

Hydroponics and Quality

AGRICOM
Viterbo, Italy

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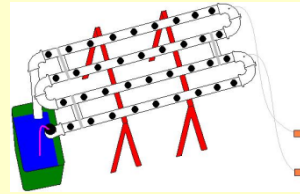
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Grossbeeren, Germany**

What I want to talk about ?

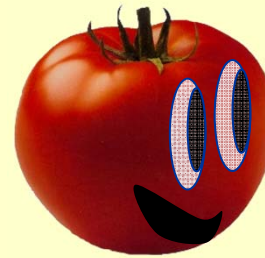
1. Hydroponics today



2. Quality terms



3. Hydroponic vs. quality



4. Conclusions



1. Hydroponics today

Background:

(Greek. υδροσ πονω = to put in water)

Definition:

Gericke 1937.

„Water culture without employing any substrate“

Today.

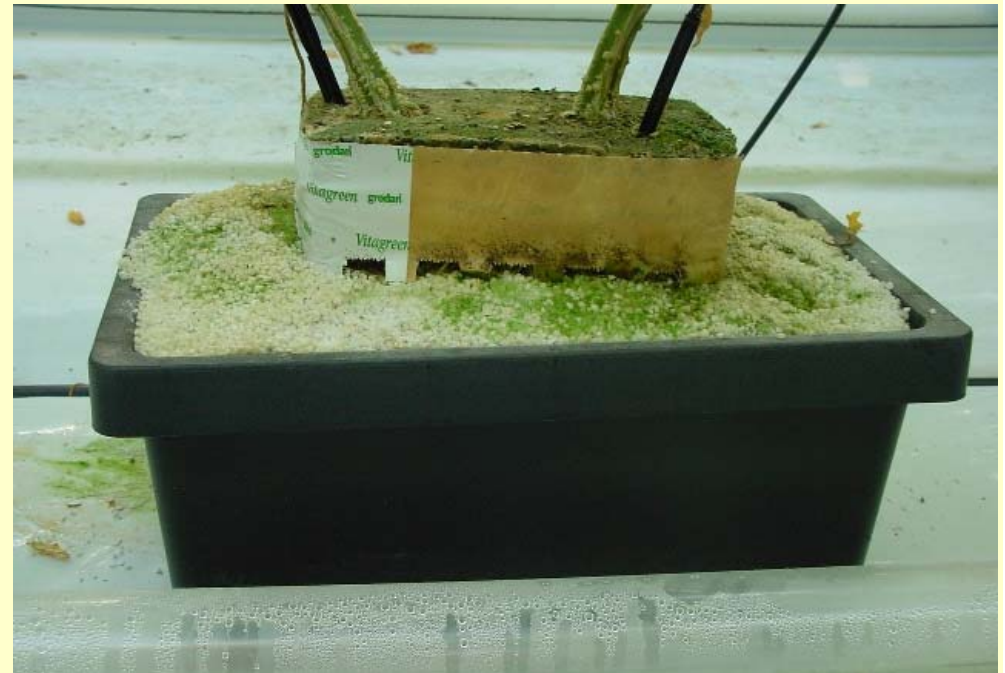
Different definitions exist:
such as cultivation

- of ornamentals in pots
- in pure nutrient solution
- in substrates supplied with nutrient solution
- in soil supplied with a nutrient solution. Examples:
 - Almeria, Spain;
 - Shandong, China)



1. Growing medium

- without (only nutrient solution)
- with
 - Inert: rockwool, foam, volcanics, etc.
 - Organic: peat, wood fibre, (rice, coco) husks, soil, etc.



1. Growing medium

- without
- with
 - inert: rockwool, foam, volcanics, etc
 - organic: peat, wood fibre, (rice, coco) husks, etc.

2. Supply of nutrient solution

- Aeroponic
- Nutrient film technique
- Deep flow technique
- Ebb and flood
- **Drip irrigation**



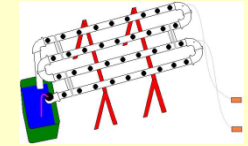


- Deep flow technique
- Ebb and flood
- **Drip irrigation**

3. System itself

- open
- closed
- semi-closed





1. Hydroponics today

Conclusion

- Systems differ widely
- The more sophisticated a system is the better it can be controlled
- System control makes the control of plant growth and its quality possible



2. Quality terms – product



Problems:

1. Quality term of a product is differentially used and thus, not clear

Our approach and understanding

Physical properties

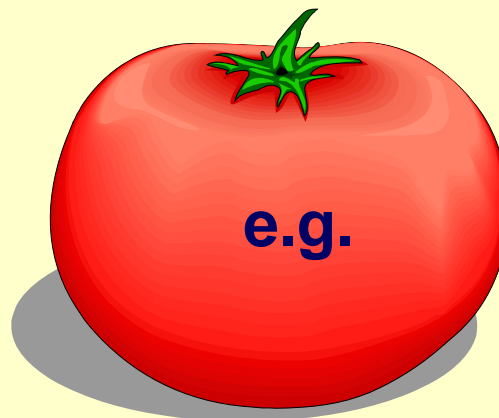
- appearance
- firmness
- texture
- dry matter
-

Flavor

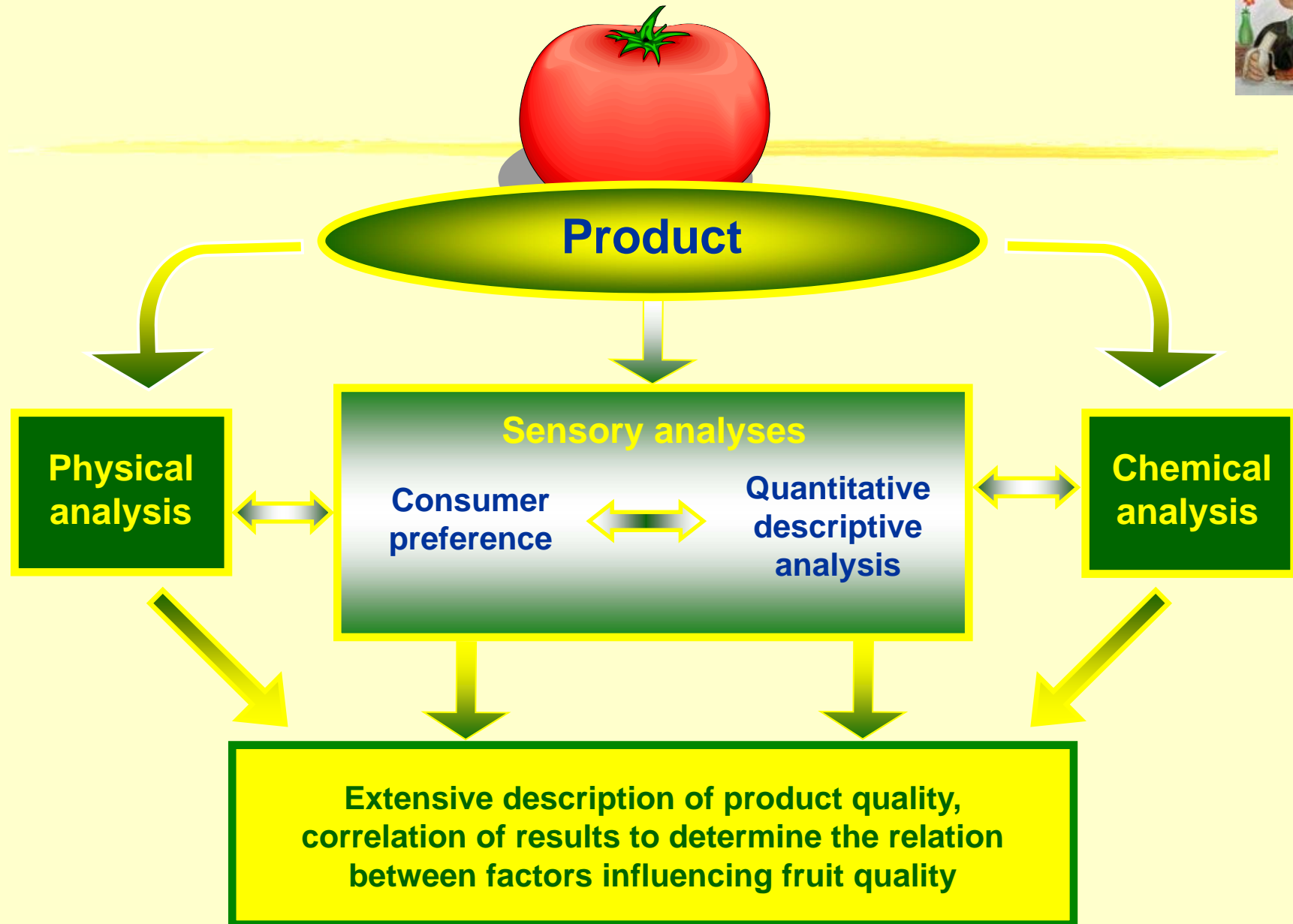
- sugars
- acids
- aroma
- volatiles
-

Health-benefits

- minerals
- antioxidants
- carotenoids
- vitamin C
- allergens
-



How to analyze the product ?

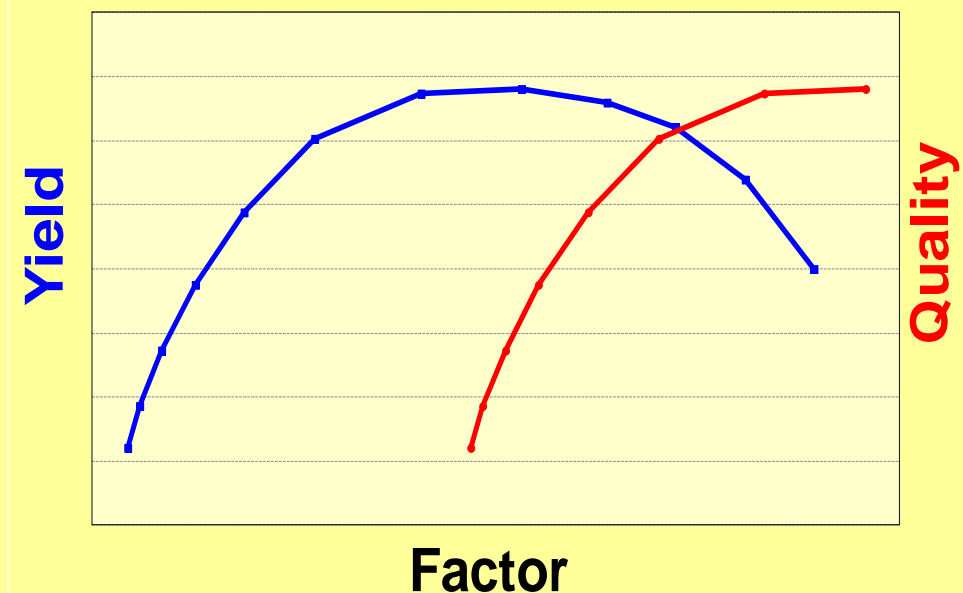
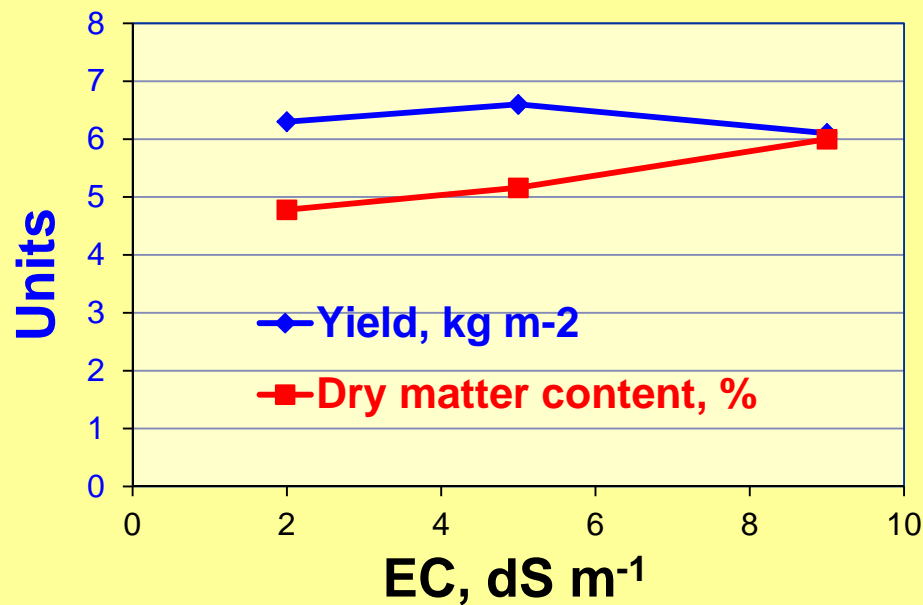




Problems:

1. Quality term of a product is differentially used and thus, not clear

2. Product quality and yield need often contrary actions



How can hydroponic systems fulfill quality demands ?



1. Quality term of a product is differentially used and thus, not clear

2. Product quality and yield need often contrary actions

3. Conditions affecting product quality:

1. cultivar

2. climate

3. nutrition

- concentration (all ions, salinity, EC).

- single ions

- composition (interactions)

4. root environment, e.g. substrates

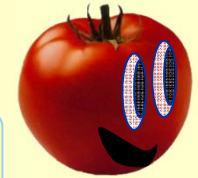
5. microorganism

6. management

7.

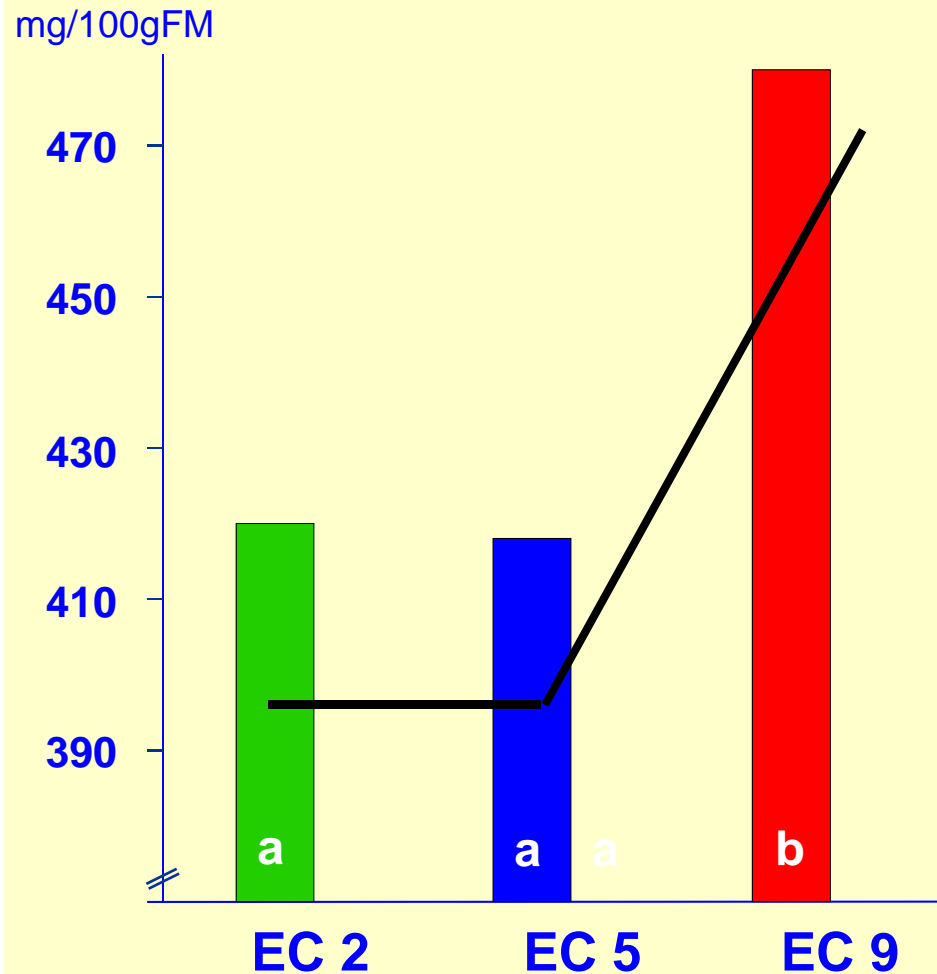
control with hydroponics

3. Hydroponics vs. quality

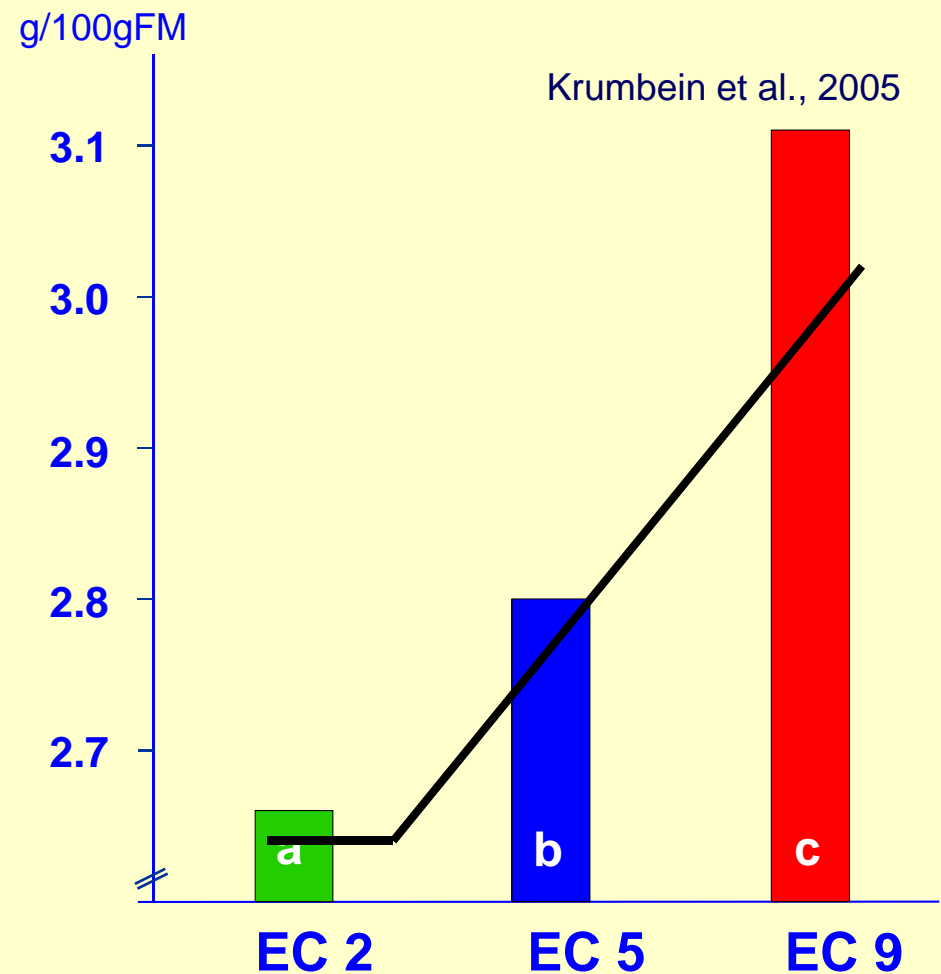


Nutrient solution concentration (EC) - flavor

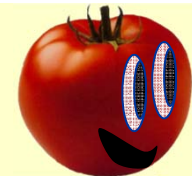
titratable acids



glucose + fructose



Flavor can be enhanced by increase of EC (total nutrients)



increase of

Flavor

Health

Nutrient concentration (EC, dS m⁻¹)



Sugars



=

Lycopene



Acids



Vitamin C

=

o macronutrients

o NaCl

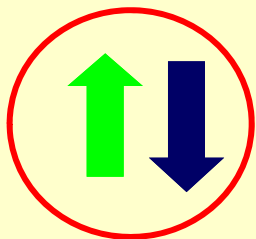
o other salinity



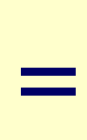
Aroma volatiles



β-Carotene

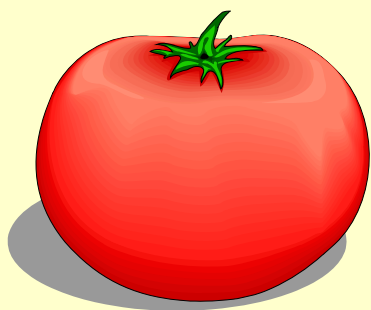


Texture



=

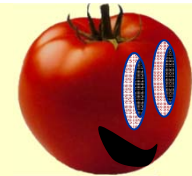
Lutein Quercetin



Juiciness

Auerswald et al., 1999
Dorais, M. et al. 2002
Krumbein et al., 2005

Does the enhancement of flavor depends on EC alone? **No!**



Increase of

Compound

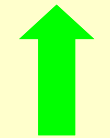
Nutrients

K, (P)



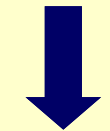
sugar, acids

K, P, (Ca)

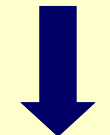


Lycopene

N, Ca



Lycopene



**Vitamin C
sugar, acids**

Ca

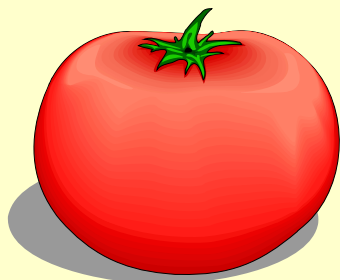


Vitamin C

**all,
B, Zn,**

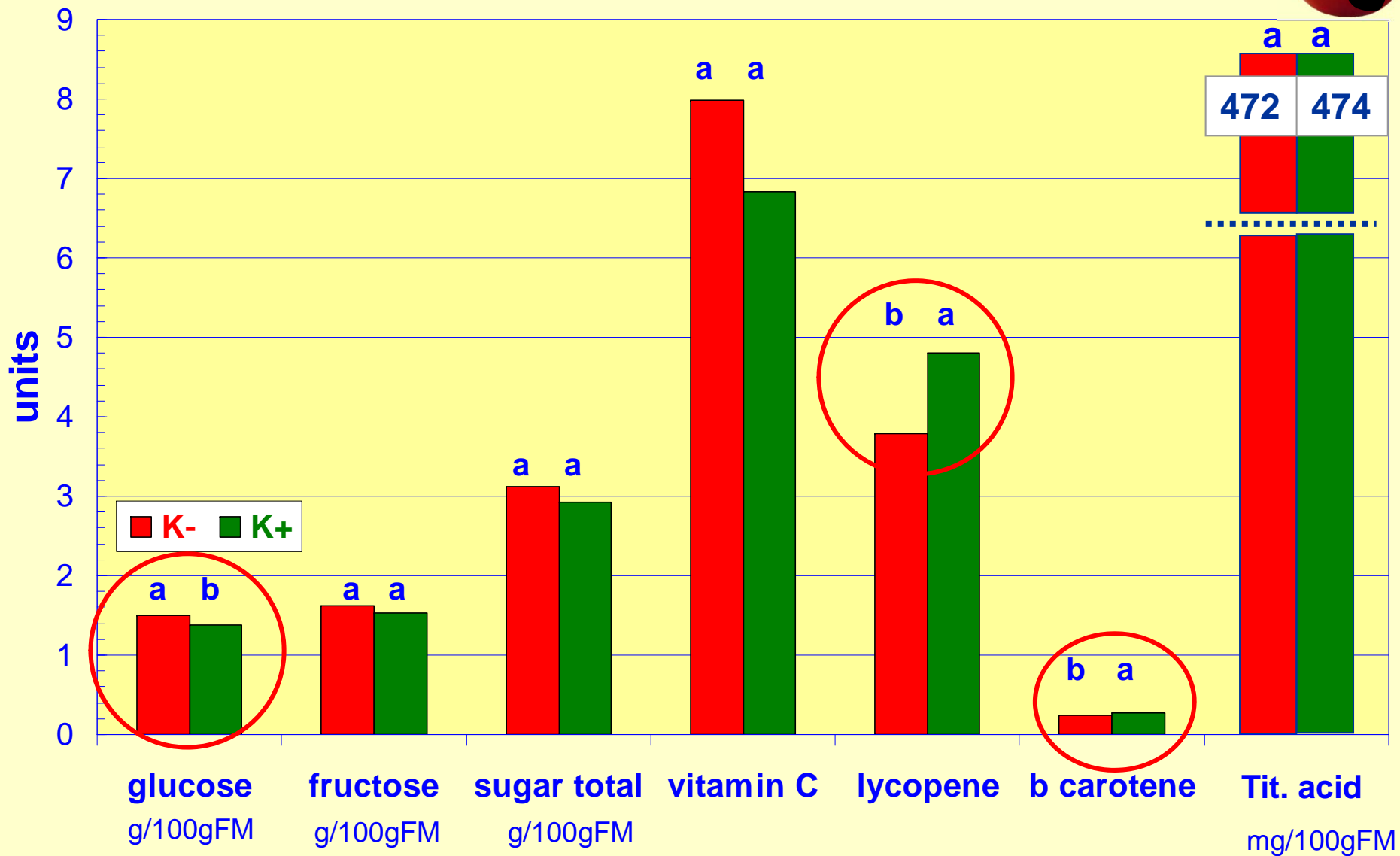
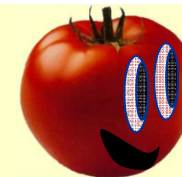


Minerals



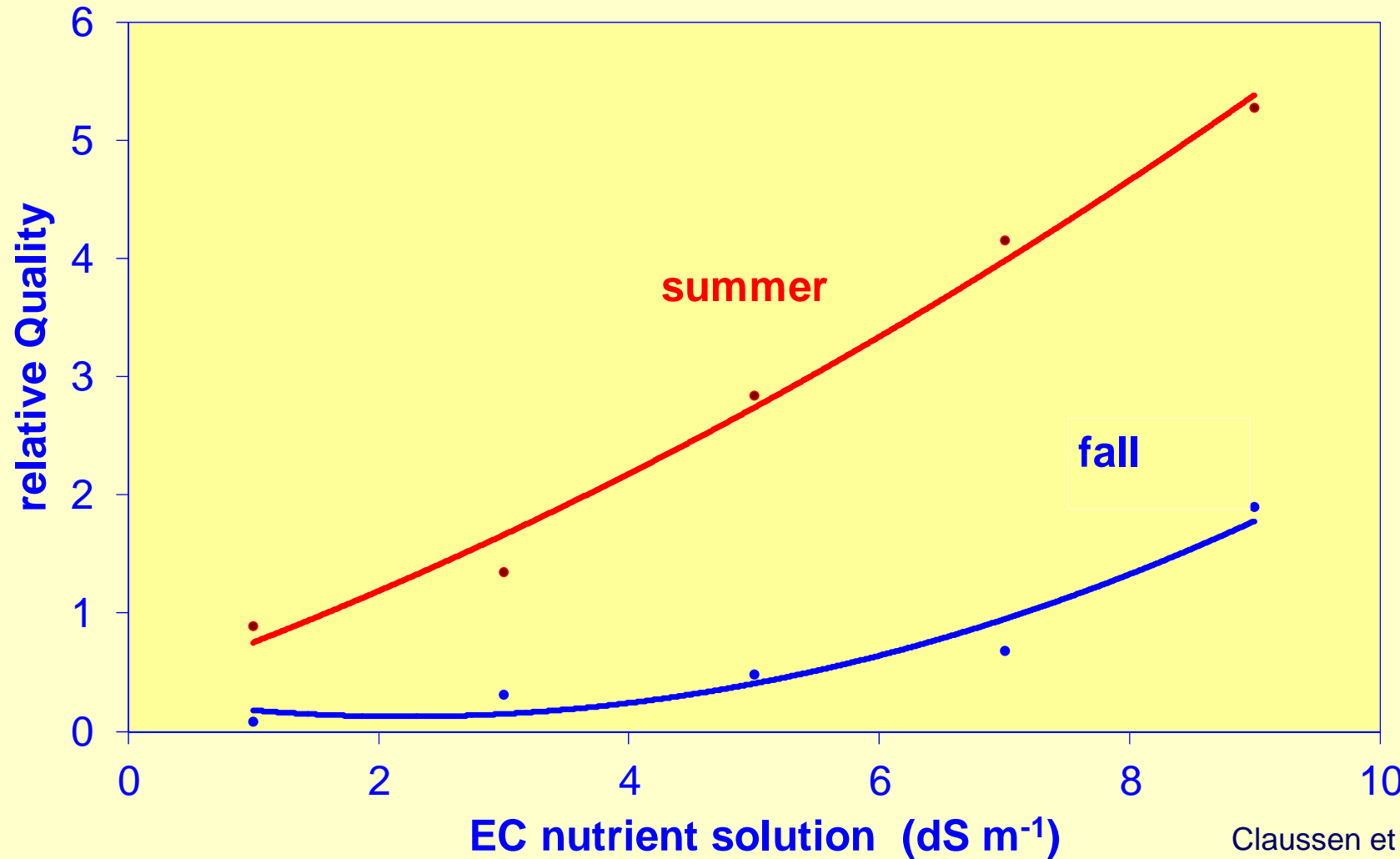
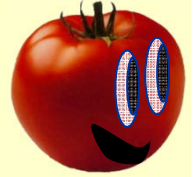
(Giovaneli et al. 1998; Montagu and Goh 1990; Locascio et al. 1984; Mengel 1979; Trudel and Ozbun 1971; Subbiah and Perumal 1990; Dorais et al., 2001; Krumbein et al., 2007)

Nutrient effect (K) – flavor and health



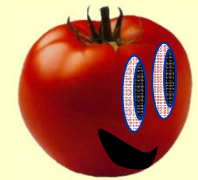
K does not always improves flavor and health – why not ?

Interactions: EC and climate on quality

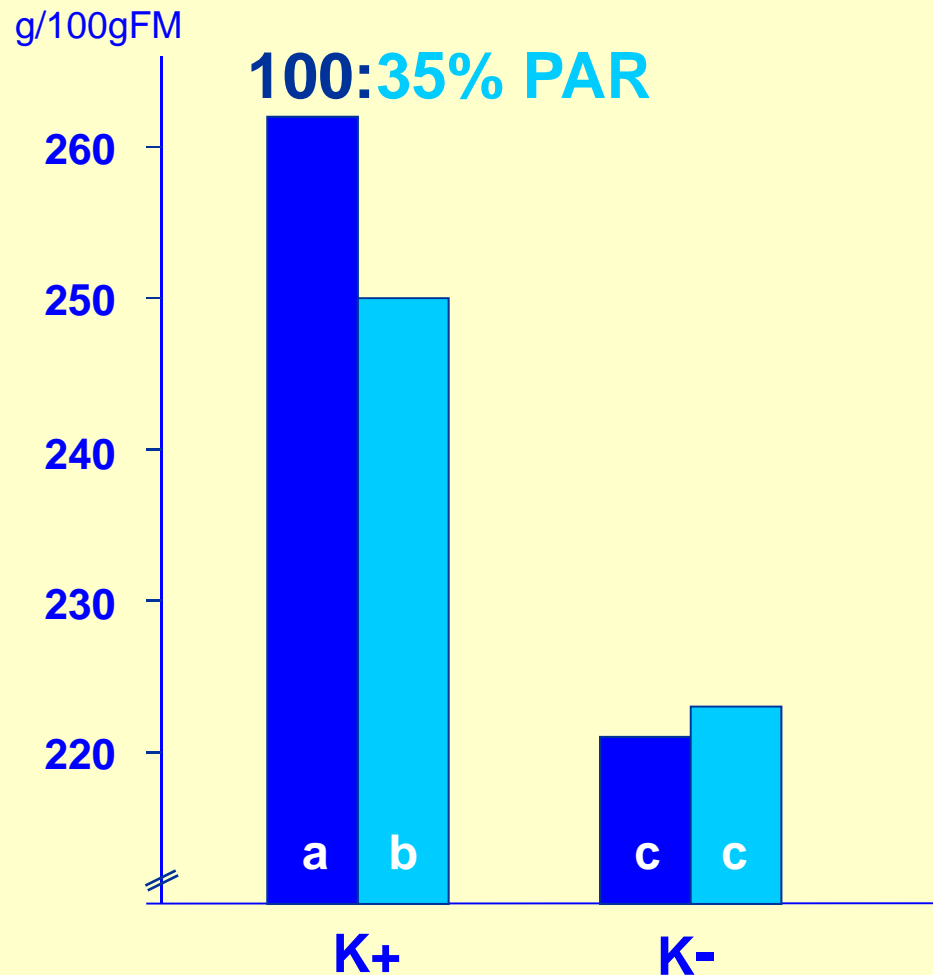


A factor related to cultivation in hydroponics may interact with a second factor, such as climate conditions.

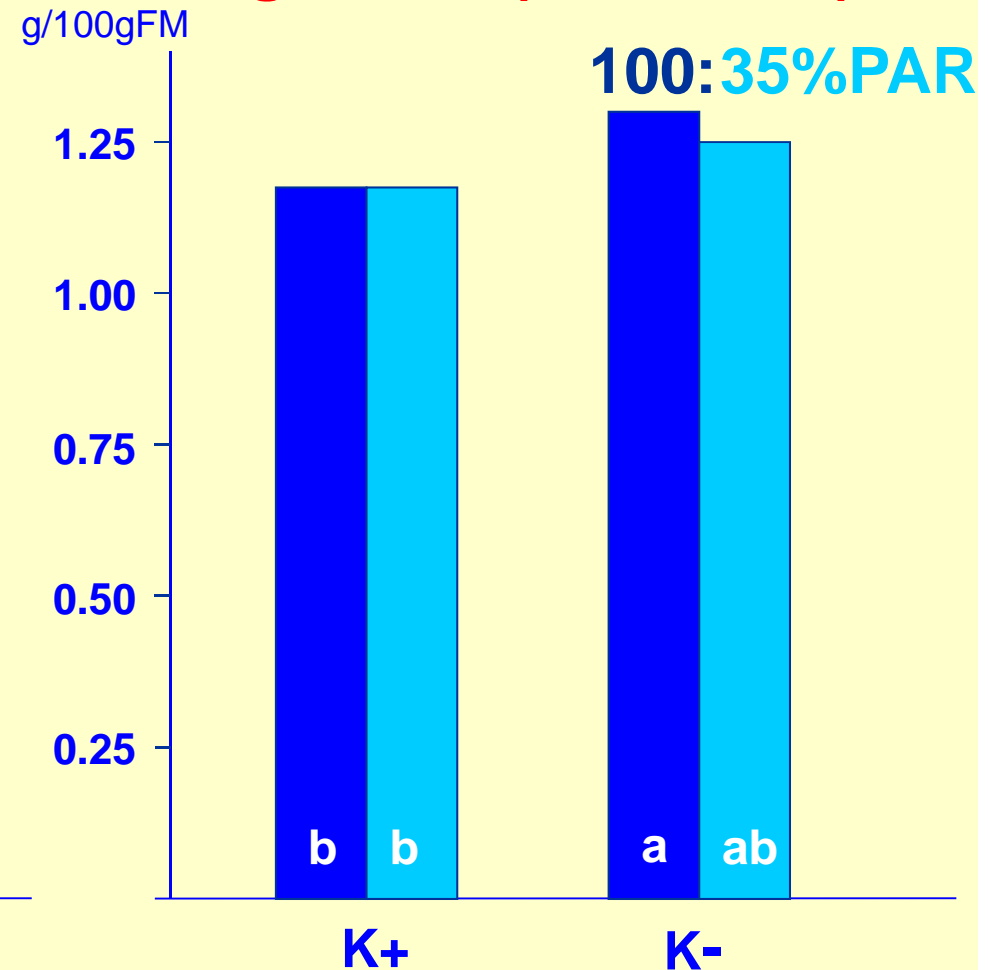
Interactions: K and radiation on taste



titratable acids

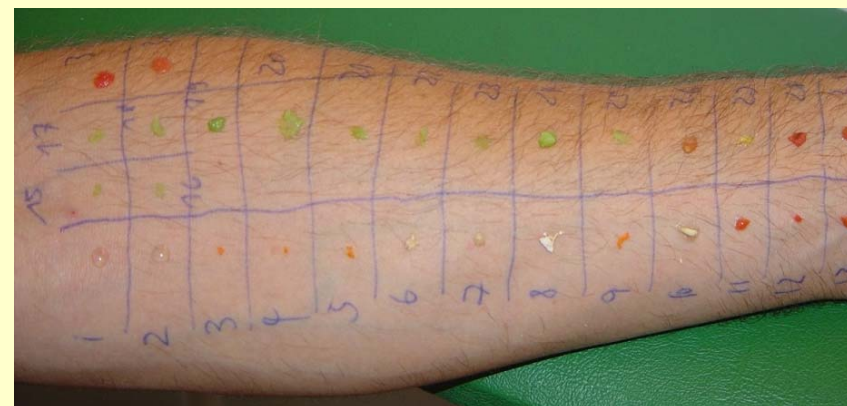
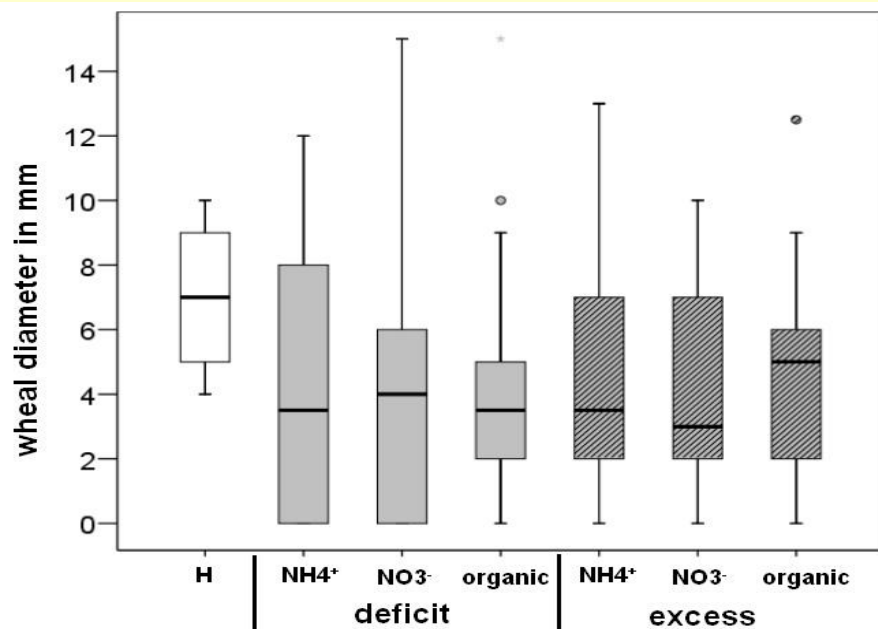
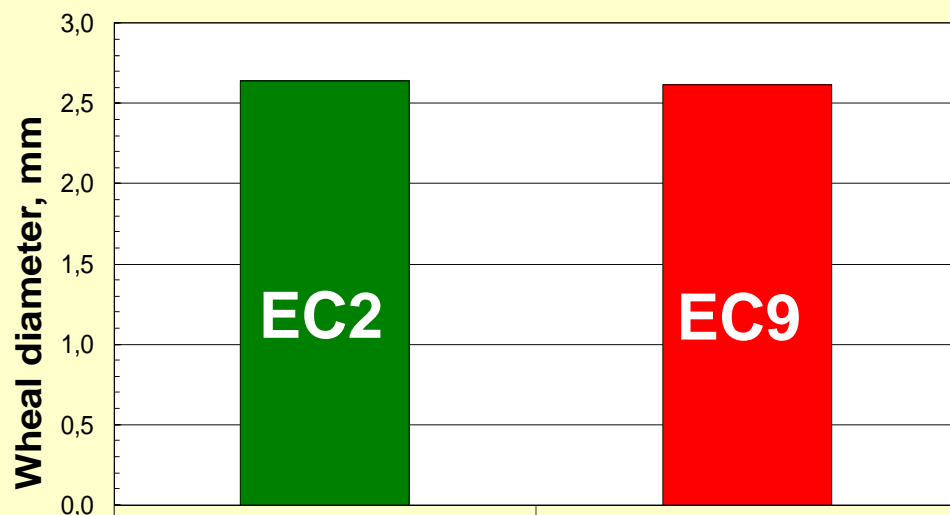
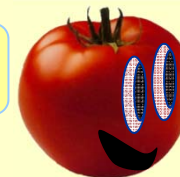


glucose (= fructose)



The second factor, such as radiation, can even annul K-effects

Nutrient effect (EC, N) – on health (allergens)

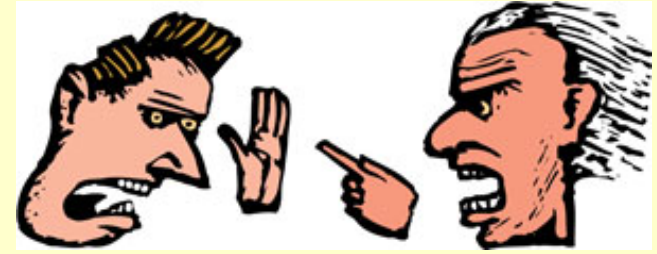


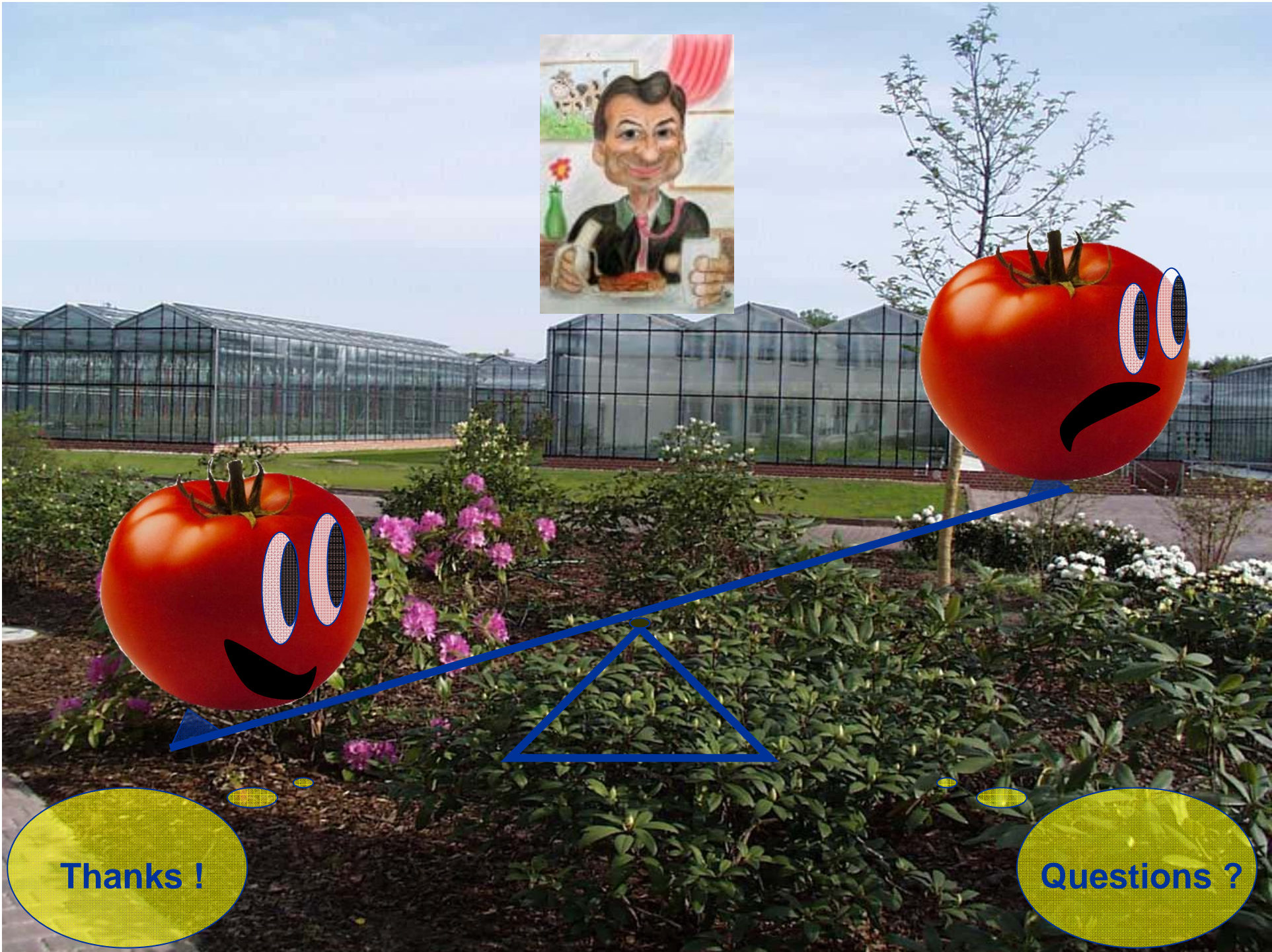
Schwarz et al., 2011
Dölle et al. 2011

Effects may interact with other conditions, however, reduction of the allergenic potential is not possible

4. Conclusions

- Hydroponic cultivation is a helpful tool to control production and quality efficiently
- Effects on physical properties and taste related characteristics are easy to gain. Primary metabolism can be simply affected.
- It is difficult to manipulate quality related to health. Hydroponics does not effect really the secondary metabolisms
- Available knowledge must be implemented into available management systems
- Cost benefits are needed particularly when demands on yield and quality are conflicting.
- Plant, environmental and consumer demands need to be balanced





Thanks !

Questions ?