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The utilisation of nutrient elements in soilless cultures of vegetable production

Rácz, I-né & Takácsné Hájos, M.

Tessedik S. College Agricultural Water- and Environment Management Department, Szarvas; racz.istvanne@mvk.tsf.hu; hajos.maria@mvk.tsf.hu

Summary: Vegetable production in greenhouses may impair the ecological balance of the environment substantially as far as being uncontrolled. Soilless cultures especially should be handled thoughtfully. A fraction of the nutrients administered, more than 25-30%, is doomed to be lost in an open system, and the resulting ecological risk is accompanied with increasing costs of the production. Experiments have been conducted with the purpose of estimate the amount of nutrients involved. According to the results, as a mean, 30-80 per cent of the main nutrients was utilised. The rate of nutrient utilisation is influenced by the plant species involved as well as by the circumstances of production. One of its most important components is the irrigation, which determines the amount of overflow and of its salt content.

Key words: hydroponics, nutrient, drainage water

Introduction

In soilless forcing, the intensity of production as well as the environmental risk is high. On the contrary, the soil stores the majority of nutrients left over by the plants, whereas a minor fraction get eroded (*Horinka*, 1997). In open systems of soilless cultures, the nutrients being already mobilised are washed out easily with the overflow, therefore, the amount of fertilisers administered is substantially higher than in traditional field cultures (*Geissler*, 1991).

Recent literature dealing with soilless plant production pinted out the ecological risk caused by the overflow of nutrient elements (*Biernbaum*, 1992; *Alarcon*, 1998). The loss of nutrient should be minimised by applying closed systems of production (*Papadopoulos* et al., 1999). Hungarian data dealing with the loss of nutrient elements in open production systems are badly needed.

Material and methods

The ecological evaluation of soilless production was based upon results of purposeful experiments. Three main vegetable species have been involved in the forcing cultures (pepper, tomato, cucumber), 3 experiments were assigned to each species, so altogether 9 independent experiments were performed between March 2004 and November 2004. Roman numerals, I–IX, were assigned to the individual experiments:

Pepper *(Capsicum annuum L.)* I., II. and III.,
Tomato *(Lycopersicon esculentum MILL.)* IV., V. and VI.,
Cucumber *(Cucumis sativus L.)* VII., VIII. and IX.

All soilless cultures were grown on rockwool, A-B and acid containers served for the feeding system, which administered the nutritive solution according to the procedure of trickling irrigation. It worked as an open system as the overflow left the installation.

The main data of the cultures are presented in *Table 1*.

- Measurements performed in the farms:
  - the amount of macro- and meso-elements in the fertilisers administered,
  - the amount of acids applied,
  - the total yield of any quality,
  - the nutrient solutions of all plots, i.e. the medium itself as well as the overflow were sampled once in every month at the same time (hour),
- The solutions sampled were checked chemically as for their content:
  pH, EC (electric conductivity), NO_3*-N, P, K, Ca, Mg, Na.*

Results and discussion

The result of measurements performed in the solutions sampled during the experimental vegetable forcing

As a result of interaction between the plants and the nutrient solution, the composition of the primary solution changed. As far as regularities in changes of the most important parameters have been revealed, a reutilisation of the overflow (leaving the system) could be elaborated. The repeated utilisation will also diminish the ecological burden of the soilless production. The mean trends of changes in pH and EC as well as in the concentration of different ions

Table 1 The main data of the vegetable forcing experiments of the farms in the Southern Great Plain region in 2004.

The identity of the experiment	The surface of the plantation (m^2)	Planting density (plant/ m^2)	Variety	Planting date	Steering of watering*	Mean rate of the overflow (%)**
Pepper						
I.	4000	4.10	'Hó F1'	2003.12.01.	K	35–39
II.	4000	3.70	'Hó F1'	2004.02.20.	K	28–32
III.	1220	6.39	'Keceli csüngő'	2003.12.30.	K	26–30
Tomato						
IV.	5000	2.50	'Pedrico' and ' 'Durinta'	2004. 01.04.	I	30–34
V.	11500	2.52	'Durinta'	2003.11.03.	K	25–29
VI.	9600	2.47	'Profilo'	2004.04.23.	I	20–26
Cucumber						
VII.	828	1.48	'Suprami'	2004.02.20.	K	18–22
VIII.	8000	1.50	'Pedroso F_1'	2004.01.15.	I	34–38
IX.	2800	1.54	'Pedroso F_1'	2004.01.20.	I	31–35

* K: climate steering of irrigation; I: time-switch steering of irrigation
** Average industrial conditions, according to the records of growers

measured during the growing period and related to the primary solution are presented in *Table 2*.

Table 2 The mean trends of changes measured in the overflow of the primary solution are shown in all the 9 experiments on rockwool (2004) (↑: rise; ↓: decline)

Property	Site of sampling	Pepper	Tomato	Cucumber
pH	Medium	↑	↑	↑
	Overflow	↑	↑	↑
EC	Medium	↑	↑	↑
	Overflow	↑	↑	↑
N	Medium	↑	↑	↓
	Overflow	↑	↑	↓
P	Medium	↓	↓	↓
	Overflow	↓	↓	↓
K	Medium	↓	↓	↓
	Overflow s	↓	↓	↓
Ca	Medium	↑	↑	↑
	Overflow	↑	↑	↑
Mg	Medium	↑	↑	↑
	Overflow	↑	↑	↑
Na	Medium	↑	↑	↑
	Overflow	↑	↑	↑

We stated that concentrations of phosphorus and potassium declined in all species and in both sampling sites, whereas the concentration of the rest of cations (calcium, magnesium and sodium) increased in both, in the table as well as in the overflow (because of the variable values of EC or electric conductivity of the solutions were standardised to EC=3 mS/cm). The changes in nitrogen content did not show any trend.

The rising and declining concentration of cations changed the relative ratio of ions in both solutions, in the medium as well as in the overflow. The concentration of the hydroxide ions also increased by some less known reasons, i.e. the pH values rose.

The ecological evaluation of the overflow

As the ratio of nutrients depleted as well as left in the overflow cannot be determined directly in the experimental production, the volume of the overflow could not be plotted against the nutrients taken up by the plants.

The total input of nutrients was estimated on the basis of the concentration of the nutrient solution and the ratio of the overflow (*Table 1*), which indicate the volume of nutrient, which left the system. By comparing the total input of nutrients and the volume lost by the overflow, the ratio of utilisation was computed for each element.

$$\textit{Utilisation of nutrients\%} = \frac{\textit{Total input of nutrients} - \textit{Nutrients, which left the system}}{\textit{Total input of nutrients}} \cdot 100$$

For the analysis of data raised in the 9 experiments, the ratios of utilisation have been applied. Computations were performed for each plant species and each farm, then also for the average of plant species over the three experiments (*Figure 1*).

In the open systems of experimental soilless cultures, the mean utilisation of main nutrient elements varied between 30 and 80%. The utilisation changed according to the vegetable species, moreover, it is also subject to the conditions of the particular farm. Most active components are the mode of irrigation, which determines the rate of overflow and its salt concentration.

The ratio of utilisation of all nutritive elements is related to the changing concentration of overflow. Best utilisation of nutrients is displayed by those elements, which are less represented in the overflow (phosphorus and potassium). Poor utilisation is found in cations, which were present in the

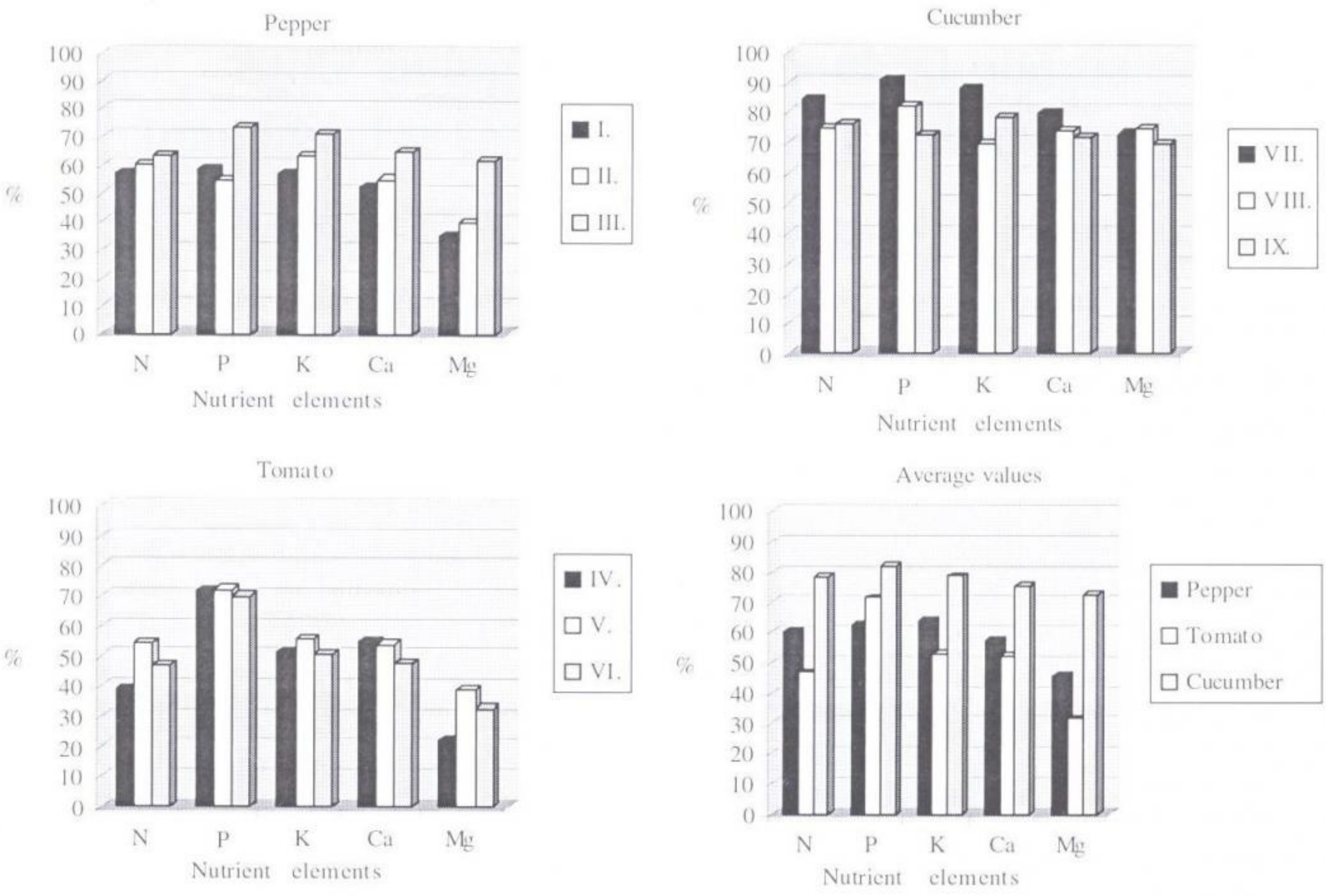

Figure 1. Utilisation of the nutrients by the three vegetable species and the means of nutrient elements utilised in the individual experiments (over the farms numbered as I–IX, 2004)

medium as well as in the overflow at higher concentrations (calcium and magnesium).

Climatic steering improved the uptake of nutrients substantially although it was not the sole condition of their higher rate of utilisation.

References

Alarcon, A. L. (1998): Trends in Spanish fertigation. Horticultura, Revista de Hortalizas, Flores, Plantas Ornamentales y Viveros. 133. 38–51.

Biernbaum, J. A. (1992): Root-zone management of greenhouse container-grown crops to control water and fertilizer. HortTechnology. 2 (1): 127–132.

Geissler, T. (1991): Gemüseproduktion unter Glas und Plasten. Produktionsverfahren. Berlin: Deutscher Landwirtschaftsverlag. 279 pp.

Horinka, T. (1997): Tápoldatozás a kertészeti termesztésben. Hódmezővásárhely: Kemira KFT. 446 pp.

Papadopoulos, A. P., Hao, X., Tu, J. C. & Zheng, J. (1999): Tomato production in open or closed rockwool culture systems with NFT or rockwool nutrient feedings. Acta Horticulturae. 481. 89–96.