

Nutrient management in practice

The fertiliser recommendation system
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Nutrient management during crop development Reasons

- Restricted root volume
- Crop development (plant stage)
- Uptake differences (climate)
- Supply differences (technique)
- pH changings (plant)
- Reduce risks



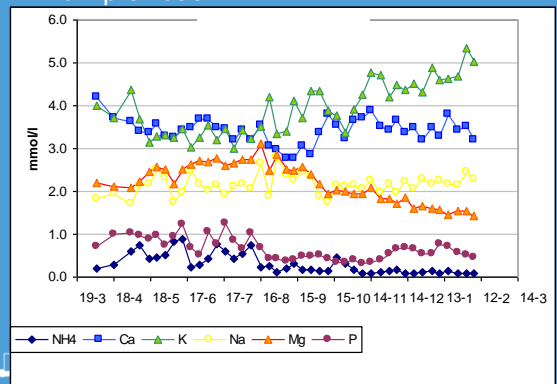
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Crop

- Standard nutrient solution
- Crop specific adjustments for:
 - substrate saturation
 - start of the crop
 - heavy fruit-load/vegetative development
 - termination of crop
- Sampling and analysis during cropping period

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Sampling and adjustments Example rose



Example nutrient solution TOMATO

	Free drainage		Closed system		Targets root environment	
	mmol/l	mg/l	mmol/l	mg/l	mmol/l	mg/l
EC ds m ⁻¹	2.6		1.6		3.7	
pH	5.5		5.5		5.5	
NH ₄	1	14	0.8	11	0	
K	9.5	371	6.5	254	8	313
Na	0	0	0	0	< 8	< 180
Ca	5.4	217	2.75	110	10	400
Mg	2.4	58	1.0	24	4.5	109
NO ₃	16.0	224	10.75	224	23	322
Cl	2.5	89	1.0	36	< 12	426
SO ₄	4.4	136	1.5	47	6.8	218
H ₂ PO ₄	1.5	48	1.25	40	1	32

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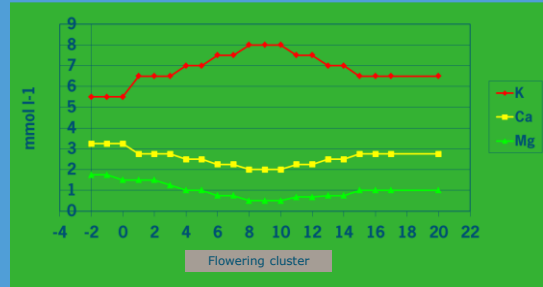
Rose

	Open system	Closed system	Target values root environment
EC	1.6	0.7	2
pH	5.5	5.5	5.5
NH ₄	1	0.8	0.1
K	4.5	2.2	5
Na	0	0	0
Ca	3.25	0.8	5
Mg	1.5	0.6	2.5
NO ₃	11.25	4.3	12.5
Cl	0	0	0
SO ₄	1.25	0.5	2.5
H ₂ PO ₄	1.25	0.5	0.9
Fe	25	15	25
Mn	5	5	3
Zn	3.5	3	3.5
B	20	20	20
Cu	0.75	0.5	1
Mo	0.5	0.5	0.5

Adjustments to standard solution

	Saturation Rock wool slab	start	Vegetative
EC			
pH			
NH4	0.5 -		0.25 +
K	0.5 -	0.5 -	0.5 +
Na			
Ca	0.35+	0.2+	0.5 -
Mg	0.15+		
NO3	0.5 -		
Cl			
SO4	0.35 +		
H2PO4	0.2 -		
Fe		15 +	
Mn			
Zn			
B	7 -		
Cu			
Mo			

Adjustments to crop development stage



How do you make adjustments ?

- The dilemmas of *changings* in nutrient solutions

Example

Nutrient Solution		Standard	fertiliser							
			mmol/l	NH4	K	Ca	Mg	SO4	P	NO3
NH4NO3			1	1			0.8	1	1	10
Ca(NO3)2			2.1			2.1				
MgSO4			0.8				0.8	0.8		
KH2PO4			1		1				1	
KNO3			4.8		4.8					4.8
K2SO4			0.2		0.4			0.2		

EC	mS/cm	1.5
NH4	mmol/l	1
K	mmol/l	5
Ca	mmol/l	2.5
Mg	mmol/l	1
NO3	mmol/l	10
SO4	mmol/l	1
P	mmol/l	1
Sum cations	meq/l	13
Sum anions	meq/l	13
K:Ca		2

fertilisers	mol weight	kg/m3 (concentrated)
A NH4NO3	1	156.1
Ca(NO3)2	2.1	320
B MgSO4	0.8	246.4
KH2PO4	1	136
KNO3	4.8	101.1
K2SO4	0.2	174.3

Example

Nutrient Solution	Standard	Extra K	Solution 1, Increase NO3 (EC increase)	Solution 2, equal settlement over all cations	Solution 3, settlement over Ca, Mg		
EC	mS/cm	1.5	?	1.6	1.5		
NH4	mmol/l	1	1	1	0.9		
K	mmol/l	5	25%	6.25	6.25	5.7	6.3
Ca	mmol/l	2.5		2.5	2.5	2.3	2.1
Mg	mmol/l	1		1	1	0.9	0.8
NO3	mmol/l	10		10	11.25	10	10
SO4	mmol/l	1		1	1	1	1
P	mmol/l	1		1	1	1	1
Sum cations	meq/l	13	14.3	13	13	13	13
Sum anions	meq/l	13	13	14.25	13	13	13
K:Ca		2	2.5	2.5	2.5	3.0	3.0

What is the effect

	standard	solution 1 EC increase	solution 2 equal settlement cations	solution 3 equal settlement Ca and Mg
fertilisers	kg/m3	kg/m3	kg/m3	kg/m3
NH4NO3	15.6	15.6	14.0	15.6
Ca(NO3)2	80.0	80.0	73.6	67.2
MgSO4	24.6	24.6	22.2	19.7
KH2PO4	13.6	13.6	13.6	13.6
KNO3	40.4	53.1	45.5	48.5
K2SO4	0.0	0.0	1.7	3.5
% K	11.6%	13.5%	13.6%	15.0%
% N	12.0%	12.8%	11.8%	12.0%
% Ca	8.7%	8.1%	8.2%	7.6%

Rules for adjustment

- 1. Determine deviation analysis from standard
- 2. Adjustments for growing stage
- 3. Corrections for EC adjustments
- 4. Corrections for water quality
 - Closed systems, corrections for drainage water
- 5. Equal settlement of cations/anions for equilibrium of the total ion-sum



Judgement analytical results

1. Individual elements

First step: judgement

K	
Boundary Values	
low	high
1	< 4.0
2	4.0 - 4.9
3	5.0 - 9.0
4	9.1 - 10.0
5	> 10.0

Second step: adjustment nutrient solution

adjustments	
1	2.0 +
2	1.0 +
3	0
4	1.0 -
5	2.0 -



Judgement analytical results II

2. other parameters

K:Ca ratio

K / Ca ratio	K	Ca
< 1.5	0.25 +	0.125-
1.5	0	0
> 1.5	0.5 -	0.25+



Standard nutrient solution												EC = 0.7
NH ₄	K	Ca	Mg	NO ₃	SO ₄	H ₂ PO ₄	Fe	Mn	Zn	B	Cu	Mo
0.8	2.2	0.8	0.6	4.3	0.5	0.5	15	5	3	20	0.5	0.5

Target values												EC(c) = 2.0
NH ₄	K	Ca	Mg	NO ₃	SO ₄	P	pH	Fe	Mn	Zn	B	Cu
< 0.5	5.0	5.0	2.5	12.5	2.5	0.9	5.2	25.0	3.0	3.5	20	1.0

Judgement corrected for EC (c)											
Element	NH ₄ *	K	Na*	Ca	Mg	NO ₃	Cl*	SO ₄	P		
laag	<	4.0		4.0	1.5	8.0		1.5	0.60		
hoog	>	7.0	6.0	7.5	4.0	16.0	8.0	4.0	1.20		
Buiten A.V.W.	<	3.0		2.0	0.75	5.0		1.0	0.25		
*	>	11.0	10.0	10.0	6.0	20.0	10.0	8.0	2.75		



Judgement not corrected for EC(c)

	HCO ₃	EC	pH	Fe	Mn	Zn	B	Cu
laag	<	1.5	5.0**	20.0	1.0	3.0	5	0.5
hoog	>	1.0	3.0	6.5	35.0	4.0	5.0	25
Buiten A.V.W.	<	1.0	6.0***	10.0		1.0	3	
*	>	2.0	4.0	7.0	65.0	10.0	20.0	60
								6.0

* Geen correctie EC(c) ** HCO₃ < 0.5 *** HCO₃ > 0.5



Boundaries for adjustments

	K	Ca	Mg	NO ₃	SO ₄	P
1	< 3.0	< 3.0		< 6.0		< 0.30
2	3.0-3.9	3.0-3.9	< 1.5	6.0-7.9	< 1.5	0.30-0.59
3	4.0-7.0	4.0-7.0	1.5-4.0	8.0-16.0	1.5-4.0	0.60-1.20
4	7.1-9.0	7.1-9.0	> 4.0	16.1-18.0	> 4.0	1.21-1.75
5	> 9.0	> 9.0		> 18.0		> 1.75

Hoofdelementen in mmol/l

	K	Ca	Mg	NO ₃	SO ₄	P
1+	1.25	0.75		2.25		0.25
2+	0.625	0.375	0.2	1.125	0.25	0.125*
3	0	0	0	0	0	0
4-	0.625	0.375	0.2	1.125	0.25	0.125
5-	1.25	0.75		2.25		0.25

* Als pH < 6.5 aanpassing is 0.25 mmol/l



Boundaries for adjustments

	Fe	Mn	Zn	B	Cu
1	< 15.0		< 2.0	< 5	< 0.30
2	15.0-19.9	< 1.0	2.0-2.9	5-9	0.30-0.49
3	20.0-35.0	1.0-4.0	3.0-5.0	10-25	0.50-3.00
4	35.1-50.0	4.1-6.0	5.1-8.8	26-30	3.01-4.00
5	> 50.0	> 6.0	> 8.8	> 30	> 4.00

Adjustments for micro elements

	Fe	Mn	Zn	B	Cu
50	50	50	50	50	50
25	25	25	25	25	25
0	0	0	0	0	0
25	25	25	25	25	25
50	50	50	50	50	50

Additional adjustments

Factor K/Ca	> 1.5	Ammonium adjustment	Combination classification	extra NH ₄ NO ₃
analysis		pH/NH ₄ /HCO ₃		mmol/l
K	Ca	6		0.4
4.0-7.0	4.0-7.0	7		0.6
adjustment		8		0.8
- 0.25 K				
+0.125Ca				

Judgement analytical results III

pH judgement

NH ₄	HCO ₃	< 5	5 - 5.5	5.5-6	6-6.5	6.5-7.5
< 0.5	< 0.5	1			6	6
	0.5-1.0	o		2	7	7
	>1.0	o	6	6	8	8
0.5-1.0	< 0.5	1		3	6	6
	0.5-1.0	5	3	3	4	o
	>1.0	5	5	4	4	o

Adjustment NH₄

o unlikely combination

class	NH ₄
6	0.4
7	0.6
8	0.8

Rules for pH adjustments

1. If possible reduce pH of the supply, not higher than 6.2. Omit NH₄NO₃ from the recipe. Replace crystalline Calciumnitrate by liquid
2. Reduce the pH of the drip irrigation, but not below 5
3. The NH₄ found is likely temporarily. Due to the presence of NH₄ the pH will be decreasing
4. The high NH₄ is likely temporarily. It is not recommendable to increase the NH₄ dosage, due to the presence of NH₄ the pH will decrease soon, but you can reduce the pH of the irrigation water, but not below 5
5. The high NH₄ is likely temporarily. Due to the presence of NH₄ the pH will decrease further. Omit NH₄NO₃ from the recipe.

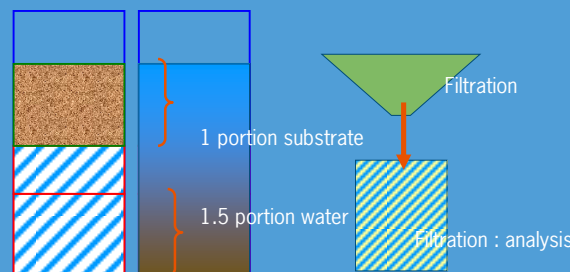
Rule for pH adjustment II

6. pH is high but also HCO₃. Reduce the pH of the drip irrigation, but not below 5. Increase NH₄ by x₁ mmol/l NH₄NO₃
7. pH is high but also HCO₃. Reduce the pH of the drip irrigation, but not below 5. Increase NH₄ by x₂ mmol/l NH₄NO₃
8. pH is high but also HCO₃. Reduce the pH of the drip irrigation, but not below 5. Increase NH₄ by x₃ mmol/l NH₄NO₃

class	NH ₄	
6	0.4	x1
7	0.6	x2
8	0.8	X3

Organic substrate

1: 1.5 volume extract



Dilution

Soil solutin

substrate

- matrix (25 %)
- moisture (45 %)
- air (30 %)

Dilution rate = $0.45 / (1.5 + 0.45) = 0.23$

Substrate solution = 4.3 times diluted

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EC recommendation

EC Nutrient solution supply

Maximum

Standaard

Nul

O A B C

EC(v) 1 : 1,5 volume-extract

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Potplants : groups

- Too many species
- Group
 - nutrient demand
 - Salt sensitivity
 - pH class

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Target values

Klasse	K* mmol/l extract (1:1,5 volume-extract)	Ca	Mg	NO ₃	SO ₄	P*
1 X.X.	1.0	0.8	0.3	1.5	0.4	0.5
2 X.X.	1.2	1.0	0.3	2.5	0.6	0.5
3 X.X.	1.6	1.2	0.5	4.0	0.8	0.5
4 X.X.	2.4	1.4	0.6	6.0	1.0	0.5

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Class	sensitivity	Salinity		EC
		Na	Cl	
		mmol/l extract (1 :1,5 volume extract)		mS/cm
X.1.X	Sensitive	<1.7	<1.7	<1.0
X.2.X	Moderate sensitive	<2.5	<2.5	<1.4
X.3.X	Not sensitive	<3.5	<3.5	<1.8

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3.1 KLASSE-INDELING

Klasse	Gewas	Synoniem
1.1.1	Dionaea	
1.1.1	Drosera	
1.1.1	Sarracenia	
1.1.4	Asplenium	
1.3.5	Apocactus	Cereus
1.3.5	Cereus	
2.1.4	Tillandsia	
2.1.4	Vriesea	
2.1.4	Zakova	
2.1.5	Saintpaulia	
2.2.3	Achimenes	
2.2.3	Aeschynanthus *	
2.2.3	Calceolaria (peripl)	
2.2.3	Callistemon	
4.2.4	Spermannia	
4.2.4	Zantedeschia	Calla
4.2.5	Capsicum *	
4.2.5	Hebe *	Veronica
4.3.4	Brugmansia	Datura
4.3.5	Pelargonium	
5.1.4	Vriesea	
5.2.4	Aechmea	

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Gewasgroep : 3.X.X. vegetatief

EC(c) = 0.67

Basisvoedingsoplossing							Elementgehalte in %					
NH ₄	K	Ca	Mg	NO ₃	SO ₄	H ₂ PO ₄	K	Ca	Mg	N	S	P
1.1	5.5	3.0	0.75	10.9	1.1	1.0	14.0	7.9	1.2	10.8	4.0	2.2

Streefcijfers 1 : 1.5 volume-extract							Dosering		
NH ₄	K	Ca	Mg	NO ₃	SO ₄	P	Standaard	EC	EC(v)1:1.5 extr.
<0.1	1.6	1.2	0.5	4.0	0.8	0.5	1.7	0.5-EC(v)<0.9	
							Maximum	2.5	0
							Minimum	0	1.8

Waardering gecorrigeerd op EC(c)

Element	NH ₄ *	K	Ca	Mg	NO ₃	SO ₄	P	EC*
laag	<	1.3	0.8	0.3	3.2	0.5	0.4	0.5
hoog	>	0.5	1.9	1.6	0.7	4.8	1.1	0.6
buiten	<				1.0			
A.P.	>	1.0	3.2	2.8	1.4	8.0	2.4	

* Geen correctie op EC(c)

Grenzen voor aanpassing hoofdelementen (gecorrigeerd op EC(c))

	K	Ca	Mg	NO ₃	SO ₄	P
1	< 0.9	< 0.3		< 2.3		< 0.25
2	0.9-1.2	0.3-0.7	< 0.3	2.3-3.1	< 0.5	0.25-0.39
3	1.3-1.9	0.8-1.6	0.3-0.7	3.2-4.8	0.5-1.1	0.40-0.60
4	2.0-2.3	1.7-2.1	0.8-1.0	4.9-5.7	1.2-1.5	0.61-0.75
5	> 2.3	> 2.1	> 1.0	> 5.7	> 1.5	> 0.75

Aanpassingen hoofdelementen in mmol/l

	K	Ca	Mg	NO ₃	SO ₄	P
1+	2.5	1.5	0.25	5.0	0.5	0.5
2+	1.25	0.75	0.25	2.5	0.5	0.25
3	0	0.0	0.0	0.0	0.0	0.0
4-	1.25	0.75	0.25	2.5	0.25	0.25
5-	2.5	1.5	0.5	5.0	0.5	0.5

