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Effect of plant protection on the production of hydroponic lettuce (*Lactuca sativa* convar. *capitata* L.)

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Purpose. In our experiment, the hydroculture cultivation of lettuce (*Lactuca sativa* convar. *capitata* L.) was studied under various Mg treatments, and we used pesticide protection against cotton bollworm (*Helicoverpa armigera*). **Methods.** The biometric evaluations were calculation with variance analysis (Tukey-HSD method and the statistical tests were performed using SPSS v19 software). **Results.** Our results observations that plant protections (Actara 240 SC, thiametoxam) were successfully contra *Helicoverpa armigera*. The recording time (94 pieces *H. armigera*) was on 5th October 2015. The number of lettuces infected with the worms of the cotton bollworm was 9 (total) of end the research. When the lettuce was harvested (29th October), we measured the weight of lettuces, counting the number of caterpillars of *H. armigera* and analysing variance on the calculation. The most infected lettuces with the caterpillar were calculated in the 150 and 200 mg/L Mg treatments. We measured 28 plants from each treatment area. The highest lettuce weight was found in the control group (186.1 g), while the lowest was among the 250 mg/L magnesium treatment. A Tukey statistical analysis was summarized. **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 (rock wool, medium raw material) can be used cost-effectively in the hydroponic cultivation. Based on our results we found that the effect of plant protection (Actara 240 SC, 21.1% w/v thiametoxam) was successful against cotton bollworm. Overall, the effect of insecticide treatments against *Helicoverpa armigera* protection was successful; the 56% infection on 5th October was reduced to a 5% infection level on 29th October. 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.

Keywords: *Lactuca sativa* convar. *capitata* L.; hydroponic; plant protection; Actara 240 SC; lettuce yield.

Introduction

Nowadays hydroponics cultivation is very popular. Göhler and Molitor [1] prepared to divide one of the most comprehensive methods. During the improvement of hydroponic cultivation, several kinds of application methods have been developed for vegetable production. According to the composition of the substrate, organic and inorganic cultivation can be distinguished. The inorganic occurring cultivation listed cultivation with rock wool, calcined clay balls, plastic sponges, perlites, pebbles, and polystyrene pellets, which may take place in culture vessels. Environmental regulations are getting stricter, allowing only closed operation. Operating the system requires greater professional skills, continuous monitoring and attention is required. Periodically check the EC value, pH, oxygen content, nutrient composition, contamination, and temperature [2].

Lettuce became from a seasonal vegetable into an all-year grown food having a wide range of species. Modern technologies, by using hydroponic lettuce growing, permit continuous cultivation of lettuce for 12 months every year [3–4]. The average consumption of the plant increased during the previous decade, so it can be inserted into modern healthy nourishment. Lettuce (*Lactuca sativa* convar. *capitata* L.) is a significant vegetable, rich in vitamins and minerals as well. Growing in hydroculture has several beneficial advantages compared to the soil growing as regard of: faster development, higher average of yield,

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balanced and schemed development. Furthermore, growing can be automated by electric technologies, in an environmentally friendly way, and the production does not require significant manual labour [5–6].

By the use of an automated (electronic technology) system, the nutrient solution can circulate several times a day in the hydroculture channel system [7–13].

Magnesium is a central component of chlorophyll, which has a unique role in photosynthesis; magnesium is an essential metal in the plant metabolism, protein biosynthesis, and collaborates as a metallic catalyst in take and release of energy [14–21].

It can influence the development of plants with low or high humidity. The optimum humidity is 70% [22]. The optimal growth of lettuce depends on the temperature. If there is no continuous air exchange, the vapour and oxygen build up, thus assimilation will deteriorate and eventually stop [23]. Due to the sensitivity of the lettuce, the drying of the rock wool may damage the root feel. For economic reasons, 4×4 or 5×5 rock wool is used for seedlings [24].

In our experiment, the hydroculture cultivation of lettuce (*Lactuca sativa* convar. *capitata* L.) was studied under various Mg treatments, and we used pesticide protection against cotton bollworm (*Helicoverpa armigera*).

Materials and methods

The experiment was carried out in the greenhouse of the John von Neumann University, Faculty of Horticulture and Rural Development in autumn 2015. A small air-space, 6.4 m wide and 6.4 m long in a closed area, three hydroponics table, in the cultivation channels dedicated Groden Delta rock wool performed lettuce experiments begin. Experimental plants were propagated by seeding and subsequent transplant raising in greenhouse. The lettuce seedlings were placed into rock cotton cubes, and put into hydroponic growing channels. The level of heating the greenhouse at 15–20 °C. The lettuce seed was thrown into the cell feeding tray on 24th August 2015. The seedlings of the Groden Delta rock wool were placed on 4th September 2015. The water-soluble fertilizer was measured by a digital laboratory scale. Treatments used in the experiment: control, 50-, 100-, 150-, 200- and 250 mg/L of magnesium treatments. Magnesium fertilizer data for the experiment: Magnisal fertilizer (active substance content N 11%, MgO 15%). It is very soluble in water. Medium: 1 litre of distilled water was added 310 grams of Magnisal fertilizer. This medium was measured for treatments (50 mg/L Mg treatment with 50 ml medium; 100 mg/L Mg treatment with 100 ml medium; 150 mg/L Mg treatment with 150 ml medium; 200 mg/L Mg treatment with 200 ml medium; 250 mg/L Mg treatment with 250 ml medium). Each channel of the closed nutrient system had a separate container with a separate submersible pump to ensure adequate circulation of the nutrient solution for plants. The number of plants per plot was 28. The experimental design was a randomized blocks with 4 repetitions. In each treatment 7 plants were measured. The 28 litre container containing the hydroculture channels was filled with the medium which was exchanged once a week. The submersible pump device in the tanks circulated the nutrient solution three times a day in the system.

The temperature control is adjusted according to the recommendation, with a thermostat automatically. During the day, we adjusted the temperature by compensating for the heat of the sunshine by manually opening and closing the ventilators.

On 5th October 2015, we noticed that the lettuce was damaged by the cotton bollworm (*Helicoverpa armigera*) larva. Probably during the ventilation it was possible for the pests to settle on the lettuces. On 8th October 2015 Actara 240 SC (21.1% m/m thiamethoxam) insecticide spray was sprayed onto the lettuce. Harvest of lettuce was made on 29th October 2015, we measured the fresh weight of lettuce. The evaluation of the lettuce data infected with the worms of the cotton bollworm was carried out using the Tukey-HSD method and the statistical tests were performed using SPSS v19 software. The mean difference is significant at the 0.05 level [25]. Following harvest, the leaves of lettuce were dried in a LTE-OP-250 drying oven in the laboratory. In the course of the experiment, the nutrient element concentrations nitrogen, magnesium and calcium were determined in the leaves of lettuce.

Results

We can show the number of lettuces infected with caterpillar of the cotton bollworm (Table 1). The most infected lettuces with the caterpillar were calculated in the 150 and 200 mg/L Mg treatments (26 and 23). The recording time (94 pieces *H. armigera*) was on 5th October 2015. The Table 2 presents the significance values of the Tukey-HSD method. The 50 and 100 mg/L Mg treatments were not significant.

Table 1

Number of *Helicoverpa armigera* caterpillars on the lettuce head before plant protection

Treatments	Total lettuce (number)	Lettuces infected with caterpillars of cotton bollworm (number)	Mean	St. Error
Control	28	6	0.2143	0.41786
50 mg/L Mg	28	10	0.3571	0.48795
100 mg/L Mg	28	13	0.4643	0.50787
150 mg/L Mg	28	26	0.9286	0.26227
200 mg/L Mg	28	23	0.8214	0.39002
250 mg/L Mg	28	16	0.5714	0.50395
Total	168	94	0.5595	0.49793

Table 2

Tukey-HSD test of significance measurement (parameter: *H. armigera* caterpillars on the lettuce head before plant protection)

Treatments (A)	Treatments (B)	Mean difference (A-B)	St. Error	Significance
Control	50 mg/L Mg	-0.14286 n.s.	0.11678	0.825
	100 mg/L Mg	-0.25000 n.s.	0.11678	0.272
	150 mg/L Mg	-0.71429*	0.11678	0.000
	200 mg/L Mg	-0.60714*	0.11678	0.000
	250 mg/L Mg	-0.35714*	0.11678	0.031

* The mean difference is significant at the 0.05 level.

n.s. = not significant

When harvesting lettuce (29th October 2015) we measured the weight of the lettuces, counting the number of caterpillars of *H. armigera* by repetition and treatment (Table 3), and a variance analysis was made on the calculation (Table 4).

Table 3

Number of *Helicoverpa armigera* caterpillars in the lettuce head after plant protection

Treatments	Total lettuce (number)	Lettuces infected with caterpillars of cotton bollworm (number)	Mean	St. Error
Control	28	0	0.0000	0.00000
50 mg/L Mg	28	1	0.0357	0.18898
100 mg/L Mg	28	0	0.0000	0.00000
150 mg/L Mg	28	6	0.2143	0.41786
200 mg/L Mg	28	0	0.0000	0.00000
250 mg/L Mg	28	2	0.1071	0.31497
Total	168	9	0.0595	0.23731

Table 4

Tukey-HSD test of significance measurement (parameter: *H. armigera* caterpillars on the lettuce head after plant protection)

Treatments (A)	Treatments (B)	Mean difference (A-B)	St. Error	Significance
Control	50 mg/L Mg	-0.03571 n.s.	0.06070	0.992
	100 mg/L Mg	0.00000 n.s.	0.06070	1.000
	150 mg/L Mg	-0.21429*	0.06070	0.007
	200 mg/L Mg	0.00000 n.s.	0.06070	1.000
	250 mg/L Mg	-0.10714 n.s.	0.06070	0.491

* The mean difference is significant at the 0.05 level.

n.s. = not significant

After plant protection, the number of cotton bollworm decreased to 9 (Table 3). Only the 150 mg/L Mg treatment was significant (Table 4), because the value was 0.007 (the mean difference is significant at the 0.05 level).

We measured 28 plants from each treatment area. The highest lettuce weight was found in the control group (186.1 g), while the lowest was among the 250 mg/L magnesium treatment. Tukey statistical analysis were summarise in Table 5.

Table 5

Tukey HSD test of lettuce (parameter: lettuce head weight)

Treatments (A)	Treatments (B)	Mean difference (A-B)	St. Error	Significance level	Wet weight (g)
Control	50 mg/L Mg	54.89*	6.904	0.000	132.3
	100 mg/L Mg	29.11 *	6.904	0.001	131.4
	150 mg/L Mg	75.46 *	6.904	0.000	111.6
	200 mg/L Mg	67.96 *	6.904	0.000	117.1
	250 mg/L Mg	77.43 *	6.904	0.000	104.1

*The mean difference is significant at the 0.05 level.

n.s. = not significant

In the course of the experiment, the nutrient element concentrations nitrogen, magnesium and calcium were determined in the leaves of lettuce (Figure 1).

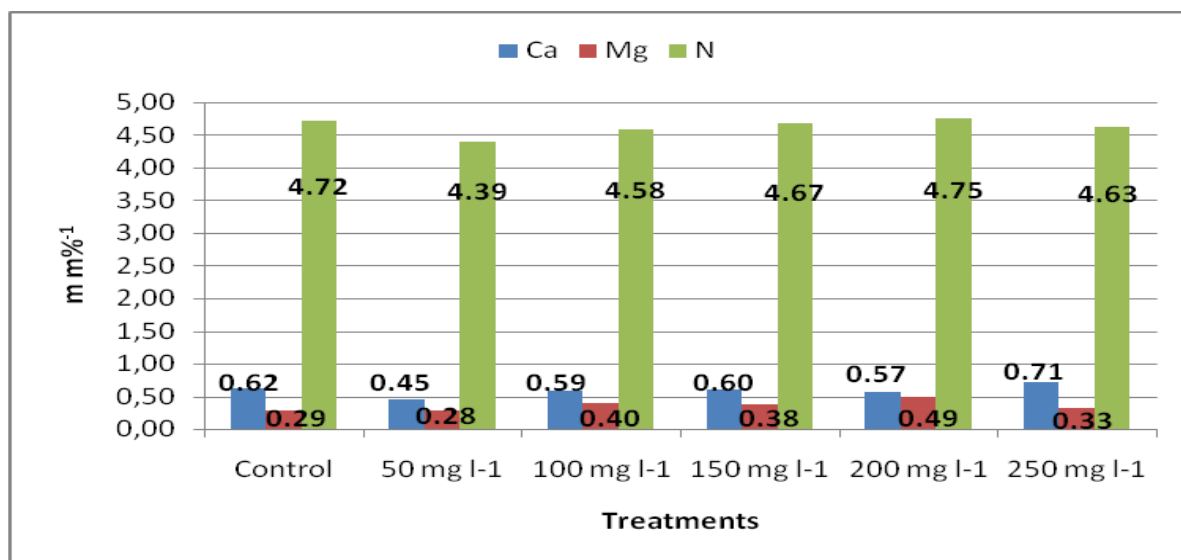


Figure 1. The nutrient element concentration (Ca, Mg, N) in the leaves of lettuce

The increasing magnesium concentration in the nutriment solution caused the decrease of nitrogen content of dry matter in the leaves from 4.72 m/m % to 4.63 m/m %. The concentration of magnesium increased from 0.29 m/m % to 0.49 m/m %. The calcium concentration was decreased from 0.62 m/m % to 0.71 m/m %, in the average of repetitions.

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 (rock 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 highest lettuce weight was found in the control group (186.1 g), while the lowest (104.1 g) was among the 250 mg/L magnesium treatment.

Based on our results we found that the effect of plant protection (Actara 240 SC, 21.1% w/v thiamethoxam) was successful against cotton bollworm. Magnesium treatments were used in our experiment. Magnesium is a central component of chlorophyll, which has a unique role in photosynthesis; magnesium is an essential metal in the plant metabolism, protein biosynthesis, and collaborates as a metallic catalyst in take and release of energy. The most infected lettuces with the caterpillar were calculated in the 150 and 200 mg/L Mg treatments. Overall, the effect of insecticide treatments against *Helicoverpa armigera* defence was successful; the 56% infection on 5th October was reduced to a 5% infection level on 29th October.

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Vojnich V. J., Pető J., Hüvely A. Вплив системи захисту рослин на вирощування гідропонного салату (*Lactuca sativa* convar. *capitata* L.). *Новітні агротехнології*. 2018. № 6. URL: <http://plant.gov.ua/article/view/-№6> (2018).

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Мета. У нашому експерименті культивування гідрокультури салату (*Lactuca sativa* convar. *capitata* L.) вивчалось за різних режимів Mg, а також ми використовували пестициди проти бавовникової совки (*Helicoverpa armigera*). **Методи.** Біометричні вимірювання виконувались з аналізом дисперсії (метод Tukey-HSD, статистичні тести проводили з використанням програмного забезпечення SPSS v19). **Результати.** Наші результати свідчать про те, що система захисту рослин (препарат Actara 240 SC, д.р. тіаметоксам) була успішно використана проти *Helicoverpa armigera*. Кількість головок салату, заражених бавовниковою совкою склала 9 (загальна кількість). Час обліку (94 одиниць *H. armigera*) результатів 5 жовтня 2015 року. Кількість головок салату, заражених бавовниковою совкою, складала 9 (всього) в кінці досліджень. На час збору врожаю (29 жовтня), ми виміряли вагу головок салату, підрахувавши кількість гусениць *H. armigera* та проаналізували відхилення у розрахунках. Найбільша кількість заражених головок салату було зафіксовано з режимами Mg 150 і 200 мг/л. Ми виміряли 28 рослин з кожного режиму Mg з різними концентраціями. Найбільше значення маси головки салату було визначено в контрольній групі (186 г), а найнижче за магнієвої обробки 250 мг/л. Отримані дані були оцінені за допомогою статистичного аналізу Tukey-HSD. **Висновки.** Незважаючи на широко поширені традиційні технології сільськогосподарського виробництва, гідропонне вирощування також відіграє велику роль і в нашій країні, і в майбутньому. В ході нашого експерименту ми виявили, що матеріали, які знаходяться у вільному продажу (кам'яна вата, сировинний матеріал) можна економічно ефективно використовувати за гідропонної культивування. На основі результатів наших досліджень визначено, що вплив системи захисту (Actara 240 SC, 21.1% г/мл, д.р. тіаметоксам) виявився ефективним проти бавовникової совки. В цілому, ефект від впливу інсектициду проти *Helicoverpa armigera* був успішним; 56-відсоткова зараженість 5 жовтня було знижено до 5 %-го рівня інфікування 29 жовтня. У наших дослідженнях салат вирощували з використанням гідропонної культивування. Ріст салату був стабільним, але спостерігалось значне відхилення у вазі головки. Відповідно до показників вимірювань гідропонного салату, ми виявили, що обробка магнієм привела до значного зниження ваги головки салату в порівнянні з контрольною групою.

Ключові слова: *Lactuca sativa* convar. *capitata* L.; гідропоніка; захист рослин; Actara 240 SC; урожай салату.

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Цель. В нашем эксперименте культивирование гидрокультуры салата-латука (*Lactuca sativa* convar. *Capitata* L.) изучалось при различных режимах Mg, а также мы использовали пестициды против хлопковой совки (*Helicoverpa armigera*). **Методы.** Биометрические измерения были произведены с анализом дисперсии (метод Tukey-HSD, статистические тесты были выполнены с использованием программного обеспечения SPSS v19). **Результаты.** Наши результаты свидетельствуют о том, что система защиты растений (препарат Actara 240 SC, д.в. тиаметоксам) была успешно использована против *Helicoverpa armigera*. Количество головок салата, зараженных хлопковой совкой составило 9 (общее количество). Время учета (94 единиц *H. armigera*) результатов – 5 октября 2015 года. Количество головок салата, зараженных хлопковой совкой, составило 9 (всего) в конце исследований. Во время сбора урожая (29 октября), мы измерили вес головок салата, подсчитав количество гусениц *H. armigera* и проанализировали отклонения в расчетах. Наибольшее количество зараженных головок салата было зафиксировано с режимами Mg 150 и 200 мг/л. Мы измерили 28 растений из каждого режима Mg с разными концентрациями. Наибольшее значение массы головки салата было определено в контрольной группе (186 г), а самое низкое - при магниевой обработке 250 мг/л. Полученные данные были оценены с помощью статистического анализа Tukey-HSD. **Выводы.** Несмотря на широко распространенные традиционные технологии сельскохозяйственного производства, гидропонное выращивание также играет большую роль и в наши дни, и в будущем. В ходе нашего эксперимента мы обнаружили, что материалы, которые находятся в свободной продаже (каменная вата, сырьевой материал) можно экономически эффективно использовать при гидропонной культивации. На основе результатов исследований определено, что влияние системы защиты (Actara 240 SC, 21.1 % г/мл, д.в. тиаметоксам) оказалось эффективным против хлопковой совки. В целом, эффект от воздействия инсектицидами против *Helicoverpa armigera* был успешным; 56 %-ная зараженность 5 октября была снижена до 5 %-го уровня инфицирования 29 октября. В наших исследованиях салат-латук выращивали с использованием гидропонной культивации. Рост салата был стабильным, но наблюдалось значительное отклонение в весе головки. В соответствии с показателями измерений гидропонного салата, мы обнаружили, что обработка магнием привела к значительному снижению веса головки салата по сравнению с контрольной группой.

Ключевые слова: *Lactuca sativa* convar. *capitata* L.; гидропоника; защита растений; Actara 240 SC; урожай салата.

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