

MINERAL CONTENT IN A SALAD LEAF (*Lactuca sativa L.*) DEPENDING OF THE GENOTYPE AND APPLIED AGRICULTURAL MEASURES

Aleksandra GOVEDARICA-LUČIĆ and Goran PERKOVIĆ

University in East Sarajevo, Faculty of Agriculture, East Sarajevo, Bosnia and Herzegovina

Govedarica-Lučić A. and, G. Perković (2015): *Mineral content in a salad leaf (Lactuca sativa L.) depending of the genotype and applied agricultural measures*-Genetika, Vol 47, No. 3,951 -958.

Four different production methods applied on three genotype of lettuce (Archimedes RZ, Santoro RZ, Kibou RZ) – have been estimated in a two-year experiment carried out at the Agricultural University of East Sarajevo. The experiment has been conducted during two-year period; lettuce was cultivated by using four different mulch materials: black PE foil, agro textile, a combination of PE foil and agro textile; control variant (bare soil). After harvesting lettuce, evaluated the content of the following minerals (N, P, K). The values of nitrogen content tend to increase from bare ground (7.47%) to a covered soil (7.98%). The reaction genotype on variants coverage shows an interaction effect. Type of material for covering soil also has an influence on the content of potassium. The highest potassium content of 4.87% was recorded at the variant of covering with agro textile, or by 18% more in comparison to the control variant.

Key words: genotype, agricultural technology , minerals

INTRODUCTION

Green vegetables are essential in proper human diet since they are rich in vitamins, minerals and various protective factors. Lettuce is the most popular vegetable according to the highest consumption rate and economic importance throughout the world (COELHO *et al.*, 2005). According to research (LAZIĆ *et al.*, 2001; MIŠKOVIĆ *et al.*, 2001) lettuce is particularly important in the diet because of the high content of scarce micro nutrients such as copper, zinc, iron and magnesium, and just in the period (spring and autumn) when there is the most want of them. The biochemical composition of the edible part of vegetables depends on the variety (GHEBRAMLAK *et al.*,2004; PETRIKOVA and POKLUDA, 2003) diets and the means of fertilization (DUCSAY and VARGA, 2003; PREMUZIC *et al.*,2004) the agro technique applied (PANCHAL *et al.*, 2011; RADOVICH *et al.*, 2005; WORTHINGTON, 2001). Manufacturing techniques affect growth rate, total yield, earlier yield and yield quality components as reported by EL-SHINAWAY and GAWISH (2006) on lettuce; EL-BEHAIRY *et al.* (2001) and SINGER *et al.* (2009) on cantaloupe. In addition soil

Corresponding author: Aleksandra Govedarica-Lučić, University of East Sarajevo, Faculty of Agriculture, sandraklepic@yahoo.com; +38757342-701

grown lettuce has statistically higher content of zinc and iron whereas, hydroponics grown lettuce has a higher contents of N, P, K, Ca, Cu, Mg and Mn (SANTOS *et al.*, 2003). RADOVICH *et al.*, (2005) reported the significant differences in the interaction between cultivars and environmental conditions accompanied in transplanting date on growth, yield and head sensory quality of lettuce as well as cabbage. In the same regard, KUNICKI *et al.*, (2010) declared that spinach yield and nitrate content were dependent on production technology and cultivar. RADOVICH *et al.*, (2003) reported that planting date and cultivar may play an important role in head of cabbage plant growth, yield and sensory quality. SINGER *et al.*, (2015) reported that the effect of four transplanting dates, lettuce cultivars and their interaction on the percentage of nitrogen, phosphorus, potassium, magnesium and calcium in leaf and root tissues during the first and second seasons. There were significant differences detected among different transplanting dates on nutrient contents of leaf and root tissues in both seasons.

MATERIALS AND METHODS

During a two-year period (2009 - 2010), the tests were carried out on the following genotypes Archimedes 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 trial was set in a randomized block system with four replications and an experimental plot of 2.4 m² (0.3m x 8m). 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 30cm between rows, so that the planting density of about 150 000 plants per hectare. 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. After picking, immediately, an analysis of quality properties of lettuce was made: mineral substances content (N, P, K). N content was determined by the CNSH Elementar Vario III analyzer by Koenig's method (1991), and P by a spectrophotometric method. K content was determined by a standard absorption photometry (atomic absorption spectrophotometer).

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 genotype (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

The nitrogen content

Nitrogen (N) is an indispensable element for the synthesis of proteins such as enzymes, which are responsible for the production of all the cellular components and secondary metabolites required for the development of the plant, and hence nitrate availability in the soil and plant tissue concentration can limit plant growth (LAWLOR *et al.*, 2002). Depending on the choice of varieties,

nitrogen content ranged from 2.84% to 3.50%. The differences found in the nitrogen content of the genotype Archimedes RZ (3.50%) compared to Santoro RZ (2.83%) and Kibou RZ (3.09%) were at the level of significance of $P < 0.01$.

The highest nitrogen content (3.34%) is found in the agro textile variant and the lowest one in control (2.89%). The differences found in the content of nitrogen of applied variants of coverage compared to the control were evaluated at the threshold of significance of 1%. The obtained results were in harmony with (WOJCIECHOWSKA *et al.*, 2007; ESCOBAR-GUTIERREZ *et al.*, 2002).

In the second year of researches the genotypes show no particularly significant differences when it comes to the content of nitrogen. The highest nitrogen content was determined in genotype Archimedes RZ (4.90%), while the other two tested genotypes had similar nitrogen content – Santoro RZ (4.56%), Kibou RZ (4.59%).

The effect of different variants of coverage on the nitrogen content in the leaves of lettuce was emphasized, too. The control variant had the lowest content (4.58%) and PE foil had the highest one (4.85%). On the tendency of increase of nitrate depending on the variant of coverage studies indicate (GOVEDARICA-LUČIĆ *et al.*, 2014; GOVEDARICA-LUČIĆ and PERKOVIĆ, 2013.) The authors emphasize that the control treatment report that at least the accumulation of nitrates.

Also the results (GOVEDARICA-LUČIĆ and PERKOVIĆ, 2013a) indicate that applied variants of applied agricultural measures a significant impact on the quality of winter salads. According to their research, the vitamin C is an important factor in the human diet and the strongest antioxidant among vitamins. Values of vitamin C content depended on the method of production i.e. on the covering variant applied. In average, a combination of mulching +agrotexile (26.77mg/100g) had the highest content, while the control variant had a significantly lower content of vitamin C).

Observing the interaction effect of covering/genotype, it is interesting that the differences in nitrogen content among the genotypes examined at the fourth variant of coverage were not statistically justified.

Table 1. Means of nitrogen content (%) in lettuce in 2009.year and 2010.year

Coverin land	G ₁		G ₂		G ₃		Average
	2009	2010	2009.	2010	2009.	2010.	
C ₀	3.11	4.96	2.62	4.33	2.95	4.44	3.73
C ₁	3.40	5.16	2.81	4.72	3.07	4.69	3.97
C ₂	3.87	4.82	3.07	4.58	3.23	4.52	4.01
C ₃	3.62	4.67	2.84	4.62	3.14	4.73	3.93
Avera. G	3.50	4.90	2.83	4.56	3.09	4.59	3.91
LSD	2009.year			2010. year			
	A	B	A × B	A	B	A × B	
	0.05	0.04	0.03	0.07	0.11	0.10	0.20
	0.01	0.05	0.05	0.10	0.15	0.13	0.27

G-genotypes (G1- Archimedes RZ, G2- Santoro RZ, G3- Kibou RZ); C-covering land (C₀-control, C₁- black -PE foil, C₂- agrotexile, C₃- black-PE foil + agrotexile)

The phosphorus content

Human needs for nutrients range from 550 to 650 mg of phosphorus per day (NOVAKOVIĆ *et al.*, 2002). The role of phosphorus in the human body is included in all our vital functions. Phosphorus is an integral part of the building of bones, teeth, RNA and DNA nucleic acids, of phospholipids every of cell membrane, of the basic energy unit of ATP, and a certain number of enzymes and coenzymes.

The average phosphorus content of all the variants of coverage applied was 0.82% regardless of the variety. The differences in phosphorus content among all of the variants of covering applied were not statistically justified.

Table 2. Means of phosphorus content (%) in lettuce in 2009.year and 2010.year

Coverin land	G ₁		G ₂		G ₃		Average
	2009	2010	2009.	2010	2009.	2010.	
C ₀	0.76	1.52	0.93	1.43	0.82	1.33	1.13
C ₁	0.79	1.56	0.77	1.57	0.90	1.44	1.17
C ₂	0.74	1.47	0.88	1.53	0.89	1.50	1.17
C ₃	0.72	1.56	0.81	1.59	0.91	1.48	1.18
Avera. G	0.75	1.52	0.84	1.53	0.88	1.43	1.16
LSD	2009.year			2010. year			
	A	B	A × B	A	B	A × B	
0.05	0.04	0.03	0.07	0.10	0.17	0.17	
0.01	0.05	0.04	0.09	0.13	0.11	0.23	

G-genotypes (G₁- Archimedes RZ, G₂- Santoro RZ, G₃- Kibou RZ); C-covering land (C₀-control, C₁- black -PE foil, C₂- agrotexile, C₃- black-PE foil + agrotexile)

The average phosphorus content of all treatments coverage regardless of cultivar was 0.82%. The differences in the content of phosphorus applied between variants coverage did not have statistical validity.

The differences in the content of phosphorus between a genotype Santoro RZ and Kibou RZ compared to genotype Archimedes RZ are rated at a level of 1%.

The phosphorus content in the second year of researches ranged from 1.33 to 1.59%. The average content of all variants was 1.49%, which is by 1.11% more than in the previous year. The varieties tested had approximately the same phosphorus content in leaves. Only the differences observed in phosphorus content between genotype Santoro RZ (1.53%) and Kibou RZ (1.44) indicate significance. The highest content of phosphorus (1.54%) is found in the combination of mulching + agro textile, and lowest in controls (1.43%)

The potassium content

The major physiological role of K is the regulation in maintaining water balance in the human body. It is considered that the daily need for K is 0.8 to 1.3 g. According to (NOVAKOVIĆ

et al., 2002) people who frequently eat "fast food" and not take fresh fruits and vegetables may have a low potassium intake.

The highest content was recorded in the genotype Kibou RZ (4.50%). The genotype Archimedes RZ had (4.50%) while the lowest content was recorded in the genotype Santoro RZ (4.32%). The differences among genotypes are highly significant, indicating that the genotype affect the potassium content in lettuce leaves. The obtained results were in harmony with (LOPES *et al.*, 2003; KOUDELA and PETRIKOVA, 2008; CONVERSA *et al.*, 2004; POKULDA and KUBEN, 2002). The highest content of potassium found in all genotypes grown in agro textiles Archimedes RZ (5.01%), Santoro RZ (4.75%), Kibou RZ (4.86%).

The differences in the content of potassium depended on the applied agricultural technology. Differences in cover variants are rated at the level of significance of $P < 0.01$, indicating that the type of material for covering land affects the content of potassium in lettuce leaves. The results obtained are in agreement with (BALALIĆ, 2004) that different methods of production (without mulching, with mulching, mulching + agro textile) show highly significant differences between K content in lettuce. The average content of potassium in the second year of researches, regardless of the treatments tested was 4.47%, which is similar to the previous research year.

The variants of covering applied affected the potassium content in the second year of researches. The observed differences between the variants of coverage were significant at the level of 1%. The values of potassium content ranged from 3.89% (control) to 4.87% (agro textile). BALALIĆ (2004), in his work, also reports about the results similar to ours. In this year of researches the differences in the content of potassium per variety were noticeable, too. The differences in potassium content between genotypes Archimedes RZ and Kibou RZ were significant at the level of 1%, while the same differences between genotypes Archimedes RZ and Santoro RZ as well as Santoro RZ and Kibou RZ had significance at the level of 5%. By analyzing the interaction effect of variety and coverage, it can be seen that the effect is highly significant in this year of researches, too.

Table 3. Means of potassium content (%) in lettuce in 2009.year and 2010.year

Coverin land	G ₁		G ₂		G ₃		Average
	2009	2010	2009.	2010	2009.	2010.	
C ₀	4.46	4.44	3.88	3.85	4.15	4.12	4.15
C ₁	3.81	4.74	4.10	4.10	4.61	4.58	4.32
C ₂	5.01	5.01	4.75	4.74	4.86	4.86	4.87
C ₃	4.73	4.72	4.54	4.53	4.65	4.80	4.66
Avera. G	4.50	4.72	4.32	4.30	4.57	4.60	4.50
LSD	2009.year			2010. year			
	A	B	A × B	A	B	A × B	
	0.05	0.06	0.05	0.11	0.10	0.17	0.17
	0.01	0.08	0.07	0.15	0.13	0.11	0.23

G-genotypes (G₁- Archimedes RZ, G₂- Santoro RZ, G₃- Kibou RZ); C-covering land (C₀-control, C₁- black -PE foil, C₂- agrotextile, C₃- black-PE foil + agrotextile)

CONCLUSIONS

The content of mineral substances varied, depending on the way of production. Thereby, nitrogen content was significantly higher on the covered soil. The values of nitrogen content tend to rise from bare soil (7.47%) to a covered (7.98%) soil. Type of material for covering soil also has an impact on the content of potassium. The variant of covering soil with agro textile had the highest potassium content of 4.87% which is by 18% more, in comparison to the control variant. The genotypes showed significant differences in the content of nitrogen and the highest content was recorded in genotype Archimedes RZ from 3.11 to 5.16% depending on the method of production. The minimum content of nitrogen through the biennial examination had genotype Santoro RZ. The average content of phosphorus is primarily depended on the applied agricultural technology while the analyzed genotype had an average of approximately the same content of phosphorus in the leaf. Both sources of variation (applied agricultural technology /genotype) in the analysis of variance showed highly significant for potassium content in lettuce. Potassium values ranged from 4.02% higher (control variant) to 4.87% (with coverage agrotexile). The differences in the content of potassium between varieties were highly statistically significant and were in the range of 4.29% to 4.73%.

Received June 17st, 2015

Accepted October 20th, 2015

REFERENCES

- BALALIĆ, I. (2004): Influence of method of production and substrates on yield and quality of lettuce (*Lactuca sativa* L.). Master's thesis. Faculty of Agriculture, Novi Sad.
- COELHO, A.F.S., GOMES, E.P., SOUSA, A.P., GLORIA, M.B.A. (2005): Effect of irrigation level on yield and bioactive amine content of American lettuce. *J. Sci. Food. Agric.*, 85: 1026-1032.
- CONVERSA, G., P., SANTAMARIA, M. GONNELLA (2004): Growth, yield, and mineral content of butter head lettuce (*Lactuca sativa* var. *capitata*) grown in NFT. *Acta Hort.*, 659: 621-628.
- DUCSAY, L., L., VARGA (2003): Cultivation of Brassica pekinensis under different forms of nitrogen nutrition. *Horticultural Science*, 30(3):112-115.
- EL-BEHAIRY, U.A., M.Z., EL-SHINAWY, M.A., MEDANY, A.F., ABOU-HADID (2001): Utilization of "A-shape" system of nutrient film technique (NFT) as a method for producing some vegetable crops intensively. *Acta Hort.*, 559:581-586.
- EL-SHINAWY, M.Z., S.M., GAWISH (2006): Effect of commercial organic nutrient solutions on growth and chemical composition of lettuce under agricultural soilless system. *Egypt. J. Hort.*, 33: 19-28.
- ESCABOR-GUTIERREZ, A.J., I.G., BURNS, A., LEE, R.N., EDMONDSON (2002): Screening lettuce cultivars for low nitrate content during summer and winter production. *J. Hort. Sci. Biotechnol.*, 2: 232-237.
- GHEBRAMLAK, A.M., S.R., SHARMA, R.K., RATTAN (2004): Genetic variability and correlation studies for quality characters in cabbage. *Indian Journal of Genetics and Plant Breeding*. Volume 64, Issue 1: 83-84.
- GHEBRAMLAK, A.M., S.R., SHARMA, R.K., RATTAN (2008): Nutrients content and yield in selected cultivars of leaf lettuce (*Lactuca sativa* L. var. *crispa*). *Hortscience*, 35(3):99-106, Prague.
- GOVEDARICA-LUČIĆ, A., G., PERKOVIĆ (2013): Effect of variety and production methods on nitrate content in lettuce. *Agro-knowledge Journal*, Vol. 14, No.4: 541-547.
- GOVEDARICA-LUČIĆ, A., M., MOJEVIĆ, G., PERKOVIĆ, B., GOVEDARICA (2014): Yield and nutritional quality of greenhouse lettuce (*Lactuca sativa* L.) as affected by genotype and production methods. *Genetika*, Vol. 46, No.3: 1027-1036.

- GOVEDARICA-LUČIĆ, A., G., PERKOVIĆ (2013a): Impact of varieties and production methods on yield and content of vitamin C in winter lettuce produced in the greenhouse. *Acta Agriculturae Serbica*, Vol.XVIII, 35: 39-47.
- KUNICKI, E., A., GRABOWSA, A., SEKARA, R., WOJCIECHOWSKA (2010): The effect of cultivar type, time of cultivation and biostimulant treatment on the yield of spinach (*Spinacia oleracea* L.). *Folia Hort.*, 22(2): 9-13.
- LAZIĆ, B., M., ĐUROVKA, S., LAZIĆ, V., MARKOVIĆ (2001): The importance and possibility of the production of quality safe vegetables. *Modern agriculture*, 1-2, 50:11-16.
- LOPES, M.C., M., FREIER, J.D., MATTE, M., GÄRTNER, G., FRANZENER, E.L.N., CASIMIRO, A., SEVIGNANI (2003): Nutrient accumulation by lettuce cultivars under hydroponic culture in the winter. *Horticultura Brasileira*, 21(2): 211-215.
- MIŠKOVIĆ, A., S., LAZIĆ, T., ZEREMSKI (2001): Nutritive value of leafy vegetables, depending on the type and variety. 1. International Symposium on "Food in the 21st Century" Proceedings, pp. 657-662, Subotica.
- NOVAKOVIĆ, B., M., MIROSAVLJEV, M. JEVTIĆ (2002): Food Hygiene. Faculty of Medicine, University of Novi Sad.
- PETRIKOVA, K., R., POKLUDA (2003): Influence of variety and cultivation time on the nutritional value of lettuce In: Quality of crop production: present and perspectives towards the EU. Proceedings of the Czech-Slovak Conference. Prague, VURV: 123-126.
- POKULDA, R., J., KUBEN (2002): Comparison of selected Swiss chard (*Beta vulgaris* ssp.cicla L.) varieties. *Hort. Sci. (Prague)*, 29, (3): 114-118.
- PREMUZIC, Z., F., VILLELLA, A., GARATE, I., BONNILA (2004): Light supply and nitrogen fertilization for the production and quality of butterhead lettuce. *Acta Horticulturae*, online acces <http://www.actahort.org>.
- RADOVICH, T.J.K., M.D., KLEINHENZ, A., SANCHEZ-VELA, J.C., SCHEERENS, B., SCHULT (2003): Fresh cabbage sensory quality: components and the impact of production factors. *Acta Hort.*, 628: 787-795.
- RADOVICH, T.J.K., M.D., KLEINHENZ, J.G., STREETER (2005): Irrigation timing relative to head development influences yield components, sugar levels, and glucosinolate concentrations in cabbage. *Journal of the American Society for Horticultural Science*, 130(6): 943-949.
- SINGER, S.M., U.A., EL-BEHAIRY, A.F., ABOU-HADID, G., NOHA, A., EL-RAHMAN (2009): Impact of different soilless culture systems on production and quality of cantaloupe grown under protected cultivation. *Acta Hort.*, 819:381-386.
- SINGER, S.M., A.E., HAMZA, E.H., ABD EL-SAMAD, OMAIMA M. SAWAN., U.A., EL-BEHAIRY, A.F., ABOU-HADID (2015): Growth, Yield and Mineral Contents of Lettuce Cultivars Grown in Nutrient Film Technique (NFT) at Different Transplanting Dates. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. RJPBCS 6(1): 172-183
- SANTOS, A.M., R.P., DANTAS, M. DAS G.A., KORN, G.B., FERNANDES, S.L.C., FERREIRA (2003): Mineral composition of lettuce (*Lactuca sativa* L.) grown in soil and hydroponics consumed in Salvador city, Brazil. *J. Food Technol.*, 1(2): 42-45.
- WORTHINGTON, V. (2001): Nutritional quality of organic versus conventional fruit, vegetables and grains. *Journal of Alternative and Complementary Medicine*, Vol .7, No.2:161-173.
- WOJCIECHOWSKA, R., P., SIWEK, A. LIBAK (2007): Effect of mulching with various films on the yield quality of butterhead lettuce and celery stalks with special reference to nitrate metabolism. *Folia horticulturae*, 19/1: 37-44.

**SADRŽAJ MINERALNIH MATERIJA U LISTU SALATE (*Lactuca sativa* L.) U
ZAVISNOSTI OD GENOTIPA I PRIMENJENIH AGROTEHNIČKIH MERA**

Aleksandra GOVEDARICA-LUČIĆ, Goran PERKOVIĆ

Univerzitet u Istočnom Sarajevu, Poljoprivredni fakultet, Istočno Sarajevo Bosna i Hercegovina

Izvod

Četiri različita načina proizvodnje primenjena na tri genotipa salate (Archimeds RZ, Santoro RZ, Kibou RZ)-ocenjena su u dvogodišnjem eksperimentu koji je sproveden na Poljoprivrednom fakultetu u Istočnom Sarajevu. Eksperiment je sproveden u dve godine; salata je gajena na četiri različita malč materijala: crna PE folija, agrotekstil, kombinacija crne PE folije i agrotekstila; kontrolna varijanta (nepokriveno zemljište). Posle berbe ocenjen je sadržaj minerala (N, P, K). Vrednosti sadržaja azota imaju tendenciju porasta od nepokrivenog zemljišta (7.47%) ka pokrivenom (7.98%) zemljištu. Reakcija genotipa na varijante pokrivanja pokazuje interakcijski efekat. Vrsta materijala za pokrivanje zemljišta takođe ima uticaja i na sadržaj kalijuma. Najveći sadržaj kalijuma od 4.87% bio je na varijanti pokrivanja sa agrotekstilom ili za 18 % više u odnosu na kontrolnu varijantu.

Primljeno 17.VI 2015.

Odobreno 20.X. 2015.