EU AQUAPONICS HUB FACT SHEET

Nutrient solutions and nutrient uptake

Since the development of soilless horticulture systems in the 1970's a number of typical nutrient solutions have been developed and adjusted according to grower's preferences (e.g. Table 1). All mixes, however, follow the principles of (a) excess availability of all elements to prevent deficiencies and (b) balance between (bivalent) cations to avoid competition between cations in plant nutrient uptake. Often the EC is allowed to rise in the root zone to a limited amount. To provide sufficient flushing of the root zone, in a typical drip-irrigation rock wool slab system 20-50% of the dosed water is collected as drainage water, mixed with fresh water, and topped up with nutrients for use the next day.

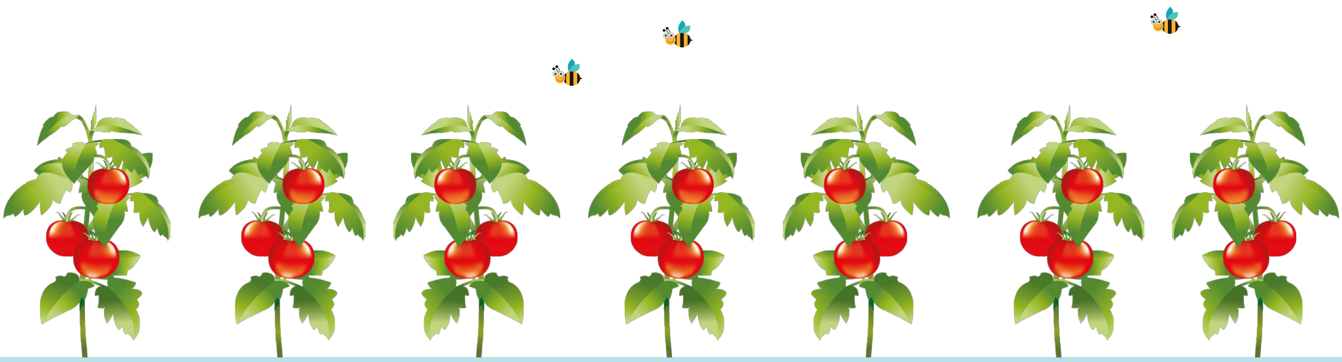

Table 1. Nutrient solutions in hydroponic cultivation of lettuce (deep flow) and tomato and cucumber (rock wool slabs) in The Netherlands.

	pH	EC	NH_4	K	Ca	Mg	NO_3	SO_4	P	Fe	Mn	Zn	B	Cu	Mo
		mS/cm	mmol/l	mmol/l	mmol/l	mmol/l	mmol/l	mmol/l	mmol/l	µmol/l	µmol/l	µmol/l	µmol/l	µmol/l	µmol/l
Lettuce (WUR)	5.9	1.7	1.0	4.4	4.5	1.8	10.6	1.5	1.5	28.1	1.5	6.4	47	1.0	0.7
Lettuce (Benton Jones Jr. 2004)	5.8	1.15	0.72	4.8	2.25	0.75	8.9	0.76	1.0	35.1	4.89	3.04	18.4	0.47	0.52
Lettuce (Mc-Keehen 1996)	5.8	1.2		3	2.5	1	7.5	1	0.5	50	3.7	0.64	4.75	0.52	0.01
Tomato generative	5.5	2.6	1.2	13.0	4.2	1.9	15.4	4.7	1.5	15.0	10	5	30	0.75	0.5
Tomato vegetative	5.5	2.6	1.2	8.3	5.7	2.7	15.4	4.7	1.5	15.0	10	5	30	0.75	0.5
Cucumber	5.5	3.2	1.2	10.4	6.7	2.0	23.3	2.0	1.8	15.0	10	5	25	0.75	0.5
Plant propagation	5.5	2.3	1.2	6.8	4.5	3.0	16.8	2.5	1.25	25.0	10	5	35	1.0	0.5

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(continued)

The nutrient composition of aquaponic solutions differs from most conventional hydroponic solutions. Plant tissue analysis (Table 2) indicates that assimilated levels of Potassium, Sulphur and micro-nutrients are low in plants from the aquaponic system. Nitrogen uptake in aquaponic systems, however, seems similar or even high compared to hydroponically grown plants. In studies with *Chrysanthemum* in hydroponic cultivation (deep flow) low levels of nitrogen (< 10 mmol/l) in the irrigation solution led to reduced uptake by the plants. Using growing systems with high-frequent refreshment of nutrients in the root zones, such as NFT (nutrient film technique) and DFT (deep flow technique), improves the availability of nitrogen to the roots and allows for lower concentrations in the nutrient solution.

Table 2. Analysis of nutrient composition in lettuce leaves

	N_{total}	P_{total}	K	Ca	Mg	Na	Fe	Mn	Zn	B	Cu	Mo
	mmol/kg dm	mmol/kg dm	mmol/kg dm	mmol/kg dm	mmol/kg dm	mmol/kg dm	mmol/kg dm	mmol/kg dm	mmol/kg dm	mmol/kg dm	µmol/kg dm	µmol/kg dm
Roorda & Smilde, 1971	2100	141	1063	360	200		2.3-26	1.85	0.5-4.5	3.2	160	31
aquaponic butterhead lettuce*	3538	202	1387	693	137		1.5	0.39	7.1	2.9	144	<10
aquaponic lettuce**	3955	353	2330	396	201	97.7	4.1	4.6	6.5	3.1	142	17.2
hydropnic lettuce	3526	306	1795	314	160	25	3.1	3.4	16	3.2	170	24.6

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Local nutrient depletion can lead to suboptimal growth or malformations. To prevent depletion, a frequent refreshment of the nutrient solution in the root zone is required. Warmenhuizen (...) found that frequencies of up to 24 refreshments per day could still improve plant development. Trying to reduce the volume of roots Goto et al. found that chrysanthemum could fully develop on a 30 ml root volume when the nutrient solution in the root zone was refreshed at least 10 times per day. Thus, especially at lower concentrations, refreshment in the rootzone is crucial.

References cited:
- *Warmenhoven M (1995) Invloed van gietfrequenties en granulaire substraten op chrysant in eb/vloedsysteem. Proef 6306-14. Rapport 13.*
- *Goto T et al. (2001) Effects of water and nutrient stresses on reduction of vegetative growth in Chrysantemum grown under restricted root zone volume. J. Jap. Hort. Science 70(6), p 760-766.*

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