EFFECT OF MAGNESIUM AND NITROGEN FERTILIZER TREATMENTS ON THE YIELD OF HYDROPONIC LETTUCE

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Abstract: *Lettuce (Lactuca sativa convar. capitata L.) is a significant vegetable, rich in vitamins, and has several beneficial characteristics in the course of growing without soil: faster development, higher average of yield, balanced and schemed development, and furthermore, growing can be automated, environmentally friendly, and growing does not require significant manual labour. The aim of this research was to determine the optimal nutrient concentrations of magnesium and nitrogen to quantify the proper fertilizer concentrations for hydroponic lettuce (Lactuca sativa convar. capitata L.) cultivation in the aspect of biomass production.*

Key words*: Lettuce, magnesium fertilizer, nitrogen fertilizer, hydroponic, yield*

INTRODUCTION

The species of lettuces are grown in extraordinary wide variety, nowadays they became from a seasonal vegetable into an all-year grown food. Modern technologies, by using hydroponic lettuce growing, permit continuous cultivation of lettuce for 12 months every year [1],[2]. The average consumption of the plant increased during the previous decade because it can be inserted into modern healthy nourishment. Lettuce (*Lactuca sativa* convar. *capitata* L.) is a significant vegetable, rich in vitamins, and has several beneficial characteristics in the course of growing without soil: faster development, higher average of yield, balanced and schemed development, and furthermore, growing can be automated, environmentally friendly, and growing does not require significant manual labour [3],[4]. The aim of this research was to determine the optimal nutrient concentration of magnesium and nitrogen to quantify the proper fertilizer concentration for hydroponic lettuce (*Lactuca sativa* convar. *capitata* L.) cultivation in the aspect of biomass production. In the course of the experiment, the nutrient element concentrations nitrogen, magnesium and calcium were determined in the leaves of lettuce.

MATERIALS AND METHODS

The hydroculture experiment was set up in two periods: 1, In autumn of 2016 (magnesium treatment); 2, In autumn of 2017 (nitrogen treatment). The experiment was conducted in the greenhouse of the Faculty of Horticulture and Rural Development at the John von Neumann University, Kecskemét, Hungary. During the course of the experiment in 2016 autumn, the magnesium supplements were added in the form of $Mg(NO_3)_2$. The following doses of magnesium were added to the standard nutriment solution in our experiment: 50-, 100-, 150-, 200-, 250 mg Mg/l solution. In the control treatment plants were grown with the use of standard nutriment solution without magnesium supplement. The necessary nutrient solution was made from the following water-soluble fertilizers: 666.7 g Ferticare komplex (N 14%, P_2O_5 11%, K_2O 25%); 733.3 g $Ca(NO_3)_2$ (N 15%, CaO 26%); 66.7 g KH_2PO_4 (P_2O_5 54%, K_2O 32%); 100 ml 60 m/V% H_3PO_4 added to 1000 liters of water. Experimental plants were propagated by seeding and subsequent transplant raising in glasshouse. Seedlings were transplanted to multi-cellular transplant raising trays on 19th of September 2016. The lettuce seedlings were placed into rock cotton cubes, and put into hydroponic growing channels on 6th of October. The first harvest took place on 16th of December 2016, when the biomass was recorded.

During the course of the experiment in 2017 autumn, the nitrogen supplements were added in the form of NO_3. The following doses of nitrogen were added to the standard nutriment solution in our experiment: 100-, 200-, 300- mg/l solution. In the control treatment plants were grown with the use of standard nutriment solution without nitrogen supplement. The necessary nutrient solution was made from the following water-soluble fertilizers: 80 g Ferticare complex (N 14%, P_2O_5 11%, K_2O 25%); 359 g $Ca(NO_3)_2$ (N 15%, Ca 19%, CaO 26%); 20 ml 60 m/V% HNO_3 added to 120 liters of water. Experimental plants were propagated by seeding and subsequent transplant raising in glasshouse. Seedlings were transplanted to multi-cellular transplant raising trays on 30th of August 2017. The lettuce seedlings were placed into rock cotton cubes, and put into hydroponic growing channels on 13th of September. The first harvest took place on 22nd of November 2017, when the biomass was recorded.

Electrical conductivity in nutrient solutions was measured by laboratory EC-meter (type ORION 3Star) in both year, in two repetitions (in two growing channels), respectively [5].

RESEARCH RESULTS

The lettuce grew at a proper rate in the stone wool. The leaves turned yellow and brown when using solutions of higher concentration. For our statistics calculations we compared the growth of the Mg-treated lettuce to that of the control plants. The development of the lettuce head weight is shown in figure 1 in 2016 autumn. The highest lettuce head weight mean was measured in the second repeat of the 150 mg/L Magnesium treatment (121.4 gramm). The lowest head weight mean was measured in the first repeat of the 250 mg/L Mg treatment (53.9 gramm).

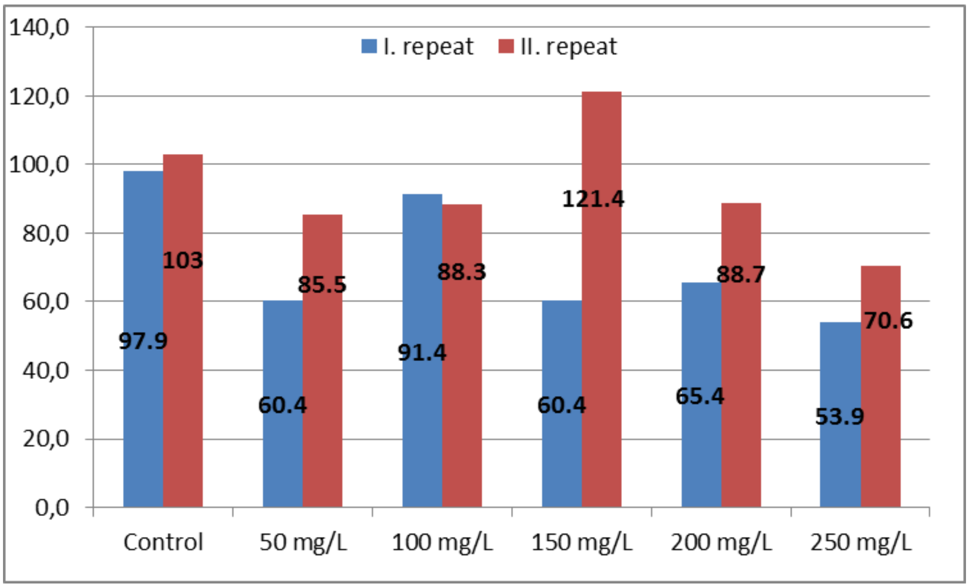

Figure 1. Lettuce head weight (gramm) in 2016 autumn.

In the course of the experiment, the nutrient element concentrations magnesium and calcium were determined in the leaves of lettuce (figure 2) in 2016. The increasing magnesium concentration in the nutriment solution caused the decrease of calcium content in dry matter of the leaves in autumn of 2016. The highest magnesium concentration were in the 100 mg/L and the 250 mg/L Mg treatments. The lowest Mg concentration were the Control and the 50 mg/L in both treatments.

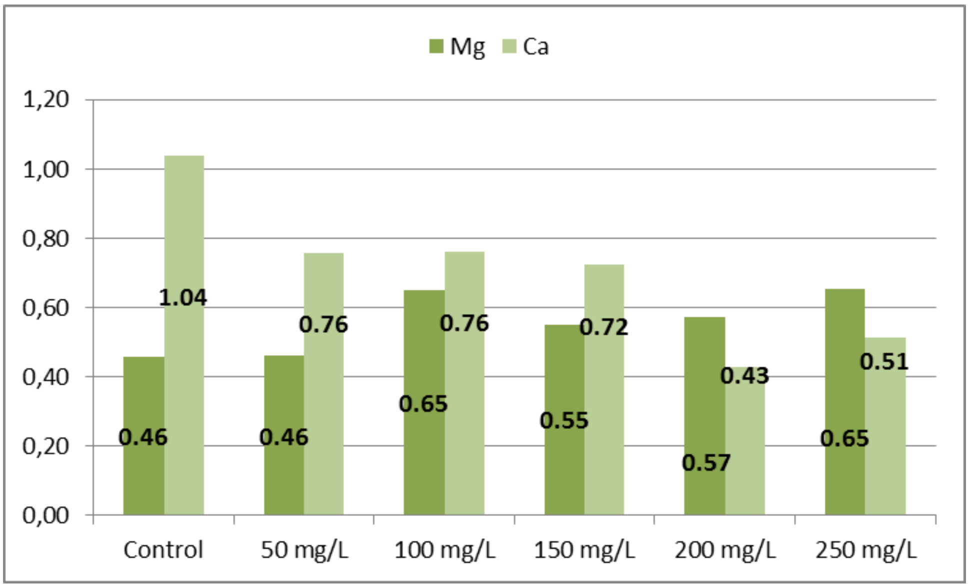

Figure 2. Magnesium and Calcium content of dry matter in the lettuce leaves (m/m%) in 2016 autumn

The highest magnesium concentration were determined in the roots (figure 3) was the 100 mg/l treatments (1.94 m/m%). The lowest was the control (1.02 m/m%). The value was the highest calcium concentration in the 50 mg/L treatment (2.52 m/m%). The lowest calcium was the 250 mg/L treatment (1.31 m/m%).

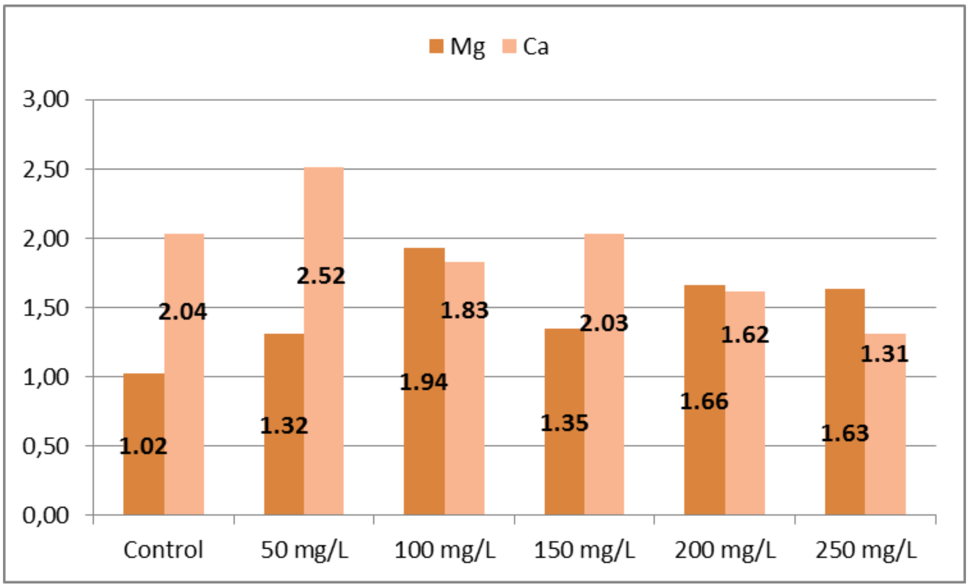

Figure 3. Magnesium and Calcium content of dry matter in the lettuce roots (m/m%) in 2016 autumn

For our statistics calculations we compared the growth of the Nitrogen-treated lettuce to that of the control plants. The development of the lettuce head weight is shown in figure 4 in 2017 autumn. The highest lettuce head weight mean was measured in the first repeat of the 300 mg/L Nitrogen treatment (186.5 gramm). The lowest head weight mean was measured in the first repeat of the Control group (120.1 gramm).

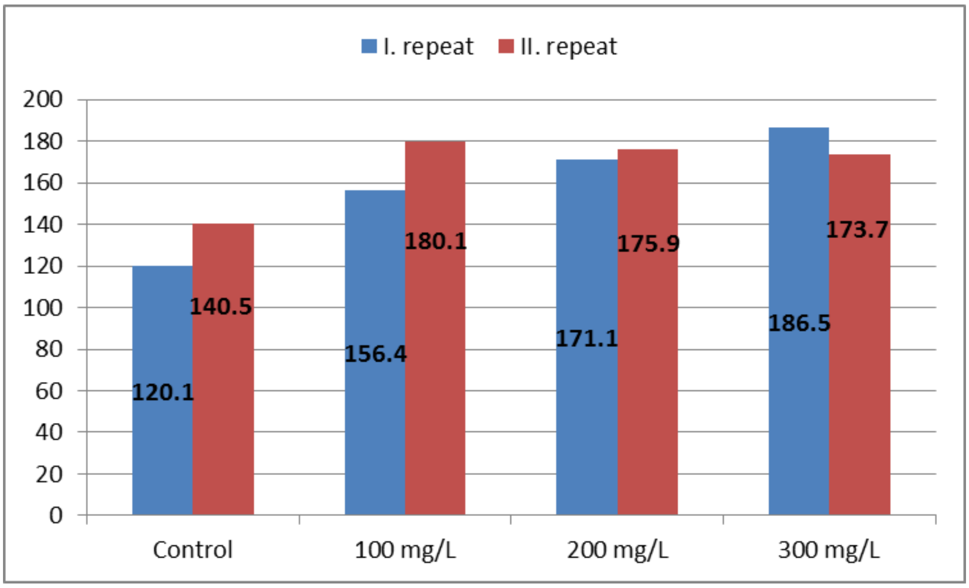

Figure 4. Lettuce head weight (gramm) in 2017 autumn.

The highest nitrogen concentration were determined in the leaves (figure 5) was the 300 mg/L treatments (4.86 m/m%) of the first repeat. The lowest was the control (4.20 m/m%) of the first repeat.

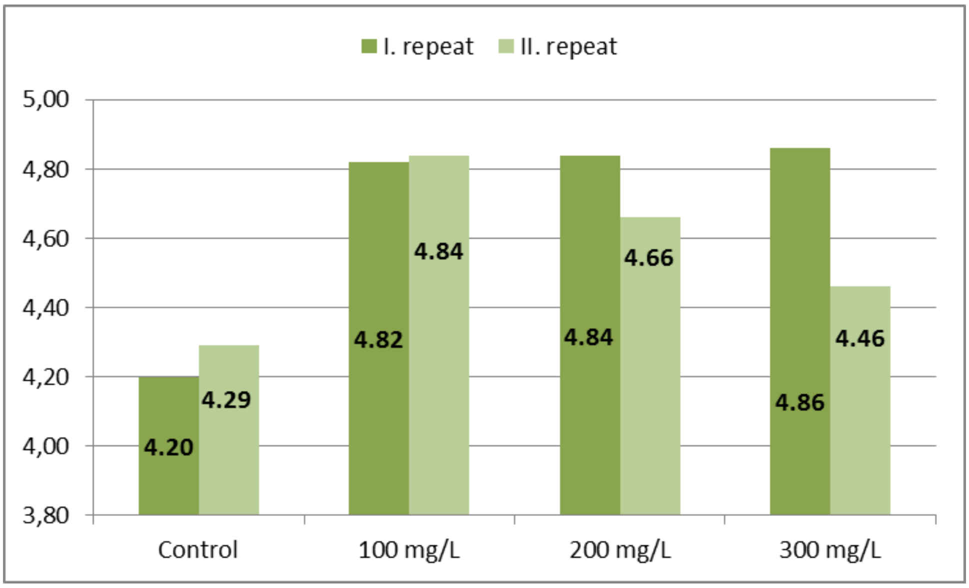

Figure 5. Nitrogen content of dry matter in the lettuce leaves (m/m%) in 2017 autumn

The highest nitrogen concentration were determined in the roots (figure 6) was the 300 mg/L treatments (4.35 m/m%) of the first repeat. The value was the lowest concentration in the 200 mg/L treatment (3.68 m/m%).

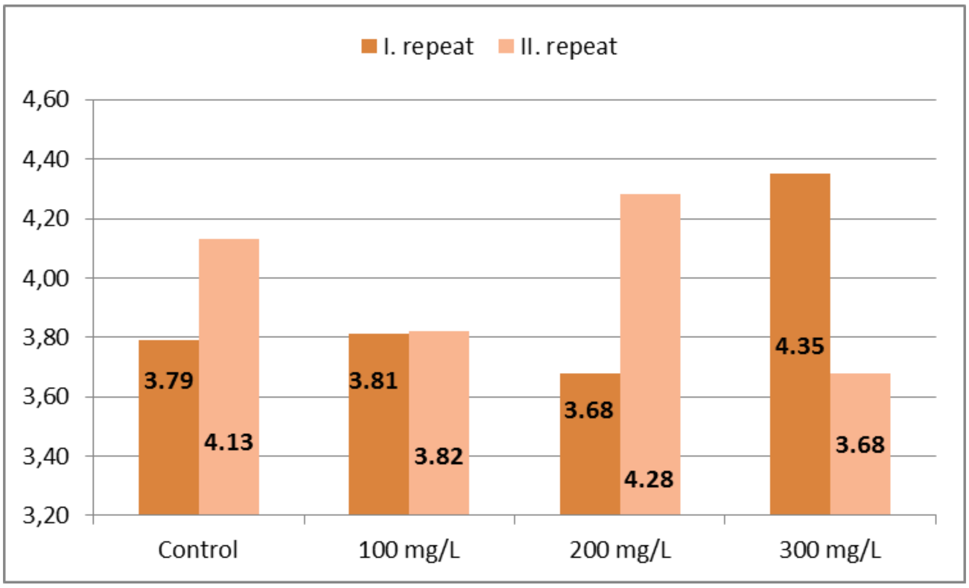

Figure 6. Nitrogen content of dry matter in the lettuce roots (m/m%) in 2017 autumn

CONCLUSIONS

Despite the widely and commonly used traditional agricultural production technologies, hydroponic growing also has a great role in nowadays and in the future as well. In the course of our experiment we found that the easily purchased materials (stone wool, medium raw material) can be used cost-effectively in the hydroponic cultivation.

Human labor is only needed for planting into stone wool, filling in the nutrient solution and harvesting. More work is needed for production on a field. In the case of hydroponic growing there is no need for weeding, fertilizing or groundwork. The leaves turning brown and rotting can be avoided with using adequate nutrient solutions. Higher salt concentration or excessive nutrient ratios may easily cause inadequate growing or disorders.

The lettuce was grown using hydroponic cultivation in our study. Their growth was steady, but there was a great deviation in head weight. While measuring the hydroponic lettuce we found that the magnesium treatment led to a significant decrease in head weight, compared to the control group.

The results (nitrogen treatments) of autumn (2017) research on lettuce head weight were higher than that of autumn in 2016 results (magnesium treatments). The mean value was the nitrogen concentration of the control group was 130.3 gramm than that magnesium concentration of the control group was 100.45 gramm. The 100 mg/L nitrogen treatments was 168.2 g than that a 100 mg/L magnesium treatment was 89.85 g on lettuce head weight. The value was in the 200 mg/L N-treatment 173.5 g. The 200 mg/L Mg treatment was 77.05 gramm. The results was in the 300 mg/l nitrogen treatment 180.1 g. The 250 mg/L magnesium treatments was 62.25 gramm.

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