

## Effect of Variety and Production Methods on Nitrate Content in Lettuce

Aleksandra Govedarica-Lučić<sup>1</sup>, Goran Perković<sup>1</sup>

<sup>1</sup>*Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina*

### Abstract

Certain trials, the effect of variety and different production methods on the content of damaging substances i.e. nitrate in lettuce leaf were carried out on the experimental field of the Faculty of Agriculture in East Sarajevo during the period of three years. The trial was set in a randomized block-system with three replications and the plot size of 2.4 m<sup>2</sup> (0.3x8m). Three lettuce varieties (Archimeds RZ, Santoro RZ, Kibou RZ) were analyzed in the trial. Each row of variety was tested in the following variants of covering: planting on soil that was not covered, mulching with PE-black folium before planting; agro-textile - covering of plants with agro textile (17gr) after planting; combination of mulching + agro textile. The three-year researches have shown that the production method and variety significantly affect the nitrate content. An average nitrate content was 2196.33 mg/kg on the control variant, and 2526.24 mg/kg on agro textile. Leafy lettuce of oak leaf type „Kibou“ had lower nitrate content (2176.85 mg/kg) compared to „Archimed“ (2843.05 mg/kg) and „Santoro“ (2221.37 mg/kg).

*Key words:* lettuce, variety, production method, quality

### Introduction

In the modern nutrition lettuce is highly valued vegetable species, which is characterized by a high content of biologically important substances (minerals, vitamins, antioxidants). Lettuce creates a feeling of fullness and is an excellent diet for obese people and even children. By using lettuce in the diet the bowels are accelerated and better digestion is achieved.

On the other hand, according to researches of Balalić (2004) and Lazić (2001), lettuce is inclined to the accumulation of toxic substances (nitrates). These authors suggest that the accumulation of nitrate largely depends on the fertilizer (especially nitrogen) and climatic conditions (lack of light and low temperature). Winter lettuce

production with insufficient lighting and a large amount of nitrogen fertilizers provides ideal conditions that lead to the accumulation of significant amounts of these harmful substances.

Knowledge of the biological characteristics of lettuce and its specific growth and development are the basis for establishing the optimal ways of growing. The aim of this paper was to examine the content of nitrates in winter lettuce produced at different growing methods.

## Materials and methods

During a three-year period (2009 to 2011), the tests were carried out on the following varieties Archimeds RZ, Santoro RZ and Kibou RZ in a greenhouse without additional heating on the experimental field of the Faculty of Agriculture in East Sarajevo.

The land on which they performed experiments is secured medium humus (2.9 %) . Chemical analysis indicates that this is a favorable soil pH for growing vegetable crops . As far as the nitrogen content data (table 1) indicate poor soil obezbjedenost this element . The content of organic carbon (C) is 1.68 % , and the content of total nitrogen content was 0.05 % , which indicates that the ratio of C / N unfavorable and is 33,6:1. According to the content of physiologically active phosphorus (96.1 mg/100 g) and potassium (56.6 mg/100 g), we conclude that it is a land of good provision to these elements.

Tab.1. Chemical properties of land  
*Hemijske osobine zemljišta*

<i>pH</i>		the organic C (%)	<i>humus</i> (%)	total N (%)	<i>Al-P<sub>2</sub>O<sub>5</sub></i> (mg/100g)	<i>Al-K<sub>2</sub>O</i> (mg/100g)
in KCL	in H <sub>2</sub> O					
6.18	6.61	1.68	2.9	0.05	96.1	56.6

The trial was set in a randomized block system with four replications and an experimental plot of 2.4 square metres (0.3 x8m). There were three rows in the experimental plot, and each row represented a new variety. Sowing for the production of seedlings was done in containers, without a nosedive on the Klasmann substrate in the first decade of September. The 25 day-old seedlings were seeded at the distance of 20cm in a row and 30 cm between rows, so that the planting density of about 150 000 plants / ha was made. We used the dripping irrigation system, which was set along with the covering of area.

The trial included four variants of soil covering: control - planting on bare soil, mulching before planting with PE black foil, agro textile - covering plants after planting with agro textile (17 grams), a combination of mulching + agro textile.

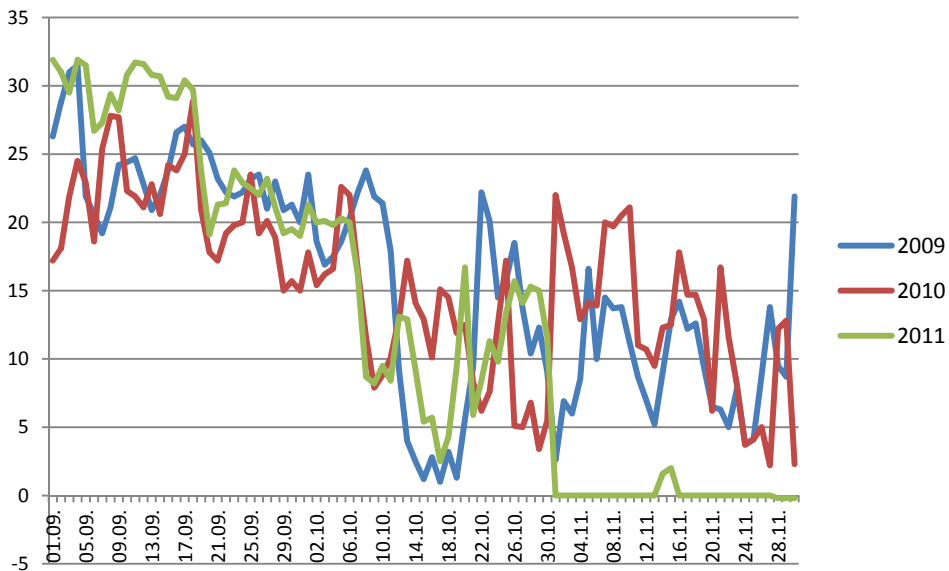
Picking of lettuce was carried out in technological maturity - the average weight per head was 250 g. Immediately after picking, an analysis of quality properties of lettuce was made nitrate content. Chemical analyzes were performed in the

laboratory of Chemical Technology Faculty in University of Novi Sad. Nitrates are determined by a spectrophotometrical method.

The results achieved were processed by variance analysis method of a two-factorial trial (ANOVA) using SPSS 4.5 software. We carried out the testing of significance of differences between the means by the method of the variance analysis of two-factorial trial covering x variety (4 x 3). The significance of differences of individual means was tested by LSD test for the general means and interaction. We conducted a statistical analysis of experimental data according to the year of research.

### Results and discussion

Nitrate content in lettuce depends on many factors. There is more nitrate in the vegetables grown with higher doses of nitrogen and organic fertilizers at low relative air humidity, under drought conditions, low light intensity, short-day, temperatures above 25<sup>0</sup>C .



Graf.1 Mean daily temperature (in the greenhouse) during experimental production of lettuce  
*Srednja dnevna temperatura (u stakleniku) tokom eksperimentalne proizvodnje zelene salate*

According to the researches of Poulsen et al., (1995) the nitrate content decreases from the outer leaves (1850-650 mg / kg) depending on the level of nitrogen added to the inner ones (455-230 mg / kg). According to Kastori (2003), there is more nitrate in the peduncle than in the leaves.

Survey results (Table 1) indicate that all four types of coverage differentiated in nitrate content. The highest content of nitrate (3192.25 mg / kg) was recorded in agro textile, and the lowest (2597.83 mg / kg) on the control. The differences in nitrate content among the II, III and IV variants of covering were evaluated at the significance level of  $P < 0.01$  in comparison to the control variant.

Depending on the choice of varieties, nitrate content ranged from 2606.12 mg / kg to 3464.56 mg / kg. The effect of the variety indicates to the existence of significant differences in nitrate content of the Archimedes variety in relation to Santoro and Kibou.

In the second year of the study, the average value of nitrate content (table 2) ranged from 2197.25 mg / kg (control) to 2526.25 mg / kg (agro textile).

The differences achieved in the average values of nitrate content at different variants of mulching are rated on the threshold of significance of 1%, only these differences were not statistically significantly justified between the third and fourth variants of mulching.

In the second year of the study, the order of the studied varieties, in terms of this trait, was identical to the one from the previous year. The variety Archimedes had the highest average value of nitrate (2842.9 mg / kg), and the variety Kibou had the lowest (2162.87 mg / kg). Variations in the values of nitrate content of the variety Archimedes compared to the other two tested varieties were evaluated at the significance level of  $P < 0.01$ .

Statistical analysis of the mean values of nitrate content showed a significant difference between the variety Archimedes and all other varieties.

In the final year of the trial, we have recorded generally lower average values of nitrate content (Tab.2) compared to the previous two years. If we look at the temperatures in the years of trial, (graf.1) it can be seen that the temperatures during October and November in 2009 and 2010 were higher than they were in 2011, when the lowest nitrate content was recorded. Nitrate content in lettuce depends on many factors. There is more nitrate in vegetables cultivated with higher doses of nitrogen and organic fertilizers at low relative air humidity, under drought conditions, low light intensity, during the short day, temperatures above 25 °C degrees. According to research (Kastori & Petrovic, 2003) for the accumulation of nitrate is very significant interaction of temperature and light intensity. Cited authors point out that the accumulation of nitrate favors high substrate temperature and low light intensity.

The study has determined that the control variant had the lowest nitrate accumulation (1797.25 mg / kg), while the highest nitrate accumulation was recorded in black PE foil (2039.58 mg / kg).

The differences were also spotted in the content of nitrate per variety. The highest accumulation of nitrate was recorded in the variety Archimedes (2221.68 mg / kg), while the lowest content was recorded in the variety Santoro (1761.00 mg / kg).

The differences among varieties were highly significant, indicating that the varieties have an impact on nitrate content in lettuce leaves. That nitrate accumulation depends on the type, variety and climatic conditions has been shown in the researches of Sorensen (1994).

Similar results are found in the works of Lazic et al. (2002). According to their research, the nitrate content is a varietal characteristics and the leaf lettuce has the highest level of it (350.30 mg / kg fresh weight), and the Roman lettuce has the lowest level (310, 90 mg / kg fresh weight).

Tab.2. Mean values of nitrate (mg / kg) in the lettuce  
*Srednja vrijednost nitrata (mg / kg) u zelenoj salati*

Covered land <i>Pokriveno zemljište</i>	2009 year/godina			2010 year/godina			2011 year/godina		
	Archimedes	Santoro	Kibou	Archimedes	Santoro	Kibou	Archimedes	Santoro	Kibou
control kontrola	3313.00	2290.00	2190.50	2727.25	2001.5	1863.00	2142.25	1713.25	1536.25
black PE foil <i>crna PE folija</i>	3491.50	2403.00	2523.00	2831.75	2211.00	2136.50	2172.50	2019.75	1926.50
Agrotex	3642.50	3253.00	2681.00	2889.70	2524.00	2165.00	2137.00	1795.00	1649.00
black PE foil + agrotex <i>crna PE folija +agrotex</i>	3411.25	2782.25	3029.75	2923.00	2148.50	2487.00	2435.00	1515.25	1944.75
Average <i>Prosjek</i>	3464.56	2682.06	2606.12	2842.90	2221.25	2162.87	2221.68	1761.00	1764.18

LSD	2009 year/godina			2010 year/godina			2010 year/godina		
	A	B	AxB	A	B	AxB	A	B	AxB
0.05	97.04	84.03	168.08	61.61	53.34	213.47	30.62	26.52	53.04
0.01	129.70	112.32	224.66	82.35	71.30	285.33	40.93	34.45	70.90

## Conclusion

The nitrate content, which is evaluated as a harmful substance for human consumption, depended on the method of production (without mulching, mulching, mulching + agro textile) and variety. A significant influence of genetic factors has been determined and the highest nitrate content was recorded in the variety Archimedes (2843.04 mg / kg), which is by 22% to 23% more than in the Kibo and Santoro. The trend of increasing of nitrate is emphasized depending on the variant of covering. The minimum content of nitrate was found in the control variant 2196.33 mg / kg, which is by 13% less than the in the agro textile variant, where the highest content of nitrate was found 2526.24 mg / kg.

The values of maximal nitrate content in our trial were below the acceptable standard (4500 mg / kg for lettuce grown in the protected area) as provided by the European Commission EC.

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# Uticaj sorte i načina proizvodnje na sadržaj nitrata u salati

Aleksandra Govedarica-Lučić, Goran Perković<sup>1</sup>

<sup>1</sup>*Poljoprivredni fakultet, Univerzitet u Istočnom Sarajevu, Bosna i Hercegovina*

## Sažetak

Na oglednom polju Poljoprivrednog fakulteta Istočno Sarajevo u trogodišnjem periodu izvršena su ogledna istraživanja, uticaj sorte i različitih načina proizvodnje na sadržaj štetnih materija tj.nitrata u listu salate. Ogled je postavljen po slučajnom blok sistemu u četiri ponavljanja sa veličinom ogledne parcele od 2,4m<sup>2</sup> (0,3x8m). U ogledu su bile zastupljene tri sorte salate (Archimeds RZ, Santoro RZ, Kibou RZ) . Svaki red sorte je bio podvrgnut sljedećim varijantama pokrivanja: kontrola-sadnja na nepokrivenom zemljištu; malčovanje pred sadnju sa PE-crnom folijom; agrotekstil-pokrivanje biljaka nakon sadnje agrotekstilom (17 grama); kombinacija malčovanje + agrotekstila. Trogodišnja istraživanja su pokazala da način proizvodnje i sorta značajno utiče na sadržaj nitrata. Prosječan sadržaj nitrata na kontrolnoj varijanti iznosio je 2196,33 mg/kg, a na agrotektilu 2526,24 mg/kg .Lisnata salata u tipu hrastovog lista „Kibou“ imala je manji sadržaj nitrata (2176,85 mg/kg) u odnosu na „Archimed“ (2843,05 mg/kg) i „Santoro“ (2221,37 mg/kg).

*Ključne riječi:* salata, sorta, način proizvodnje, kvalitet

Aleksandra Govedarica-Lučić

*E-mail adres:*

*sandraklepic@yahoo.com*