“Influence of waterquality, EC and pH on sustainability in relation to chemical cropprotection in horticulture”…….

"Hariduse juured on kibedad,
aga vili on magus"...

Aristoteles

Market trends (in Europe)

- The **demand** *(customer awareness)* for environmentally friendly production has increased
- Regular loss of products because of this reason *(no sales)*
- Margins for growers are under pressure = production costs control and higher cultivation reliability are necessary.
- Trade and consumer demand higher quality and stronger product

How to fight diseases in our crops:

1. **What does fungi need to start:**
   - Spores or other sources of contamination.
   - Susceptible plants
   - High humidity and right temperature

2. **Which action is the best to do:**

	Success %
Remove all spores and avoid contamination	0
Use the right chemicals/treatment against fungi	20
Increase plant quality	*50*
Control the climate	30

80% !!

Why is sustainability a future need?

- It becomes very difficult to register new chemicals, due to environmental reasons.
  - The number of chemicals goes down every year.
  - Development new ones limited and very expensive.
- A sustainable production is WHO target for future development of agriculture world wide. (World Health Organisation)
- Society opposition against chemicals to avoid damage to nature, water, bees, and bio-diversity.

GET AWAY FROM GUT FEELING !!!

- Instead of defending the **relative** quality of plants,

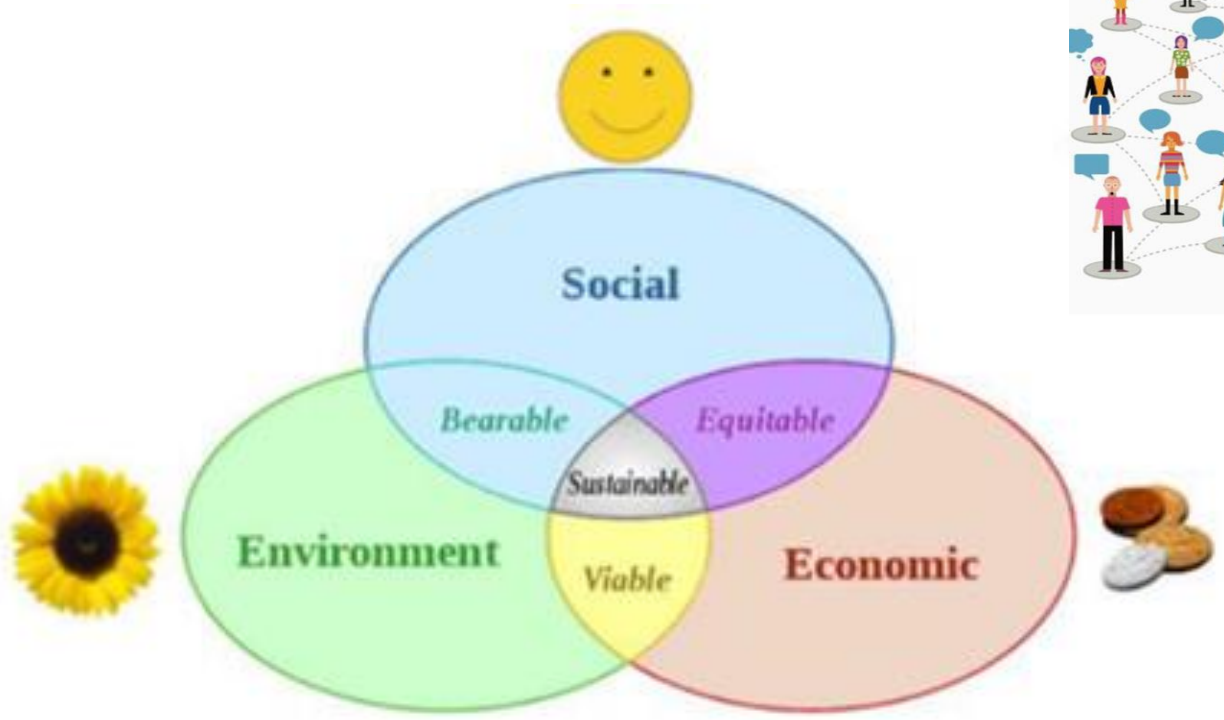
- we'll need **to invest** significant resources in the creation of repeatable, scientific growing processes and procedures

- that will focus on **objective data points** rather than subjective "gut feelings"

Sustainability

Most issues are combinations of social, environmental and economic.

If you create a solution that considers all three, then you are being sustainable and have achieved a win – win - win



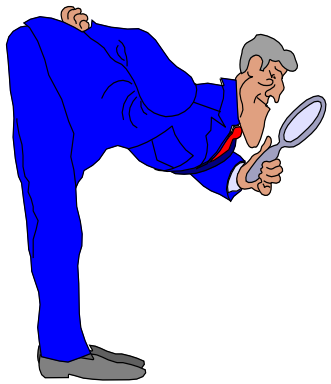
Viable = realistic

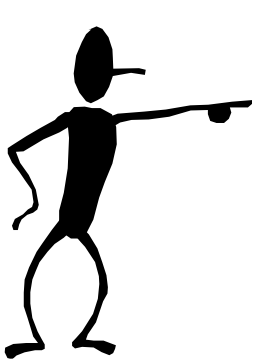
Equitable = fair

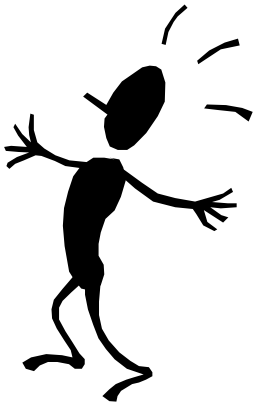
Bearable = tolerable

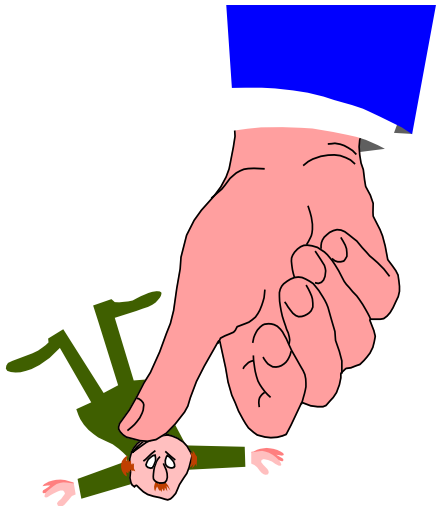
What should YOU do ?

Focus	Choose	Solve
what's the problem	*which to solve first*	*how to do it*









These topics we are going to highlight today

Substrate	Future peat-free compositions
Greenhouse climate	Some attention points
Light	Amount and spectrum
Water	Quality, Stability, Availability,
Nutrition/Fertilization	Composition, EC levels, Growth inhibition
New developments	Resilience cultivation, New developments

Substrate

Future peat-free compositions

These partners (University/NGO's) are involved in the development and building peat-free future

Goal:

- Clear targets for **2025, 2030, and 2050** to increase the use of renewable resources.
- Investment in innovation and research to develop alternative raw materials and growing media.
- Responsible peat use with mandatory certification through the *RPP* label.
- Active consumer education and market transparency.

(RPP - Foundation Responsibly Produced Peat)

Strategy of participating partners

- Step 1. Increasing the supply of renewable raw materials
- Step 2. Pre-processing and stabilization
- Step 3. Sanitation and Plant Health
- Step 4. Food Safety and Environmental Impact
- Step 5. Basic Knowledge and Application
- Step 6. Application-Oriented Knowledge Development
- Step 7. Regulations and specific applications

Biochar.

Residual material released during the production of methane from organic raw materials at high temperatures and oxygen-free conditions (temperatures >600˚C).

Basic requirements substrate

- reliable supplier
- constant quality
- don’t save on the price
- add a standard nutrition + pH buffer
- good structure till end of production
- air filled porosity
- waterholding capacity
- disease free
- pH 5,5 - 6,5
- EC +/- 0.6 – 0.8
- packaging / storage

50 cents/litre 30 cents/litre

Current substrate parts

- White and black peat
- Cocopeat, coco fibre
- Composted Bark / wood fibre

https://www.rhp.nl/en/new-growing-media

Future renewable peat-free substrate parts

- Biochar
- Woodfibre
- Expended clay
- Bark
- Cocopeat
- Rice husk
- woody waste
- poorly degradable straw
- easily degradable fibers
- Bagasse (By-product of sugar cane)
- By purpose produced green products
- Etc….

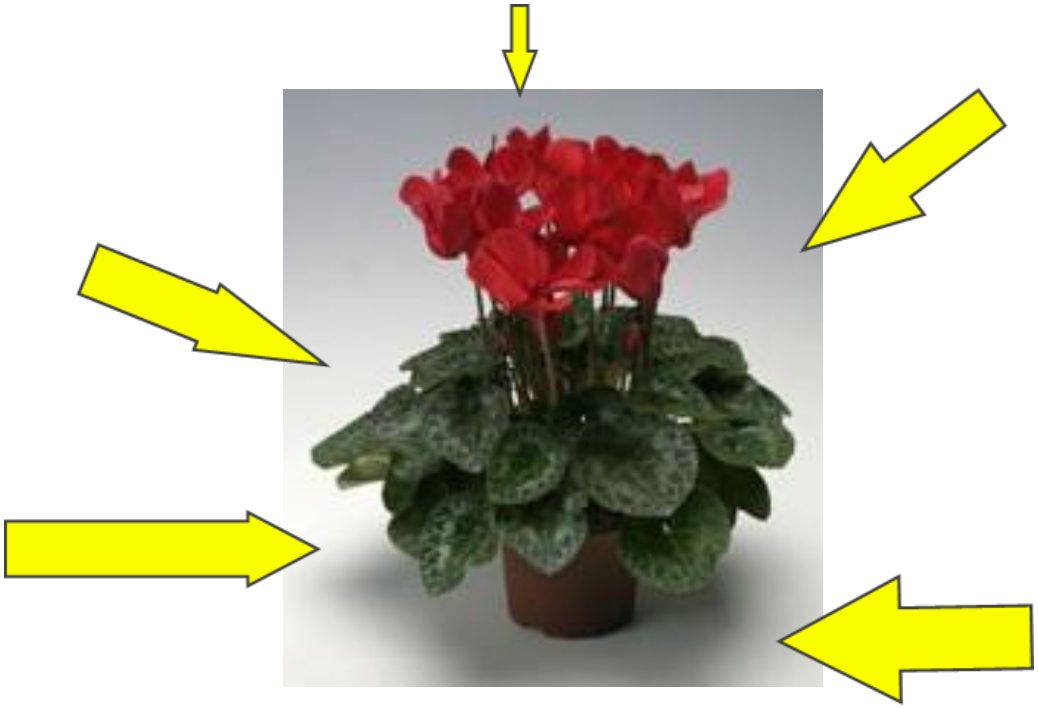
Examples of alternative peat-free products.

bark woodfibre cocopeat rice husks biochar

Greenhouse *climate* related topics

Climate is everything in the surrounding of the plant

- Temperature
- Air humidity
- Light
- Radiation
- Air circulation
- CO2 = Carbon dioxide
- Pesticides, growth retardants
- (air pollution)



Botrytis, firsts sign of a bad climate

- Infection takes place by *wounds or direct penetration* of *soft tissue.* (this tissue being either very young or old).
- Germination of spores: *4-25ºC and high humidity*
- The amount of water needed for germination and infection of Botrytis is a *relative humidity of 94%* during at least *8 hours* or an *8 hour period of free water* on the leaves.
- Lesions appear within *2 to 3 days at 4ºC* and *within 24 hours at 25ºC.*

Summary of Climate rules

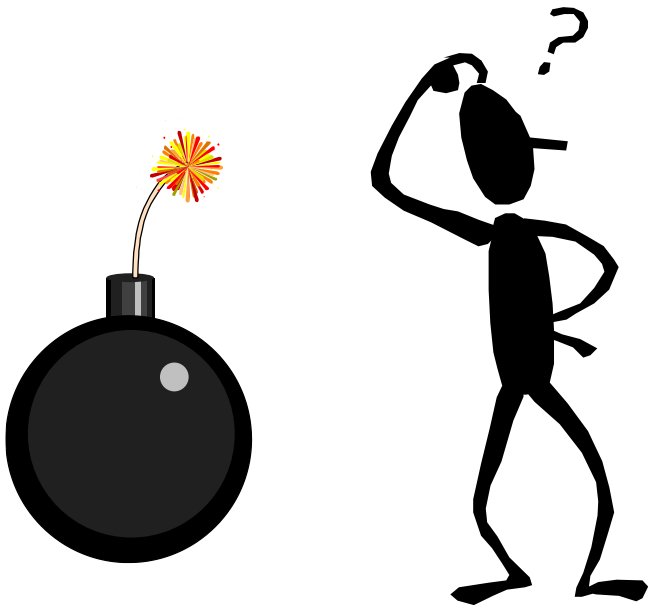
- don't give too much water. *(look at daylength, temp. light intensity)*
- try to grow as regularly as possible. *(like flying, or driving)*
- carry off always (high) humidity. *(keep windows open)*
- prevent big shakes in temp. RH and radiation. *(light intensity)*
- use heating system in time. *(even in August nights)*
- be aware of day and night differences. *(spring and autumn)*
- control climate between the plants. *(is far higher than average)*
- react proactive on weather changes. *(be informed about weather forecast)*
- avoid problems by taking action immediately. *(don't postpone)*
- *Ventilate!!* Also in winter. ***(RH and CO_2)***

Remember !!

A

Bad climate

is the most important reason of all possible problems !!

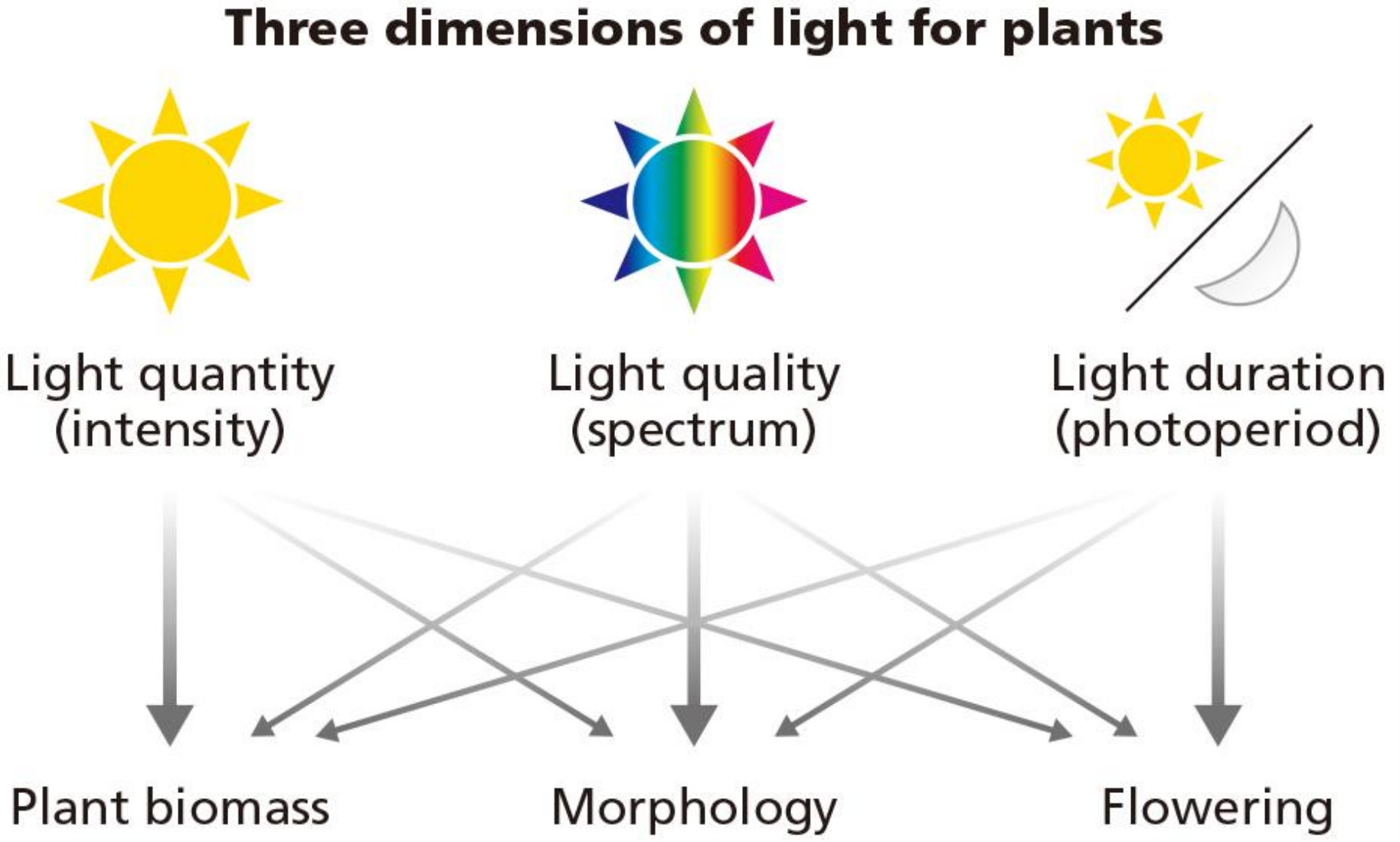


and one of the first aspects that must be solved as soon as possible.

Light

Light spectrum has a significant impact on a wide variety of plant processes including photosynthesis and photomorphogenesis which in turn impact plant productivity.

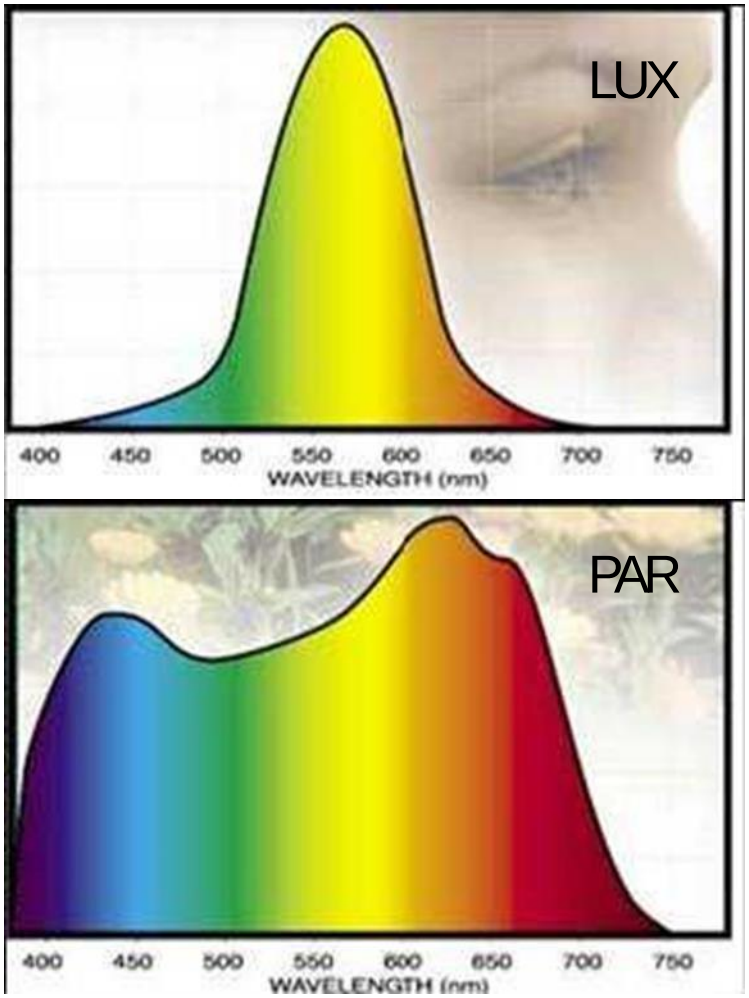
- **Your assumption??**
  - In Estonia easily the minimum factor in winter?
- **Negative for Estonia**
  - Daylength, low sun position to horizon
- **Positive for Estonia**
  - Frost days is regular clear sky
  - Snow means light reflection


Three dimensions of light for plants
Light quantity (intensity)
Light quality (spectrum)
Light duration (photoperiod)
Plant biomass
Morphology
Flowering

Light response difference human eye and plants.

LUX 380-780 nm

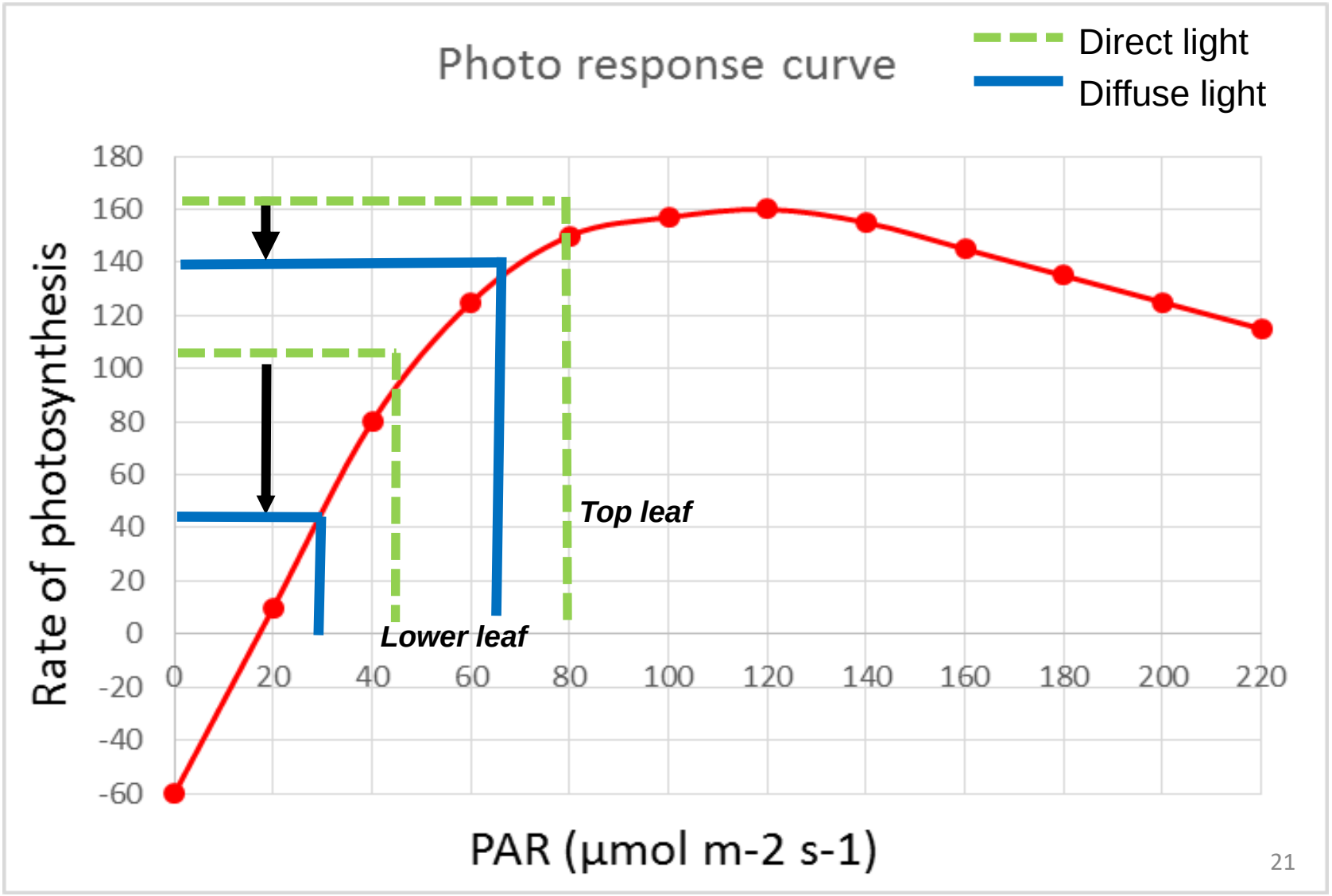
PAR (µmol) 400-700



- Light HPS-lamps (high pressure sodium) is yellow-orange:
  - highest sensitivity of human eye
- Light in horticulture:
  - µmol/m2/s is the only reliable,
  - Lux unfit for use!
- Use a PAR-meter!
  - (photosynthetic active radiation)

Difference in leaf activity = assimilation speed

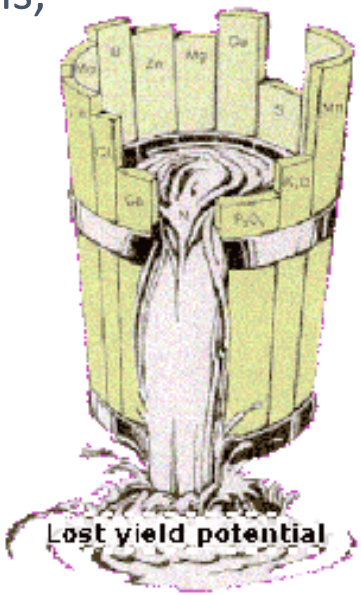
Fotosynthese with direct and diffuse light



Water Most important ingredient of the plant.

The next questions need to be answered:

- Do I know the quality of the water?
- Is there a big chance on change? Seasonal, weather conditions, environment, pollution?
- Is it recent information? Test it once a year!
- Does it meet my quality demands? And what are they?
- If not, do I have alternatives?
- Can I adapt the fertilizer accordingly?
- Do I need some help?



Water

The most important factor in plant production

In case the quality is out of line next problems can occur

- Destroyed soil structure
- Cause direct salt damage to leaves and roots
- Individual ion toxicities or deficiencies
- Wrong pH which decreases fertilizer uptake
- Introduction and spread of fungi and bacteria
- Stunting, chlorosis, poor development

*Advice: **rain water** should be the first choice*

Eurofins Holland laboratories water analysis result

Results		analysis	guideline	converted results	
	pH	7,8	5,5-7,5		
mS/cm 25°C	EC	0,2	<0,5		
Cations mmol/l	NH_4	< 0,1	<0,3	< 1,9	ppm
	K	< 0,1	<1,0	< 4,0	ppm
	Na	0,6	<1,5	14	ppm
	Ca	0,7	<1,0	28	ppm
	Mg	< 0,1	<1,0	< 2,5	ppm
Anions mmol/l	NO_3	0,5	<2,0	31	ppm
	Cl	0,6	<1,5	21	ppm
	S	< 0,1	<1,0	< 3,3	ppm
	HCO_3	1,0	<3,0	61	ppm
	P	< 0,04	<0,20	< 1,3	ppm
Micro-nutrients µmol/l	Fe	0,2	<10	11	ppb
	Mn	< 0,1	<3	< 5,5	ppb
	Zn	0,5	<2	33	ppb
	B	3,0	<10	32	ppb
	Cu	< 0,1	<1,0	< 6,4	ppb
	Mo	< 0,1	<0,8	< 9,6	ppb
mmol/l	Si	0,04	<1,5	1,1	ppm

Converted results: ppm = mg/l and ppb = µg/l.

- All important elements
- Analysis in mmol and Umol per liter
- Converted into ppm = mg per liter
- A guideline for the risky levels

Rainwater collection

Advantage: free water, high quality

- Collecting equipment
- Gutters, pipes,
- Basin, tanks, pumps,
- Plastic on slopes with basin in case no sufficient tunnels

- Yearly amount of rain + melted snow
- Average Estonia 750 mm total * +/- 50% = 400 mm / year

- Example: 400 mm = 400 ltr / m2
- 1000 m2 greenhouse * 400 ltr / m2 = 400.000 ltr/year means **400 m3 in total per year.**

Waterquality examples Estonian growers

EC	pH	NH4	K	Na	Ca	Mg	NO3	Cl	SO4	HCO3	PO4	Si	Fe	Mn	Zn	B	Cu	Mo
0.50	8.00	0.10	0.30	1.80	1.10	0.60	0.40	1.70	0.30	1.70	0.04	0.11	1.60	1.30	0.40	11.00	0.10	0.10
0.50	7.50	0.10	0.30	1.00	1.30	0.60	0.40	0.80	0.80	1.70	0.04	0.04	32.00	2.50	0.30	2.70	0.10	0.10
0.80	7.10	0.10	0.30	0.50	3.70	0.90	0.30	0.40	0.90	5.90	0.04	0.13	0.90	0.40	0.10	9.70	0.10	0.10
0.60	7.30	0.10	0.30	0.80	1.90	0.80	0.10	0.60	0.60	4.00	0.04	0.09	0.40	0.10	0.10	20.00	0.10	0.10
0.40	7.40	0.10	0.20	0.60	1.10	0.70	0.10	0.60	0.20	2.20	0.04	0.06	0.80	0.10	0.40	1.00	0.20	0.10
0.80	7.30	0.10	0.30	0.90	3.10	1.30	0.60	0.80	0.50	4.90	0.04	0.16	0.80	0.20	1.20	1.00	0.20	0.10
0.29	7.66	0.01	0.10	0.09	1.22	0.36	0.01	0.07	0.05	3.11	0.00	0.00	0.54	2.18	0.31	4.63	0.09	0.05
0.70	7.17	0.04	0.10	0.00	3.14	0.70	0.03	0.00	0.51	6.36	0.00	0.00	1.07	364.03	96.36	4.72	64.52	6.05
0.90	7.50	0.10	0.40	1.00	3.20	1.00	0.40	1.20	1.70	4.00	0.04	0.08	0.20	1.50	0.50	2.60	0.10	0.10

- All of them has too hard water, and need adjustments (HCO_3 > 0.5 - <1.0 mmol/ltr)
- pH has no direct link with hardiness. (HCO_3)
- Huge differences per grower means different fertilization schedule for the same crops!

Main impact of minor elements:

Fe	Mn	Zn	B	Cu	Mo	Si
1,60	1,30	0,40	11,00	0,10	0,10	0,11
32,00	2,50	0,30	2,70	0,10	0,10	0,04
0,90	0,40	0,10	9,70	0,10	0,10	0,13
0,40	0,10	0,10	20,00	0,10	0,10	0,09
0,30	0,10	0,10	3,50	0,10	0,10	0,10
0,80	0,10	0,40	1,00	0,20	0,10	0,06
0,80	0,20	1,20	1,00	0,20	0,10	0,16
0,54	2,18	0,31	4,63	0,09	0,05	0,00

Too less / too much

- Mn **-** = chlorosis young leaves like Fe.
  + = less Ca transport
- Zn **-** = malformation of leaves
  + = antagonism with Fe.
- B **-** = dying tips, roots and leaf edges
  + = necrotic dots in leaf edge
- Cu **-** = complete yellowing young leaves
  + = dwarfs, lack of Iron
- Mo **-** = N-deficiency
  + = gold-yellowing of shoots

Problems of a wrong pH

- In general the different elements are too much or too less soluble, what gives a big imbalance in availability of them.
  - = bad development and bad quality

- Too low = bad uptake of Phosphorus and Calcium
- Too high = bad uptake of minor elements as Mn, B, Fe

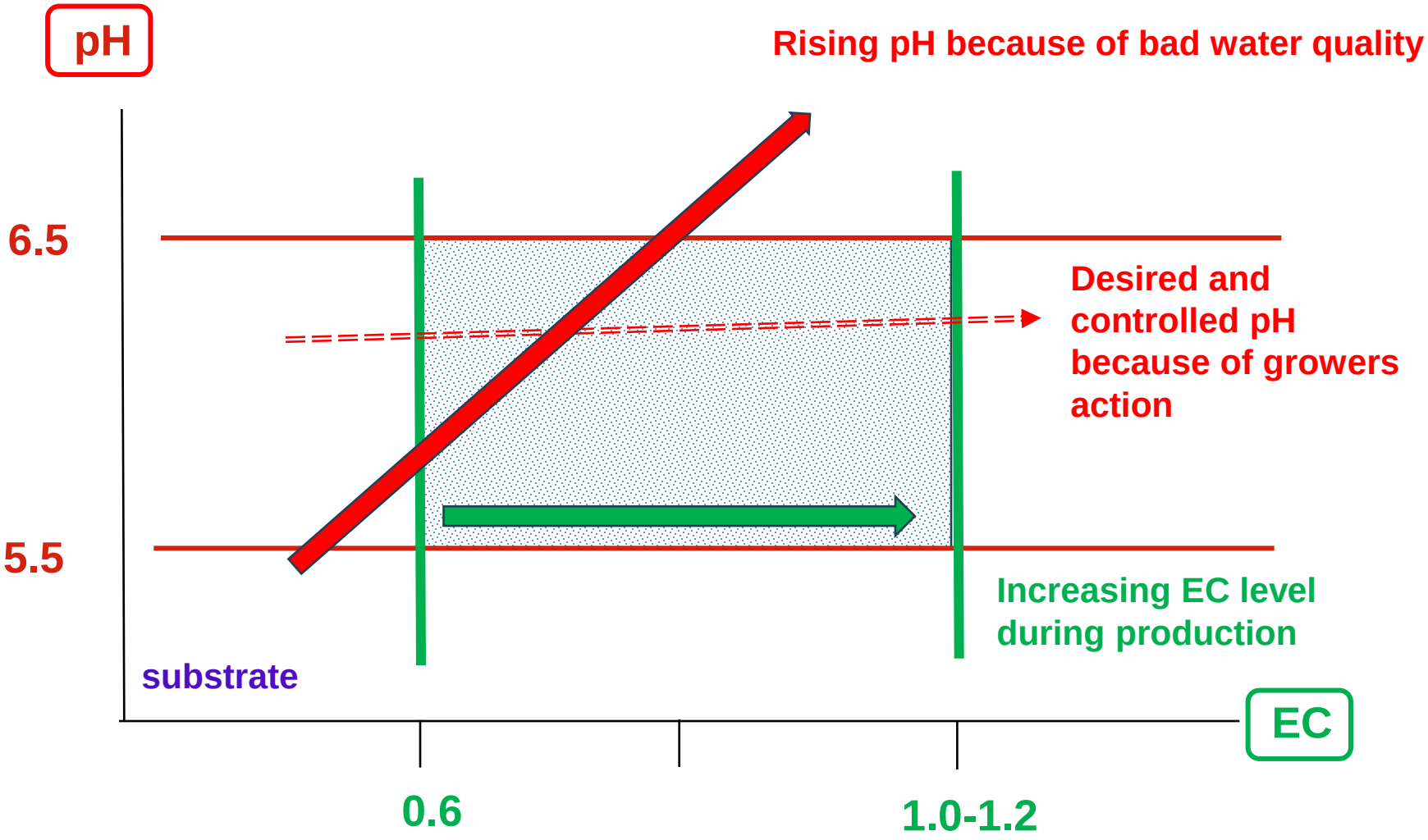
- *pH changes are going up or down rather slow, so pH level need constant attention and action*.

Overview of solubility of elements at different pH

Excess Manganese (Mn) Iron (Fe) Boron (B) Copper (Cu) Zinc (Zn) Sodium (Na) Nitrogen (NH4) **Deficient** Calcium (Ca) Magnesium (Mg) Phosphorus (P) Potassium (K) Sulfur (S) Molybdenium (Mo)	Readily available	**Excess** Calcium (Ca) Nitrogen (NH4) **Deficient** Manganese (Mn) Iron (Fe) Boron (B) Copper (Cu) Zinc (Zn) Magnesium (Mg) Phosphorus (P)

pH range **5. 5** **6. 5**

Optimal pH values (your situation?)



Problems of a too high pH

pH = yellowing = Fe lack
What makes the difference?

Most sensitive crops:
Petunia and Calibrachoa

Problems of a too high pH

- pH problem in Petunia seedlings

and

Gerbera youngplants

The most simple option to increase water quality…??

Dilution!!

With rainwater quality

MACRO NUTRIENTS or major elements which are required by the plant in fairly **large amounts**.

- **6 MINERAL NUTRIENTS**
  - N, Nitrogen
  - P, Phosphorus
  - K, Potassium
  - Ca, Calcium
  - Mg, Magnesium
  - S, Sulphur
- **3 NON-MINERAL NUTRIENTS**
  - C, Carbon
  - H, Hydrogen
  - O, Oxygen

MICRO NUTRIENTS or minor elements which are required by the plant in relatively **small amounts.**

- **6 MICRO NUTRIENTS**
  - Fe, Iron
  - Zn, Zinc
  - Mn, Manganese
  - B, Boron
  - Mo, Molybdenum
  - Cu, Copper
  - (Cl, Chlorine)

EC 1,048 and still yellowing and no shoots

What does this mean?

Low nitrogen treatment

= actual way of thinking !!

- Result: weak, hungry
- sensitive for diseases
- too early flowering
- no branching

Too less food, no quality

What about shelf live you think ?

Importance of the right fertilization !!

Lack of Boron

Lack of Calcium in fruits and salad

Blossom End Rot

Cork or dod edge in apple

Edge in lettuce

Allocation of elements 1:

Easy/mobile: K, N, S, Mg

- They can be relocated from older plant parts
- Shortages first visible in the older / lower parts of the plant.

NO_3

K

NO_3

Allocation of elements 2:

Difficult/immobile: Ca, Fe

- Fertilisers are fixed in the plant and can't be relocated
- Shortages first visible in the youngest parts of the plant.

Ca

Fe

EC = Electric Conductivity from the total diluted salts

Does the EC inform us about the fertilizer level of the substrate?

NO

- Attention: the EC is the value of the TOTAL diluted elements
- It can be only NaCl, so it say nothing about the chemical composition.

Yes

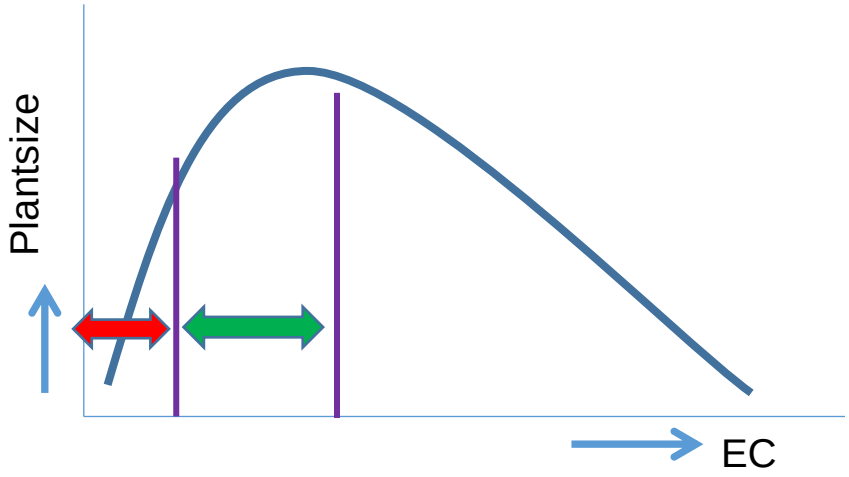
- When you have a complete analysis from the water or the substrate
- Or you know which fertilisers has been given the last weeks.

Possibilities of *Growth Regulation*

- Choice of genetic material. (variety)
- Light = distance, space, additional light
- Amount of water
- **Amount of fertilizer** *(EC level)*
- **Balance of elements.** *(LOW PHOSPHATE)*
- Average growth temperature
- DIF and quick temperature drop
- Chemicals *(Bonzi, Alar, CCC)*

Or a combination of these

Balans water stress ⟺ fertilizers



Optimal EC depends on:

- Crop
- Development phase
- Climate
- Day/night rythm (daylength, assimilation capacity)

- High radiation → more cooling = more evaporation needed → EC ↓
- Too high EC → difficult calcium transport
- Target values substrate > 0.8 -1.2 EC in the substrate at sales
- In most cases the drip EC should be almost doubled

EC differences trial: size and color

Salvia

Zinnia

Cyclamen EC differences

Too low **Okay** **Too much**

Results of the right EC use….

NO PGR’s.

A- and B- tank system

- Why are all fertilisers shared over an A-tank and an B-tank?

  Because Calcium and Sulphate forms insoluble gypsum at high concentrations ($CaSO_4$)

- Which elements (ions) are not allowed together, and why not?

  So keep Calcium always apart from SO_4 and PO_4

Example A- and B-tank system on rainwater

Drip EC:	2.0	Grower:	Sittig
Tank size (Litres):	1000	Country:	South Africa
Concentration:	100%	Culture:	Pansy etc.
Water from well:	0%	Soil analysis:	No
Ureum:	0%	Advice:	standard whole culture
Potas. Phosphite Y/N:		Water	Rainwater
P2O5 +/- :	100%		
SO4 +/- :	100%	Schedule:	F 12 - Group 3 generative
NH4 /- :	100%		

	1000 litre A			Tank composition		1000 litre B	
Calcium Nitrate (sol)		80.6	Kg.	Nitric Acid	60%	----	L.
Ammoniumnitrate (liq)	18.0%	7.4	L.	Phosphoric Acid	59%	----	L.
Potassiumnitrate		11.3	Kg	Potassiumnitrate		38.6	Kg.
Nitric Acid	60%	----	L.	Mono Potassium Phosphate		14.5	Kg.
Magnesiumnitrate (liq)		----	L.	Magnesium Sulphate		26.3	Kg.
Ureum		----	Kg.	Potassium Sulphate		23.2	Kg.
Calcium Chloride		----	Kg.				
		101.0	Kg.			102.7	Kg.
Fe. DTPA (sol)	11.6%	705	Gr.	Manganese Sulphate (Sol)		85	Gr.
				Zinc Sulphate (sol)		81	Gr.
% Calcium Nitrate kg`s		*40%*		Borax (sol)		143	Gr.
% Magnesium Sulfaat kg`s		*13%*		Copper Sulphate 25% (sol)		13	Gr.
% Potassium Sulfaat kg`s		*11%*		Sodium Molybdate (sol)		12	Gr.
HCO3 buffer mmol		*0.00*					

	Balance:	N	P	K	Mg	Ca	
		1	0.37	2.0	0.21	1.0	

Example A- and B-tank system on groundwater

Drip EC:	2.0	Grower:	Sittig
Tank size (Litres):	1000	Country:	South Africa
Concentration:	100%	Culture:	Pansy etc.
Water from well:	100%	Soil analysis:	No
Ureum:	0%	Advice:	standard whole culture
Potas. Phosphite Y/N:		Water:	Groundwater
P2O5 +/- :	100%		
SO4 +/- :	100%	Schedule:	F 12 - Group 3 generative
NH4 /- :	100%		

1000 litre A				Tank composition	1000 litre B		
Calcium Nitrate (sol)		58.0	Kg.	Nitric Acid	60%	12.8	L.
Ammoniumnitrate (liq)	18.0%	10.1	L.	Phosphoric Acid	59%	----	L.
Potassiumnitrate		18.9	Kg	Potassiumnitrate		31.9	Kg.
Nitric Acid	60%	4.3	L.	Mono Potassium Phosphate		14.5	Kg.
Magnesiumnitrate (liq)		----	L.	Magnesium Sulphate		12.1	Kg.
Ureum		----	Kg.	Potassium Sulphate		19.3	Kg.
Calcium Chloride		----	Kg.				
		94.7	Kg.			93.7	Kg.
Fe. DTPA (sol)	11.6%	686	Gr.	Manganese Sulphate (Sol)		81	Gr.
				Zinc Sulphate (sol)		78	Gr.
% Calcium Nitrate kg`s		*31%*		Borax (sol)		----	Gr.
% Magnesium Sulfaat kg`s		*6%*		Copper Sulphate 25% (sol)		10	Gr.
% Potassium Sulfaat kg`s		*10%*		Sodium Molybdate (sol)		10	Gr.
HCO3 buffer mmol		*1.00*					

	Balance:	N	P	K	Mg	Ca	
		1	0.35	1.9	0.20	1.0	

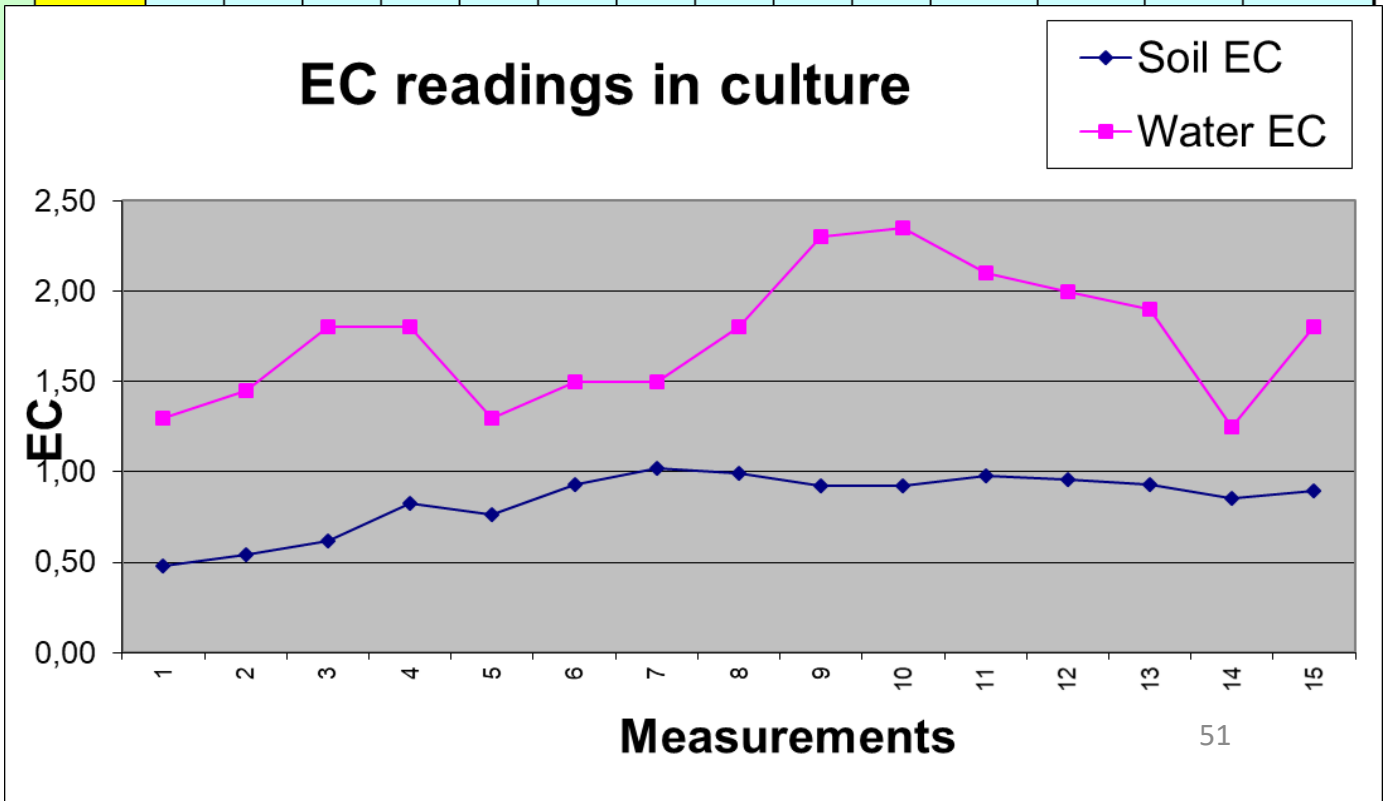
History and calculation is basis of today action. EC and pH

Substraat EC eigen metingen

Week nummer	Datum	Gewas	Oppot week	Geplande leverweek	Druppel Water EC	EC pot 1	EC pot 2	EC pot 3	EC pot 4	EC pot 5	EC pot 6	EC pot 7	EC pot 8	EC pot 9	EC pot 10	Hoogste meting	Laagste meting	Aantal potten	Gemiddelde pot EC
27	4-Jul-14	Cyclamen	18	34	1.50	0.62	0.64	0.67	0.63	0.63	0.64	0.72	0.51	0.66	0.64	0.72	0.51	8	0.64
28	11-Jul-14	"	18	34	1.50	0.71	0.57	0.82	0.63	0.54	0.58	0.83	0.76	0.72	0.66	0.83	0.54	8	0.68
29	18-Jul-14	"	18	34	1.80	0.89	0.61	0.75	0.74	0.83	0.61	0.79	0.73	0.80	0.51	0.89	0.51	8	0.73
30	25-Jul-14	"	18	34	1.80	0.90	0.70	0.89	0.61	0.75	0.74	0.83	0.61	0.79	1.00	1.00	0.61	8	0.78
31	1-Aug-14	"	18	34	2.00	0.92	0.89	0.67	0.89	0.61	0.75	0.74	0.83	0.61	0.79	0.92	0.61	8	0.77
32	8-Aug-14	"	18	34	2.00	0.78	0.89	0.61	0.75	0.74	0.83	0.61	0.79	1.20	0.88	1.20	0.61	8	0.78
33	15-Aug-14	"	18	34	2.30	0.70	0.78	0.99	0.88	0.90	0.98	0.79	0.88	0.90	1.30	1.30	0.70	8	0.89
34	22-Aug-14	"	18	34	2.30	0.90	0.78	0.89	0.83	1.04	1.08	0.76	0.88	1.19	1.50	1.50	0.76	8	0.95
35	29-Aug-14	"	18	34	2.30	0.80	0.78	0.88	0.83	1.19	1.20	0.79	0.91	1.34	1.76	1.76	0.78	8	0.99
36	5-Sep-14	"	18	34	2.00	0.86	0.78	0.70	0.82	1.33	1.31	0.81	0.93	1.48	1.00	1.48	0.70	8	0.98
37		"																	
38																			
39																			
40																			

Look at drip EC differences compared with substrate EC.

What's going on here?



Resilience **cultivation,** means future license to grow.??

Ability of enough and effective chemicals for crop protection will become a bigger problem in the near future due to legislation and social acceptance.

It is a must to prepare now already for that future.

Piisavate ja tõhusate taimekaitsekemikaalide olemasolu muutub lähitulevikus seadusandluse ja sotsiaalse aktsepteerimise tõttu suuremaks probleemiks.

Selleks on vaja juba praegu valmistuda

Summary Plant disease management strategies

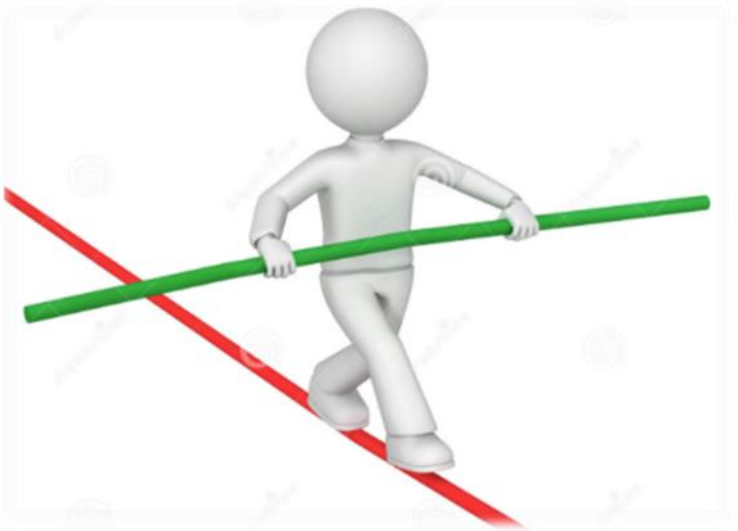
Follow the Traditional Principles of Plant Disease Control

- Avoidance — prevent disease by selecting a crop, a season or a site where the environment is not favorable for infection.
- Resistance — utilize cultivars that are resistant to or tolerant to infection.
- Daily action — **make plants happy** with balanced fertilization, pH and EC control
- Exclusion — prevent the introduction of disease/pest. (control incoming material)
- Protection — prevent infection by means of a barrier to infection. (insect mesh)
- Eradication — eliminate, destroy, or inactivate the enemy. (and affected plants)

Finally…

Edu ei ole lõplik, ebaõnnestumine ei ole saatuslik.

Oluline on julgus jätkata.



Winston Churchill