QUALITY MANAGEMENT OF LETTUCE PRODUCTION IN PROTECTED AREAS UNDER THE INFLUENCE OF ABIOTIC FACTORS

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RESEARCH ARTICLE

Abstract

This study presents the influence of abiotic factors (light, temperature, humidity, and fertilization) on the accumulation of nitrates in lettuce leaves grown in protected spaces with a major impact on its quality. To carry out this study, a monofactorial experiment was implemented, more specifically the influence of the light factor, which includes two lettuce crops established in protected spaces in two different periods of the year, respectively autumn and winter, with different light intensities, the light intensity being the control factor. Being carried out over a period of one year, the study includes two experiments with a single repetition, with the next repetition to be carried out over a period of another year. The experiments were located on an area of 2000 m², in solariums equipped with a heating, drainage and irrigation system.

Keywords: lettuce, abiotic factors, crop cycle.

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INTRODUCTION

Lettuce, known scientifically as Lactuca Sativa, is part of the Asteraceae family with origins in the Mediterranean. It is a long-day herbaceous plant that, under short-day conditions and low light intensity, does not produce a flower stalk, forming up to 50-70 leaves gathered in a head, depending on the variety or hybrid cultivated (Muntean, 2008). In recent years, this vegetable has occupied an important place in the consumption of fresh vegetables, especially during winter, and can be considered a seasonal vegetable, since it does not have high temperature requirements (Indrea & co., 2007). Lettuce, due to its low caloric value, but having a high concentration of vitamins, mineral salts, and fiber, is part of various diets (Apahidean, 2021). On the Romanian market, the demand for lettuce is increasing and because the Horeca industry absorbs a large amount of this vegetable, being part of a varied range of menus (Popescu & Atanasiu, 2001). At the same time, in recent years, several varieties and hybrids of lettuce have appeared, which can satisfy almost all tastes. In terms of economic efficiency, this is given by the reduced consumption of thermal energy, which ultimately reduces the cost price, this crop contributing to the efficiency of solariums during the winter. Being a small plant, it can also be grown in intercrops, which leads to an increase in the profit made in crops in protected spaces. As a technological use, lettuce can also be used as an indicator in fruit nurseries in field 1. Analyzing all these aspects, lettuce cultivation proves to be economically profitable (Apahidean & Apahidean, 2020).

The general goal of the research was to contribute to a better understanding of the physiological mechanisms involved in the process of assimilation of lettuce plants, of certain substances, namely nitrates, under certain cultivation conditions and to draw up fertilization programs in accordance with their needs and environmental factors.

The main objectives through which the proposed goal was pursued were:

- developing a culture system that would allow the most rigorous control of plant nutrition.

- verifying fertilization procedures that would allow maintaining the optimal level of plant nutrition, but also the allowed level of

contaminating substances from chemical fertilizers.

- protecting the soil, by continuously improving the organic matter content.

- maintaining the quality of production, along with its increase.

The goal of the research was to develop a technology that would allow for greater and better-quality production per unit area by minimizing the level of nitrates and other contaminants in lettuce plants.

MATERIAL AND METHOD

The study was carried out in a vegetable farm in the village of Nojorid, Bihor County, a locality located in Northwestern Romania. To conclude the conditions under which lettuce plants tend to accumulate a higher number of nitrates in their leaves, several measurements were made regarding light intensity both during the vegetation period of the first crop cycle and during the vegetation period of the second crop cycle. Both crop cycles had the same cultivation technology and were established by planting seedlings as follows: the first crop was established on October 1, 2024, with the beginning of the harvest on November 5, 2024, and the second crop was established on October 10, 2024, with the beginning of the harvest on December 5, 2024.

The biological material used for the establishment of the crop was provided by a hybrid of lettuce for head under the name Centore, a hybrid with a short vegetation period (approximately 55-65 days from planting), with cold resistance and high tolerance to the emission of floral stems. A LINI-T - UT363 BT luxmeter was used to measure the light intensity. The crops were irrigated by a drip irrigation system, through which fertilization (fertigation) was also carried out. Fertigation was provided by organic fertilizers in the form of peat and compost-based substrates, applied as basic fertilization before planting and 100% water-soluble mineral fertilizers with different concentrations of macro and microelements, these being applied together with the irrigation water (fertigation). The commercial names of these mineral fertilizers are: Geliasol, Potassium Nitrate, Calcium Nitrate, Magnesium Nitrate. Temperature control during the cold period was ensured by a hot air generator equipped with an ambient sensor. Specific laboratory analyses were performed at DSP-Bihor to determine the nitrate level in lettuce leaves.

Light is the essential factor in plant life, without its photosynthesis, i.e. assimilation, cannot be achieved. Being the control factor for the two experiments (lettuce crops), established in different periods of the year, respectively autumn and winter, knowing that light intensity decreases with the photoperiod, we performed several measurements in this regard. At the same time, from the studies carried out to date it is known that light intensity also has an influence on the accumulation of nitrates in lettuce leaves, which is also the main objective of this study. To achieve this objective, measurements were made regarding the light intensity throughout the vegetation period of the two crop cycles as follows:

Crop cycle 1 with the vegetation period October 1 - November 5, the following light intensity values were measured:

- October 1 - November 1 - sunny days, values between 60,000- 75,000 lux, respectively up to 50,000 lux, on cloudy days the measurements were made at noon. Under these conditions, the nitrate content value in lettuce leaves was 7.5 mg / kg

Crop cycle 2 - October 10 - December 5, the following light intensity values were measured:

- November 1 - December 1 - sunny days, values between 42000- 50000 lux, respectively up to 20000 lux on cloudy days.

Under these conditions, the nitrate content value in lettuce leaves was 8.8 mg / kg.

Lettuce is a plant with low temperature requirements, but still the optimal growth and development temperatures are between 18-22°C in the air and between 15-20°C in the soil. Under these conditions, the growing season can be shortened by half, which happened in the present experience from the first crop cycle carried out in autumn.

Lettuce has high demands on humidity, both in the seedling phase and during the period of intensive growth and head formation, with a slight reduction in humidity in the final stage of head compaction, in this case the air humidity was between 40-50% on days with high temperatures and high light intensity and 70-80% on days with lower temperatures and low light. The water norm on sunny days and high light intensity was 200 ml/plant, and on days with lower temperatures and low light between 0-100 ml/plant.

Lettuce plants have moderate demands for macroelements and microelements, but like all vegetation factors, the nutritional regime

directly influences their growth and development. The amounts of fertilizers used and the ratio between NPK, were different during the vegetation period depending on the phenophase and environmental conditions. The total amount of water-soluble mineral fertilizers was 3 Gr/plant, at an average weight of 300 Gr/head.

RESULTS AND DISCUSSIONS

As can be seen in the graphs below, on the two crop cycles, as well as during their vegetation period, we have different values regarding the accumulation of nitrates in the leaves, depending on the light intensity.

The accumulation of nitrates in the leaves increases with the decrease in light intensity, reaching the maximum value of 9.5 mg/kg leaves at a maximum light intensity of 20,000 lux, this value being measured in December.

Also, the vegetation period until reaching the weight and volume necessary to be marketable increases in the second cycle, this fact being explained by the reduction of the photoperiod and implicitly the accumulation of dry matter in the leaves.

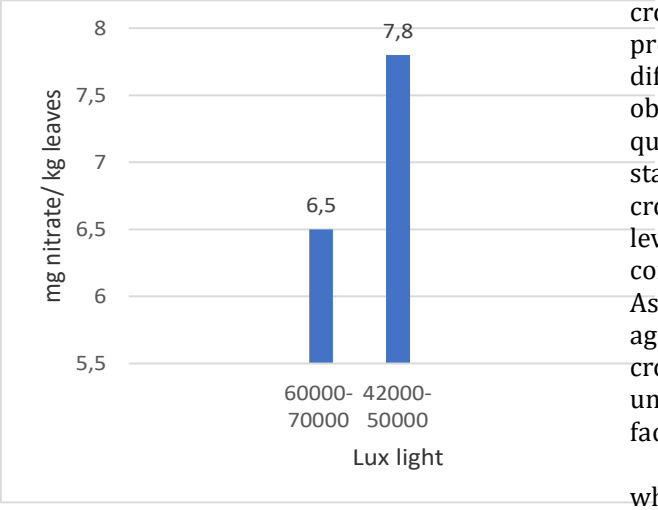

Fig. 1. Nitrate quantity in mg, registered in the first cycle (1st October- 5th November)

In both cases, the total value of nitrates accumulated in the leaves is very low, of max. 9.5 mg/ kg leaves, (0.0095 Gr), given that the maximum allowed value is 2500 mg/ kg leaves, (2.5 Gr).

It can also be noted that although the light intensity is significantly reduced towards the end of the second crop cycle, the amount of nitrates accumulated does not increase proportionally to this decrease.

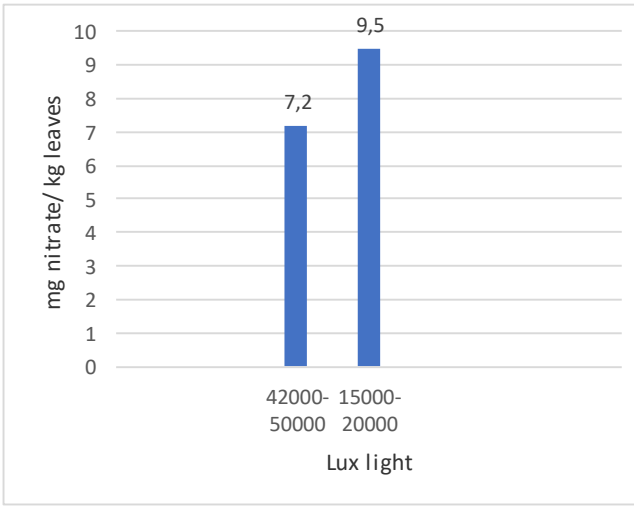

Fig. 2. Nitrate quantity in mg, registered in the second cycle (10th October- 5th December)

To make this crop economically efficient, we aimed to reduce the cost of production by using a hybrid with a short vegetation period that would best utilize environmental factors and applied technology. The homogeneity of the crop led to the capitalization of over 95% of the production, at the same price, with no differences in quality. Through the results obtained, in terms of economic efficiency and quality of head lettuce production, it can be stated that even in conventional vegetable crops, high-quality products with a very low level of nitrates and other chemical contaminants can be obtained.

As for the soil, the results obtained following agrochemical analyses at the end of the two crop cycles show that all the technology applied under the influence of the described vegetation factors do not have negative effects on it.

The study is part of a larger research in which other vegetation factors are analyzed, which have an impact on the quality and quantity of lettuce production, therefore, these results were obtained under the technological conditions described in this paper.

CONCLUSIONS

Following research conducted on the influence of abiotic factors (light intensity, temperature, humidity, and fertilization) on the quality of head lettuce production, grown in protected areas, we reached the following conclusions:

-Light intensity, under the environmental and technological conditions described in this study, does not have a decisive effect on nitrate accumulation in lettuce leaves;

- The influence of light intensity on nitrate accumulation in lettuce leaves is in full agreement with other vegetation factors;
- No vegetation factor, whether biotic or abiotic, can have an independent influence on lettuce plants or on the accumulation of nitrates in their leaves;
-Light intensity also has an influence on shortening the growing season, on reaching the weight of the lettuce head to be marketable and on achieving the potential of the hybrid;
- The intensity of light intensifies the photosynthesis process and implicitly the biochemical processes in the plant, this could explain the reduction in nitrate accumulation in lettuce leaves and not only, but this process is fully consistent with the nutritional, thermal and water regime of the plants;
- On days with high cloudiness (winter), it is recommended to reduce the doses of nitrates and nitrites in fertilizers used in fertilization programs;
- Adapting fertilization according to the physiological state of the plants and the microclimate conditions in which they grow and develop;
- Using chemical fertilizers in combination with organic ones and continuously improving soil organic matter;
- Soil analyses before the establishment of crops and during their growing season;
- Using hybrids with high adaptability to the conditions and technologies available in cultivation.

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