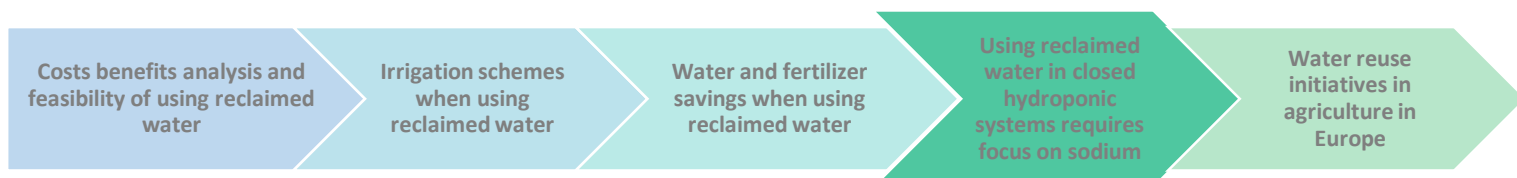




Info-package 2

Agricultural Advisory Services

Fact Sheet 2.4 – Using reclaimed water in closed hydroponic systems requires focus on sodium



SUWANU EUROPE is a H2020 project aiming to promote the effective exchange of knowledge, experience and skills among practitioners and relevant actors on the use of reclaimed water in agriculture. This factsheet is part of a total of 5 factsheets in Info-package 2 aimed at agricultural advisors and describes the essential need of sodium management in hydroponic system using reclaimed water.

1. Introduction

In the North-Western part of Europe, a considerable part of greenhouse production is performed in so-called “closed hydroponic systems”, referring to the recirculation of water and nutrients throughout the growing cycle. Although these closed systems require few water inputs per kg production, recent dry summers urged some farmers to search for additional water sources in order to meet the crops’ water needs. In this context, the use of reclaimed water is being discussed as a potential alternative water source for closed hydroponic systems. Understanding the presence, effect and eventual removal needs of a variety of compounds in treated wastewater is necessary prior to reuse this water source for agricultural irrigation. For closed hydroponic systems, specific attention needs to be given to the sodium (Na^+) concentration. This factsheet focusses on the importance of sodium management when using reclaimed water in closed hydroponic systems.

2. Open, semi-closed, and closed hydroponic systems

In horticultural crop production, hydroponics refers to a method to grow crops without soil. Instead, crops are grown with or without growing media (e.g. stone wool, peat, perlite, coconut fiber, pumice, etc.). Nutrient solutions supply water and minerals to the crops. In contrast to soil, the buffering capability of the growing medium is rather limited. Therefore, an excess of nutrient solution is applied assuring that all plants receive sufficient water and minerals, and that the salt accumulation in the growing medium is prevented. This excess of nutrient solution is referred to as drain water. When all drain water is recycled, the hydroponic system is defined a “closed” system, in case only part of the drain water is recycled, the system is referred to as “semi-closed.” If no recirculation is applied, the system is “open”.

3. The importance of sodium in hydroponic systems

For almost all terrestrial plants, sodium is not essential for either growth and development or reproduction. Therefore, the uptake of sodium by the crop is only limited, resulting in the accumulation of this component in the recirculated drain water. High concentrations might cause negative effects on plant production and quality as shown in Figure 1.



Figure 1. Blossom end rot in tomatoes, one of the effects of sodium misbalance of the nutrient solution.

Recent studies identified sodium accumulation being the primary bottleneck keeping farmers from 100% recirculation [1,2]. In hydroponic systems, the main source of sodium entering the water and nutrient cycle originates from the primary water source. Fertilizers, plant protection products, disinfection products, etc. contribute to a much lesser extent. In case the water source does not meet the criteria of at least class 3 (Table 1), it is not suitable for use in greenhouse hydroponic horticulture. In Flanders, sodium concentrations in reclaimed water amount 2,0 to 6,4 mMol/l (based on a limited number of samples).

Table 1 Classification of water quality. A water source of class 1 can be used for most applications. A water source of class 2 is not suitable for cultures with limited root volume or when only limited amounts of water can be applied. A water source of class 3 is not suitable for salt sensitive crops [3].

Quality class	EC (mS/cm)	Na (mMol/l)	Na (ppm)
Class 1	<0.5	0.0-0.5	0-11
Class 2	0.5-1.0	1.5-3.0	34-69
Class 3	1.0-1.5	3.0-4.5	69-103

Table 2 Sodium threshold values of 1980s versus more recent research outcomes [5,6].

Crop	Old threshold value (1980s) (mMol/l)	Threshold value based on recent research (mMol/l)
Tomato	8-10	18-20
Sweet pepper	6	8-10
Rose	6	-
Gerbera	10	-

Table 2 provides an overview of some crops' sodium tolerance. These varies strongly depending on the type of crop. Most threshold values are based on research initiatives of the 1980's and included considerable safety margins. More recent Dutch research showed that with an adequate sodium management, crops like tomato and sweet pepper could be grown with nutrient solutions containing sodium levels of respectively 18-20 mMol/l and 8-10 mMol/l. Simulations based on the "Water streams model" of Wageningen University [4] showed that in case a threshold value of 8 mMol/l Na would be maintained in tomatoes using reclaimed water as an additional water source during periods of water shortage, around 1.000 m³ per hectare should be discarded. In case the threshold value is increased to 18 mMol/l using the same water source, the discarded volume would decrease to only 500 m³ per hectare. A higher threshold would enable longer recirculation of the water. In case tap water would have been used (with low presence of sodium), no discharge would have taken place. The concentrations of sodium in both the primary water source entering the hydroponic system as the accumulation in the drain water require careful attention, especially using reclaimed water.

4. Selective sodium removal

In the past years, a series of technologies were developed supporting selective sodium removal. The technologies are based on a series of working principles, e.g. nanofiltration sometimes combined with reversed osmosis to treat the permeate, electro dialysis, modified ion exchange, In most cases, the removal processes showed being semi-selective as it showed being difficult separating, for example, sodium and nitrate as they have very similar characteristics.

Reference / Further readings

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