Deep Flow Technique (DFT) and Nutrient Film technique (NFT) for the cultivation of Lettuce

Technical information sheet No. 7 1

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System design

From the beginning of hydroponics lettuce is being used as pilot crop for many system designs. However in commercial practice lettuce did not break through. One of the big disadvantages is the large amount of plants per m^2 (15-25 plants per m^2), the short cultivation period (3-6 weeks) and, in general a low market price, resulting in a poor economic performance. Nowadays mainly two systems are being used: DFT and NFT.

Deep Flow Technique (DFT)

In general there is a container filled with nutrient solution (10-20 cm deep) in which panels are floating and covering the surface. Containers are being filled with the appropriate lettuce solution (see fig. 4). Control of EC and composition hardly takes place within the short growing cycle. The system is relatively cheap and robust if solution flows slowly but continuously. There is no disinfection of the nutrient solution, because the volume is very big and therefor too costly.

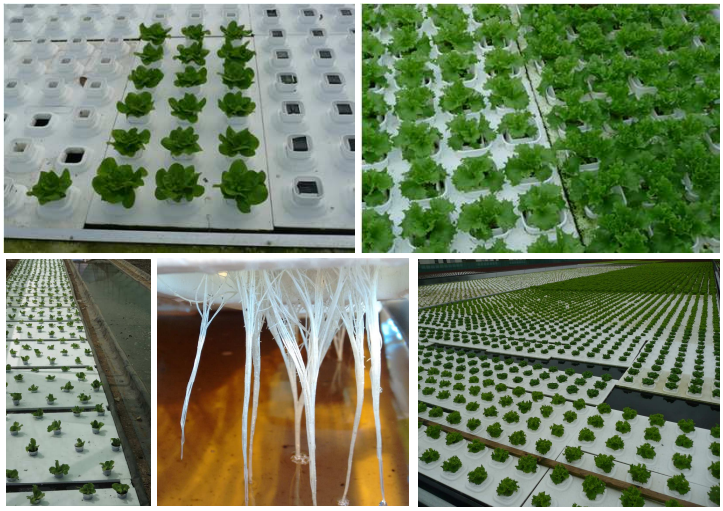

Figure 1: DFT panels floating on a solution.

Often there are young and old plants in the same system, consequently the system does not get empty, there is a continuous harvest at one end and planting at the other end. The design should be such that a grower can harvest each week a certain amount of plants. It is important to have a nutrient solution suitable for plants of all ages.

Nutrient Film Technique (NFT)

Troughs of about 10 cm are placed on stages at a slope of 0.5-2 % and adequate nutrient solution (see recipe fig. 4) is flowing from the top-end to the down-end and is recirculated. In some systems the troughs are fixed to one place, in other systems the troughs are movable for spacing and mechanisation of planting and yielding. Water volume of the system is small and control of EC and composition always take place. There is no disinfection of the nutrient solution, because the recirculating volume is still large and therefor an economic problem.

Figure 2: NFT in troughs.

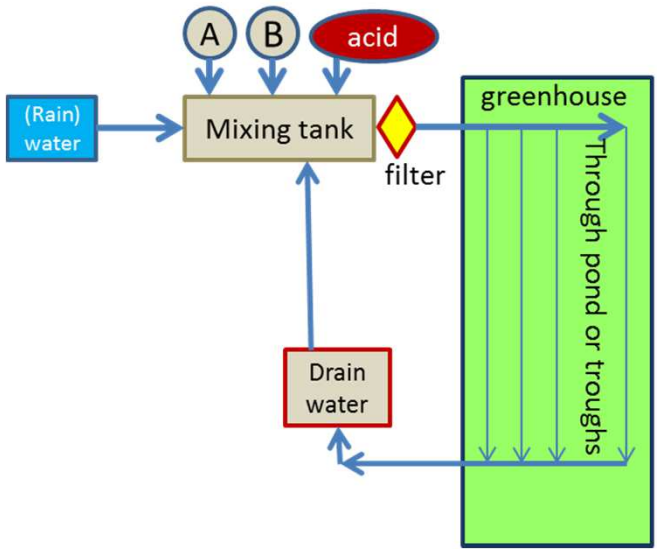

Figure 3: Schematic scheme of DFT/NFT.

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Irrigation

- The nutrient solution refreshes the roots avoiding a surplus of nutrients around the root tips. In NFT there is mostly a continuous flow. In DFT one thinks that there is enough water, so recirculation is not needed. This is a misconception, at least each 5 minutes water has to be recirculated for 2.5 minutes.
- Enough oxygen must be available around the roots. Oxygen availability can be improved by a gentle continuous pump flow or by bubbling. Bubbling is less effective and may increase water temperature fast when hotter air is used. Heating the water (f.e. to 17 ˚C when greenhouse air temperature is 10-11 ˚C) improves growth.
- An EC of 1.6-2.0 and pH of 5.0-6.0 is needed. Too low pH results in root dieback.
- An adequate nutrient recipe has to be given permanently, fig. 4.
- It is important to use measurements to know what is going to happen before it affects the plants:
  - Daily EC of the drain water
  - Daily pH of the drainage water
  - Once per 14 day analysis of elements. It is more important in NFT as in DFT.

  The trends in the measured values tell how to adapt.

Pests and diseases

Fungal diseases. Lettuce is susceptible to various fungal diseases like *Bremia lactucae* (Downy Mildew), *Botrytis cinerea*, *Rhizoctonia solani* (lettuce rot) and *Sclerotina sclerotiorum*. Downy Mildew and Botrytis occurs due too wet conditions and high air humidity, so these conditions have to be avoided as much as possible. Partly resistant varieties for Downy Mildew are available. Sometimes preventive spraying of fungicides is needed. Root rot (*Pythium spp*) can be a serious problem. In general the system is not well designed resulting in stress of the lettuce plants and outbreaks of pythium. The cause must be found in taking away the stress factors and only a little bit in chemical application.

Pests. Several pests can occur like: aphids, root aphids, caterpillars, white fly, thrips and leaf miner. Resistant varieties for aphids are available.

Element	Standard nutrient solution		Target value in root environment
	Closed system	Open system	
EC, mS/cm	1.6	2.0	2.5
pH			5.5
NH_4, mmol/l	0.1	0.1	0.1
K	4	6	6
Na			<8
Ca	4.5	6	7
Mg	1.0	1.0	1.5
NO3	12	15	15
Cl	<6		<10
SO4	1.25	2	2
HCO3	<0.6		<1
H2PO4	0.6	1.0	1.0
Fe, µmol/l	40	40	40
Mn	5*	2	1
Zn	4	5	5
B	30	30	50
Cu	0.6	0.6	1
Mo	0.5	0.5	0.5

** If peat cubes are used Mn may be 0.*

Figure 4: Nutrient solution recipe for lettuce in DFT/NFT.

Physiological disorders

- **Tip burn**: Part of the leaf wilt and dry. The damage is caused at the moment leaves are losing water into the air faster than the roots can take water in. This can be prevented by using less susceptible varieties and/or by air fogging.
- Glassiness: Mostly the edges of the leaves become filled with fluid, which makes them look translucent. It happens when leaves are unable to lose sufficient moisture into the air (kind of the opposite of tip burn). It can be prevented by stimulating the transpiration of the plants and by decreasing the root pressure by increasing the EC.

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