Salinity Effects on Fruit Yield in Vegetable Crops: a simulation study

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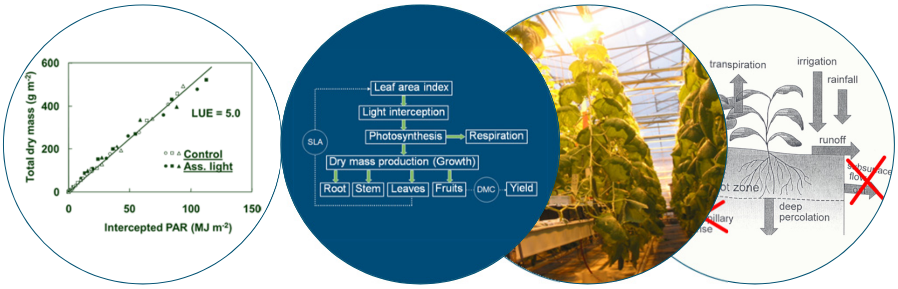

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Salinity Effects on Fruit Yield in Vegetable Crops

- *via plant-water relations* -

- Increase fruit dry matter content
  →*But reduce fresh yield (less dilution with water)*
- Reduce leaf expansion
  →*Not enough turgor to extend leaf area*
  → *Less LAI, less light interception, less yield*
- Stomatal closure
  → *Stomata partly close, to reduce transpiration*
  → *Higher resistance for CO2, less Photosynthesis*

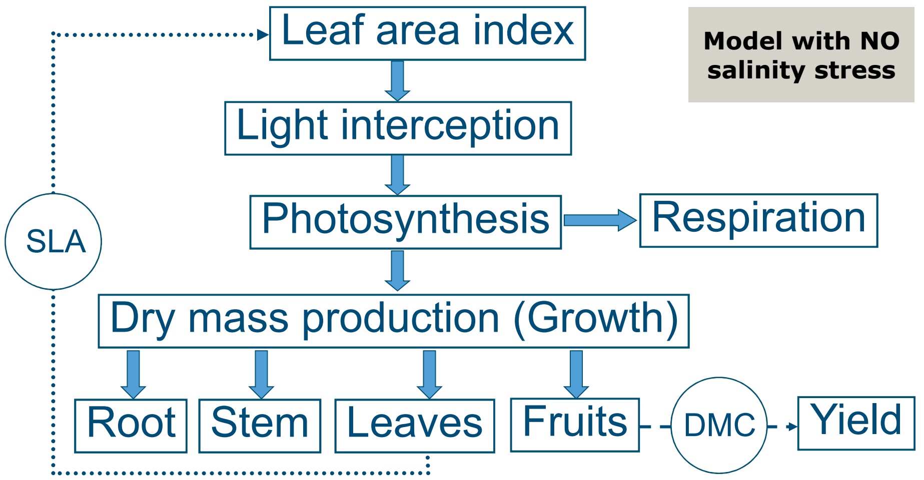
Nutrients in high salinity solution reduce the water potential at soil level, and consequently in the whole plant (via osmotic potential of the soil solution)

Aim: Determine salinity impact on fruit yield of single and combined effects

Approach: Simulation study (model TOMSIM)

Salinity Effects on Fruit Yield in Vegetable Crops

- Crop growth: principles of the simulation model -



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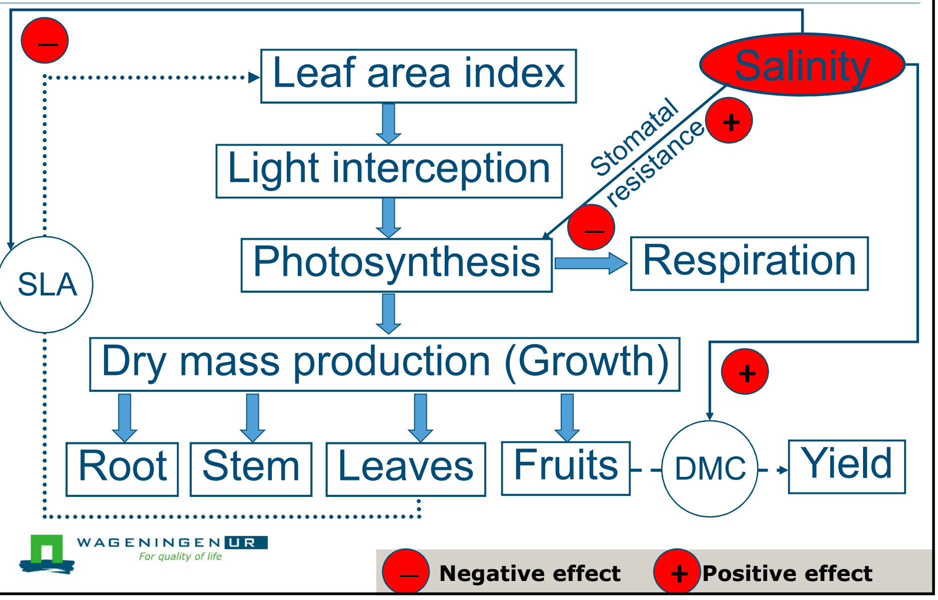
- Crop growth model: influence of salinity -



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-Quantifying salinity effects -

- Fruit dry matter content (DMC)
  5% at EC=2 dS m^{-1}; linear increase by 0.2% per dS m^{-1}
- Leaf Area Expansion
  - SLA according to seasonal pattern
  - decrease 8% per dS m^{-1} (from threshold 3 or 6 dS m^{-1})
- Stomatal resistance
  50 s m^{-1}; increase with EC over the range 1 to 10 dS m^{-1} by either a factor 2 or a factor 4

Li et al. (2001); Li & Stanghellini (2001)

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Salinity effects on fruit yield in vegetative crops

Dry matter production: explanatory crop growth model

$$dW/dt = C_f\,(P_{gd} - R_m)$$

dW/dt = Crop Growth Rate (g DM m^{-2} d^{-1})

P_{gd} = Crop gross Assimilation Rate (g CH_2O m^{-2} d^{-1})

(In the model all leaves have identical photosynthetic properties)

R_m = Maintenance Respiration Rate (g CH_2O m^{-2} d^{-1})

(Depends on Organ Dry Weight, Temperature, RGR)

C_f = Conversion Efficiency (g DM $g^{-1}CH_2O$)

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- the simulation model: Dry Matter partitioning -

- Regulated by the sinks
  (fruit trusses and vegetative units)
- Sink strength = demand for assimilates
  = potential growth rate
- $\textit{Fraction to organ} = \dfrac{\textit{Sink strengh of organ}}{\textit{Sum of all organs' sink strengths}}$
- One common assimilate pool

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More information is given in Chapter 5, dry matter partitioning

Experiments for Salinity Effects

simulation settings

Crop:

- Start January 10; flowering of first tomato truss
- End: September 7 (day 250)
- Plant density 2.5 plants m^{-2}
- No side shoots retained; no decapitation
- All trusses 7 fruits (no abortion simulated)

Greenhouse climate:

- 20°C; 350 ppm CO_2;
  average radiation The Netherlands

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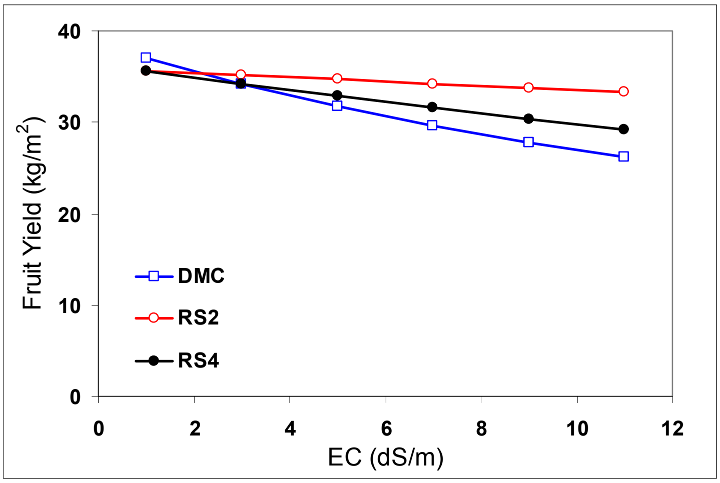
Experiments for salinity effects

Results (1)

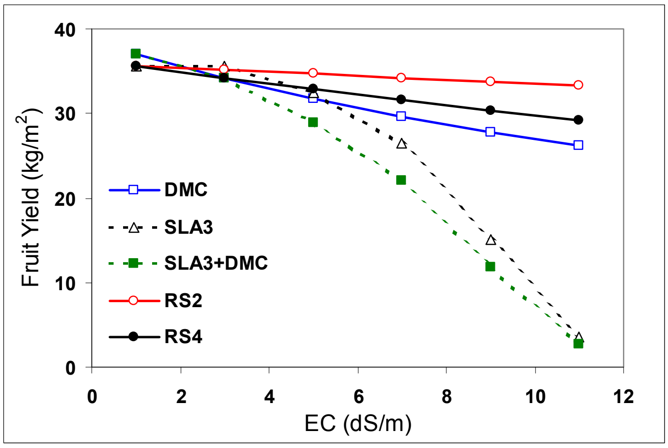


Impact on fruit yield by Increased dry matter content (DMC) or Stomatal resistance (RS2 - factor 2; RS4 - factor 4)

Both these two factors: Increased fruit dry matter content and stomatal resistance have **modest impact** on yield (2-3 % yield loss per dS m-1)

Experiments for salinity effects

Results (2)

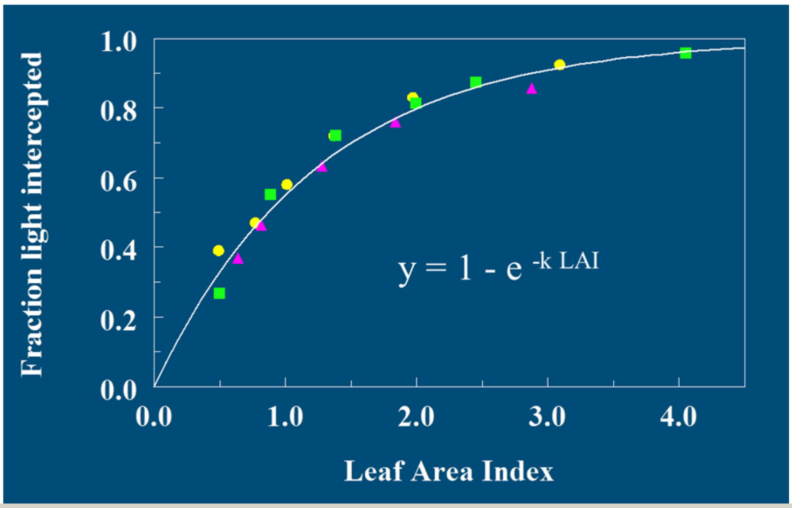


Impact on fruit yield by reduced SLA

- *8% per (dS m^{-1})*
- *threshold 3 dS m^{-1}*

Strongest salinity effects result from effects on **leaf expansion (reduced SLA)** (12-17% yield loss per dS m^{-1})

Influence of Leaf Area Index (LAI) on the fraction of light intercepted by a tomato crop (k = extinction coefficient = 0.8)



- Higher EC at low LAI has bigger impact on light interception.
- To reduce yield loss caused by high EC, **high LAI** is preferred

Salinity Effects on Fruit Yield in Vegetable Crops

- *how to mitigate salinity effect via leaf expansion* -

What can a grower do to mitigate salinity effect via leaf expansion ?

2 Hypotheses:

- **Increase plant density**
- **Delay leaf picking**

- To verify the hypotheses, following experiments were conducted …

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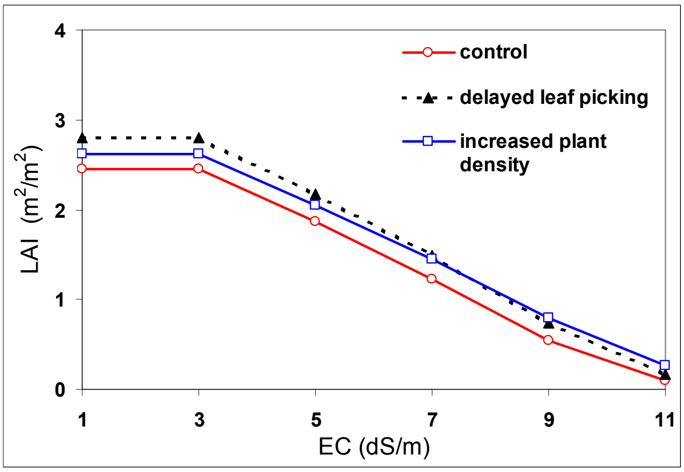
mitigate salinity effect - influencing Leaf Area Index (LAI)



- LAI is drastically declined with high EC level, because of decreased SLA
- Increased plant density and delayed leaf picking gave relatively **higher LAI**

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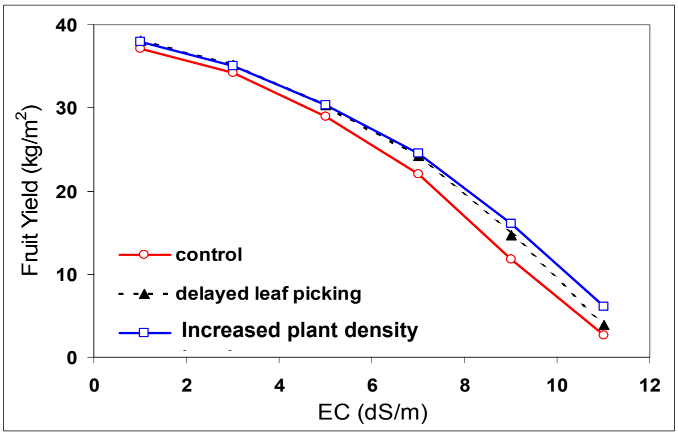
mitigate salinity effect – effect on fruit yield



- Delayed leaf picking and increased plant density has **positive effect** on reducing yield loss caused by high EC.

Salinity Effects on Fruit Yield in Vegetable Crops

- *conclusions* -

Conclusions:

- Increased fruit dry matter content or stomatal resistance modest impact on yield (2-3 % yield loss per dS m^{-1})
- Strongest salinity effects result from effects on leaf expansion (12-17 % yield loss per dS m^{-1})
- Delayed leaf picking or increased plant density mitigate this negative effect

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❖ Within the ranging of EC between 1 and 11