



Levity LoCal (AXM) chemistry, allows calcium to enter low auxin producing tissues.

It can be used to push Ca into ripening strawberry fruits, where conventional fertiliser would be ineffective.

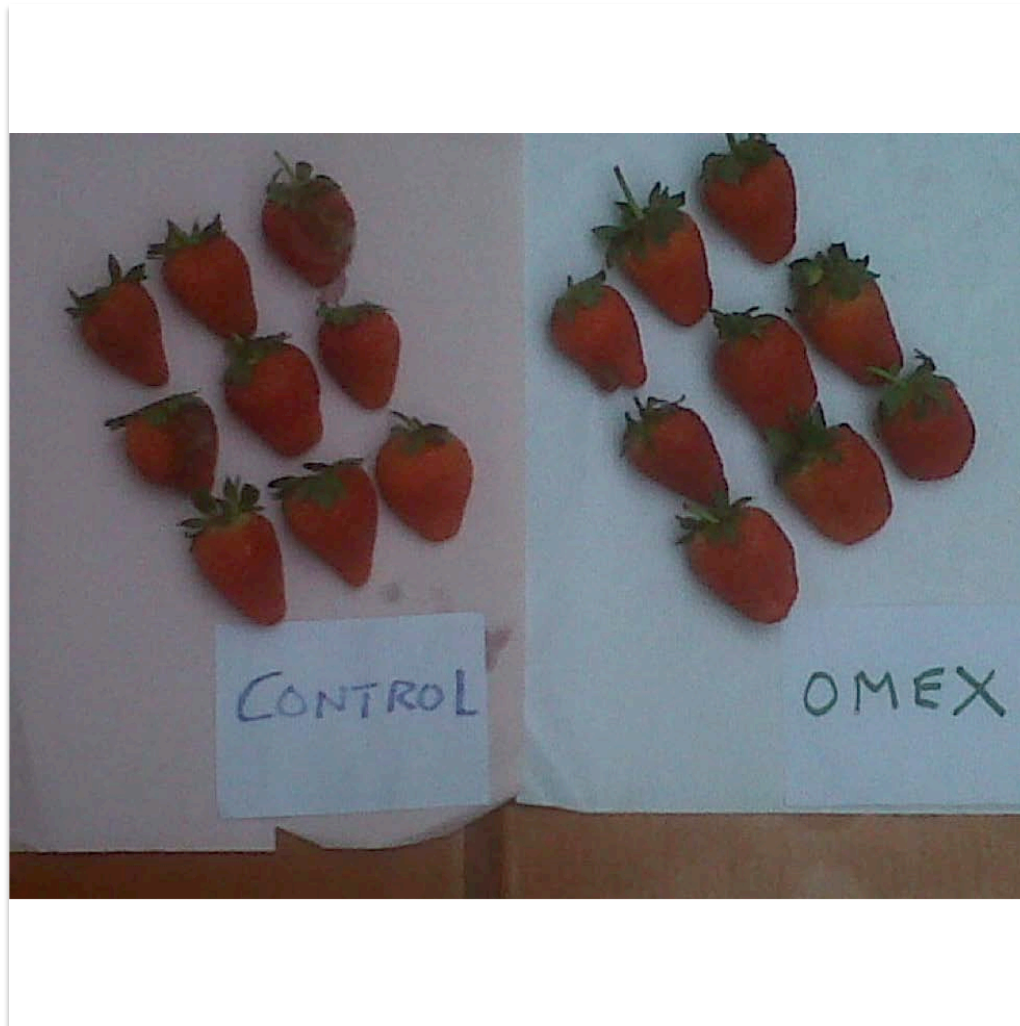
# How to use effectively

## Timing is crucial

- To prevent Tip Burn use when hot or damp.
- To improve fruit setting apply at flowering.
- To improve firmness apply as fruit ripens

## Placement is crucial

- Transport of Calcium is dependent on transpiration.
- Always apply to target tissue (in this case the fruit).



Average fruit rots – 4 days post harvest  
Control 18%  
Calmax Ultra 11%

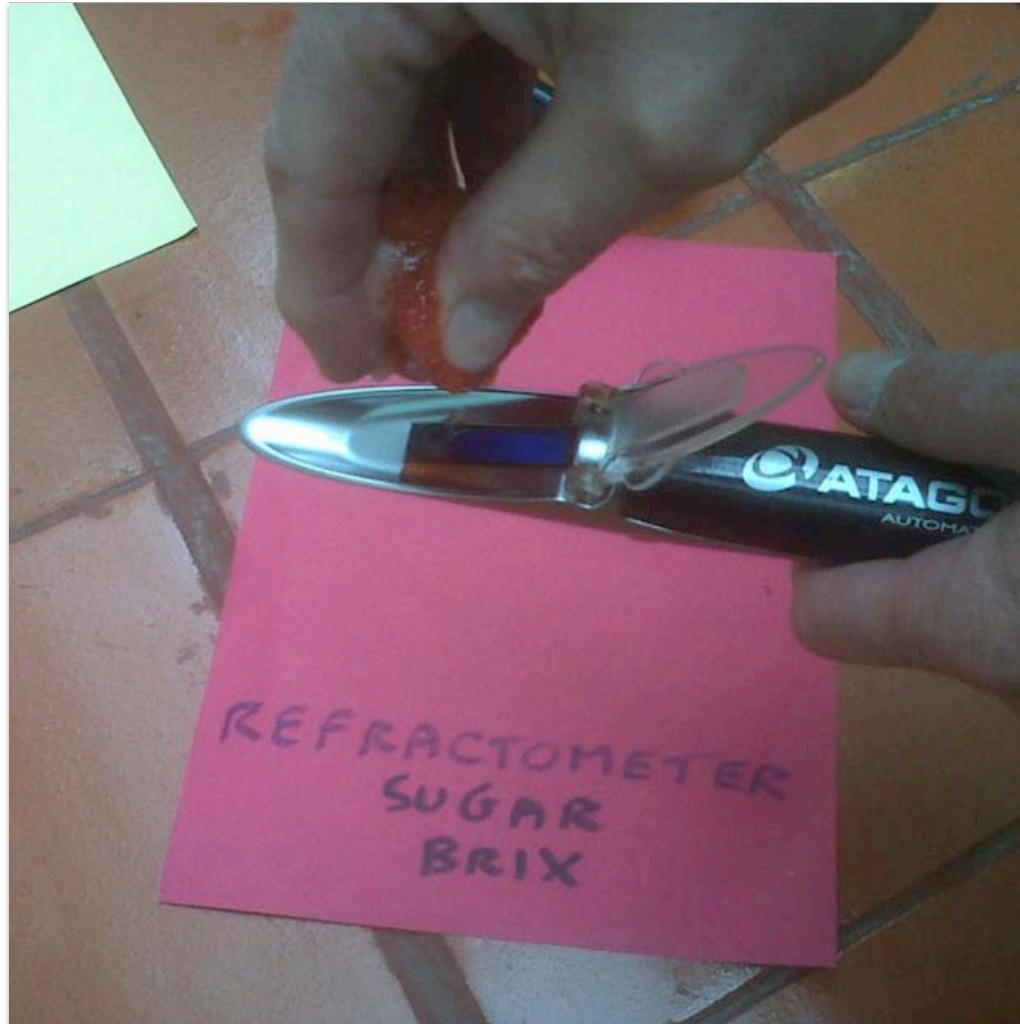




Fruit firmness : pressure in Kg

Control 1.02

Calmax Ultra 1.24



Fruit brix : Sugar levels

Control 6.34

Calmax Ultra 6.41

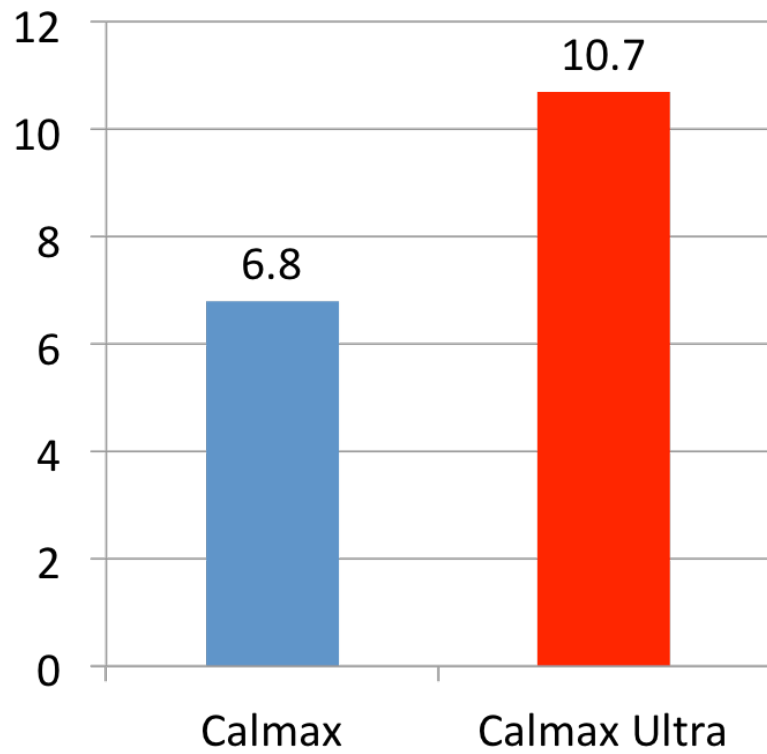


Control: fruit before and after penetrometer and refractometer readings

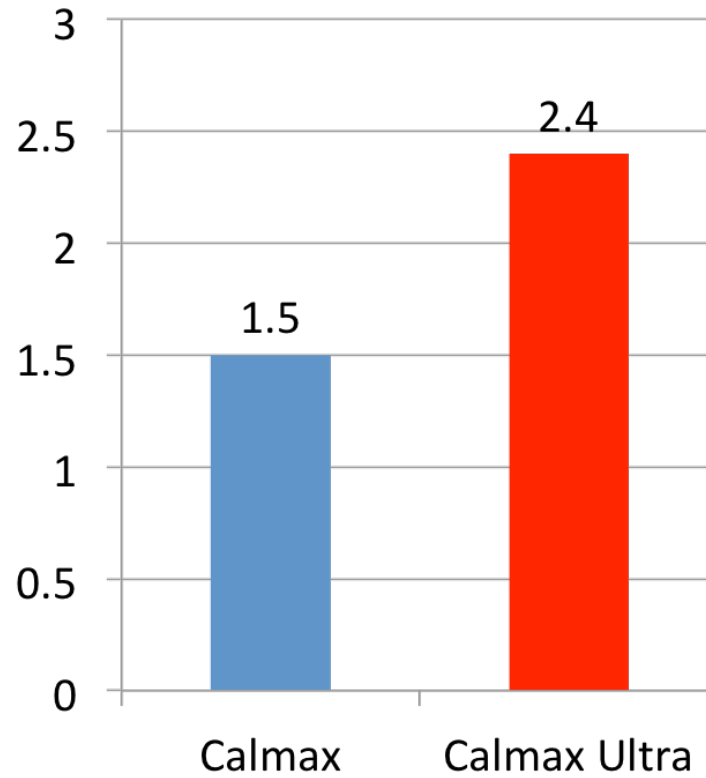


Calmax Ultra: fruit before and after penetrometer and refractometer readings

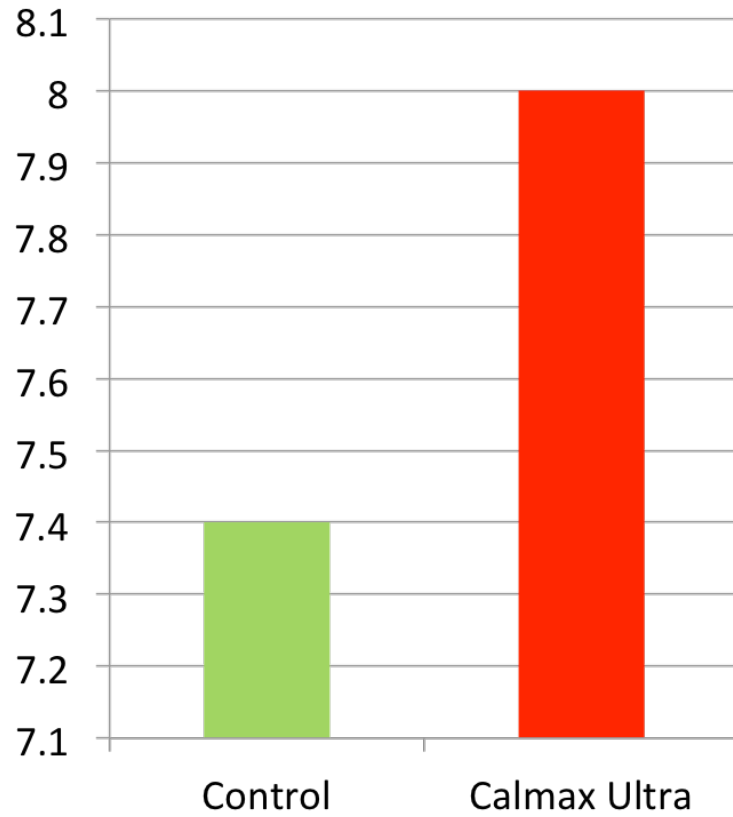
### Average No. Fruit per Plant



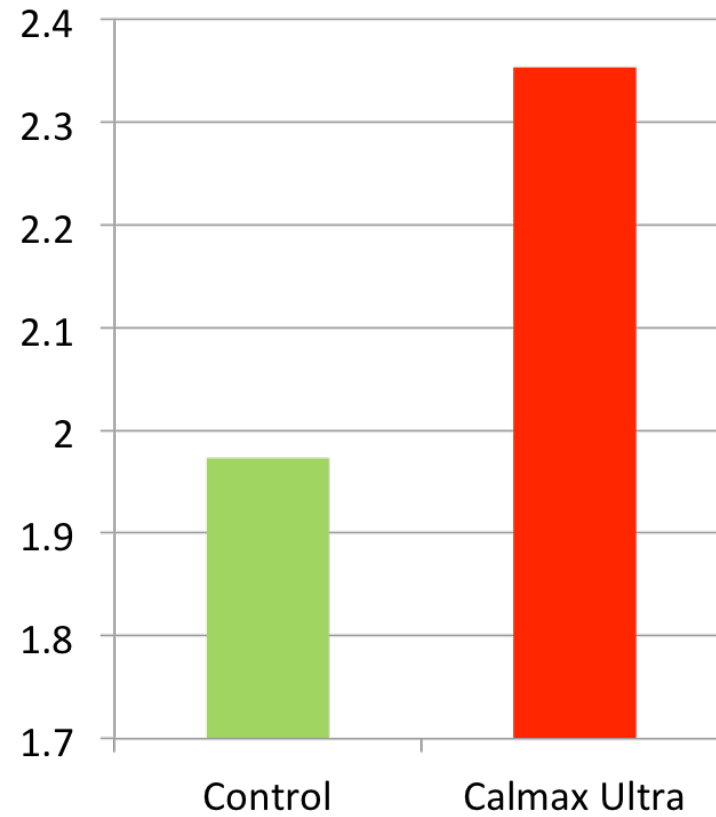
### Average No. Flowers per Plant



## Soluble Solids %



## Firmness



# What else are we working on?

- Nitrogen use efficiency
- UK strawberry production is highly inefficient in use of nitrogen, typically only 8-20% of N applied is taken up by the crop.
- Leivity have developed more efficient nitrogen fertiliser technology, that prevents loss of N due to leaching and volatilisation.
- Leivity LimiN chemistry encourages the plant to use it's N to create reproductive growth (fruit not shoots).
- Leivity LimiN chemistry is 12 times more efficient during stress than conventional N fertiliser.
- Trials in Netherlands on strawberry in 2016 – watch this space.

# Maturity

- Leivity have developed chemistry that can enhance production of colour and brix.
- Our Blush product ensures that plants can produce adequate levels of ABA, improving maturation.
- This chemistry is particularly useful on ethylene insensitive fruits like strawberry.
- Trials underway on soft fruit during 2016 in the Netherlands
- Looking for UK trial partners.