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YIELD AND CONTENT OF NUTRIENT ELEMENTS IN VARIOUS CULTIVARS OF LETTUCE DEPENDING FROM PRODUCTION METHOD

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In order to examine the influence of cultivars and to estimate how mulching and plant covering with agrotextile affects the content of P, Ca, K, Mg and Mn in lettuce leaves this three-year experiment has been established. In the experiment, black and white plastic foil were used for mulching prior to planting, and agrotextile for plant covering after planting. The effect of each of them as well as their combination on the content of nutrients and yield of lettuce leaves was examined. There were six treatments in the experiment: control, black foil, white foil, black foil and agrotextile, white foil and agrotextile, and agrotextile. Mulching had a significant impact on yield, as well as the content of P, Ca, K, Mg and Mn in lettuce leaves in the three-year experiment. The highest yield was registered in the cultivar Nizzi in treatment with black plastic foil, compared to all cultivars and treatments. The largest P content was registered in the cultivar Sunstar (0.71%), while the smallest content was registered in the cultivar Sunny (0.59%). The Ca content ranged from 2.59% (Sunny) to 2.84% (Nizzi). The Mg content ranged from 0.46% in treatment with black foil to 0.70% in treatment with white foil. The content of

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Mn in lettuce leaves ranged from 60.99 mg kg^{-1} in the cultivar Zeralda to 81.79 mg kg^{-1} in the cultivar Devonia.

Keywords: cultivars, *Lactuca sativa* L., macroelements, mulching, yield

INTRODUCTION

In Bosnia and Herzegovina, the production of lettuce in the open field was dominant until a few years ago when the traditional lettuce cultivation was replaced by the greenhouse lettuce production. Due to the production in protected area and availability of numerous high-yielding varieties, lettuce is available in markets throughout the year (ZDRAVKOVIC *et al.*, 2014). In order to achieve a better quality of lettuce, in addition to the adequate adaptation of different production technologies, appropriate cultivars should be selected (ROUPHAEL *et al.*, 2017). All cultivars of lettuce are imported into Bosnia and Herzegovina, which is why the knowledge of optimal cultivation requirements of specific lettuce varieties is limited. Therefore, it is extremely important to test different lettuce cultivars with different production technologies.

The lettuce is usually consumed raw and it is a good source of minerals (CALISKAN *et al.*, 2014). Minerals (Ca, Mg and K) facilitate human biochemical processes and minimize the lack of micronutrients. It is known that calcium maintains strong bones and plays an important role in muscle contraction and relaxation and blood clotting (ODUSE *et al.*, 2012), while magnesium is important for metabolic activity because it is associated with many enzymes that control the metabolism of carbohydrates, fats, proteins and electrolytes (FASUYI, 2006; HAARENEN, 2003).

The selection of appropriate color of mulch is very important in the production of vegetables (MUTETWA and MTAITA, 2014). Agricultural producers mainly use mulch in lettuce production, especially for the earliness in comparison to conventional method. Different colors of plastic foils for mulching and agrotextile for plant covering are used to achieve a better quality of lettuce (TOŠIĆ *et al.*, 2014; GUSTAVSSON, 1999). Different colors of mulch can have multiple effects on the vegetable production (KOSTERNA and ZANIEWICZ-BAJKOWSKA, 2010; FRANQUERA and MABESA, 2016). Variations in the accumulation of nutrients due to the use of mulch material and agrotextile are issues that are not well studied. Therefore, it is extremely important to find the optimal combination of mulching and agrotextile.

The aim of this study was to examine the influence of mulching and plant covering with agrotextile on the content of phosphorus, calcium, potassium, magnesium and manganese in leaves of different lettuce cultivars, as well as yield. The results of this research can help lettuce growers in the selection of cultivars and the most efficient production technologies in order to achieve high yields and high nutritional values in this plant species.

MATERIAL AND METHODS

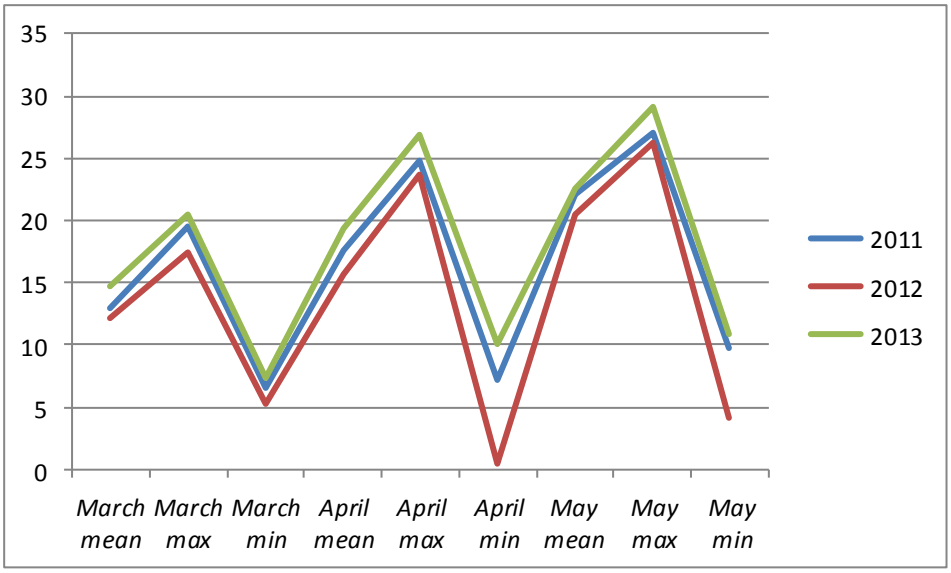
In a three-year period (2011-2013) in the greenhouse of the Agricultural Institute of Republic of Srpska in Banja Luka, at the location Lazarevo (latitude: 44° 46'N, longitude: 17° 11'E), the experiment with five lettuce cultivars (Nizzi, Zeralda, Devonia, Sunny and Sunstar) was conducted. The soil on which the experiment was set is classified as fluvisol. The experiment was set up in two factorial-randomized block systems with six treatments and four repetitions. The area of a plot was 5 m^2 (1 m x 5 m). Lettuce seeds were sown in styrofoam containers in the second half of January. The seedlings were transplanted 40 days later with a spacing of 25 cm and a distance between plants of 30 cm. Vegetation of lettuce lasted 60 days. For the soil mulching before planting the black and white plastic foils were used, as well as

agrotextile for plant covering after planting. There were six treatments in the experiment: 1. control (CO), 2. black foil (BF), 3. white foil (WF), 4. combination of black foil and agrotextile (BFA), 5. combination of white foil and agrotextile (WFA) and 6. agrotextile (A).

Before the planting of lettuce, NPK fertilizer (7:20:30) was applied to the soil in the amount of 640 kg ha^{-1} and 300 kg ha^{-1} with KAN (27% N) fertilizer. The fertilization was done twice with Ferticare fertilizer with microelements (10:5:26) in the amount of 1g per plant. The soil moisture was maintained at the optimal level by dropwise system, four times during the vegetation of lettuce with 15l water per m^2. Harvest was done when the plants reached a stage of technological maturity in the first half of May.

Weather conditions

The mean, minimum and maximum air temperatures were measured by using digital thermometer from March 2011, 2012 until May 2013 and are given in Graph 1.



Graph 1. Mean monthly temperature in the period March to May

Plant material

The lettuce plants were harvested at technological maturity. During the harvest, 30 plants from each plot were weighed to determine the lettuce yield and from each plot four whole plants were randomly sampled for the chemical plant analysis. The phosphorus was determined spectrophotometrically, and the determination of potassium was carried out by flame photometry. Manganese and magnesium were determined by atomic absorption spectrophotometry (AAS), after the wet digestion of plant matter with mixed acid (HNO_3+$HClO_4$+H_2SO_4).

Statistical analysis

The obtained data were processed by InfoStat software. Two-factorial analysis of variance (ANOVA) was run for each year and the means were compared using Tukey's test.

RESULTS AND DISCUSSION

The variance analysis showed that the effect of the year, cultivars and their interaction had a significant ($p<0.01$) effect on the yield of five lettuce cultivars (Table 1). In the three-year research, the highest yield was registered in the cultivar Nizzi in BF treatment, compared to all cultivars and treatments. In the treatment BF yield in 2011 was 91.75 t ha^{-1}, in 2012 it was 73.86 t ha^{-1}, while in 2013 it was 85.44 t ha^{-1}. The average yield in this treatment in 2011 was 32.74% higher compared to the control. The obtained results are in accordance with the studies of other authors, which show that mulching have a positive effect on plant growth, increase of vegetative mass and yield (MAGED and EL-NEMR, 2006; GIMENEZ *et al.*, 2002). In the first year of the experiment, the highest yield values were recorded in relation to other years of research. The decrease in yield is explained by the occurrence of low temperatures and occasional temperature drops below 0°C (Graph 1). Lower growing temperatures and shorter periods are important to maximize economic returns from lettuce, which is a notable source of minerals (Ca, Fe and Mg), (SUBLET *et al.*, 2018). In all cultivars, the lowest yield was recorded in control treatment (Table 2). In 2011, cultivars Nizzi, Devonia and Sunny had the highest yield in treatment with black foil, ranging from 63.76 t ha^{-1} (Sunny), 86.14 t ha^{-1} (Devonia) to 91.75 t ha^{-1} (Nizzi), while cultivars Zeralda and Sunstar had the highest yield in treatment with black foil and agrotextile ranging from 67.16 t ha^{-1} (Sunstar) to 69.87 t ha^{-1} (Zeralda). The obtained results are in accordance with the studies of other authors, which show that lettuce yield depends on cultivar and production conditions (SANTAMARIA *et al.*, 2001). The difference in yield between all examined treatments compared to the control is statistically highly significant. The three-year research has shown that the applied treatments significantly influenced lettuce yield. Similarly, YAGHI *et al.* (2013) state that the plastic foil influenced the increase in the lettuce yield.

Table 1. The analysis of variance for lettuce yield using AMMI model

S.V.	SS	df	MS	F
Total	28191.96	359	-	-
Environments	6839.3	2	3419.65	41277.67
Cultivars	11672.88	4	2918.22	35225.07
Treatments	3961.48	5	792.3	9563.59
E*C	1537.83	8	192.23	2320.35
E*T	686.3	10	68.63	828.41
G*T	1880.12	20	94.01	1134.72
E*C*T	1591.69	40	39.79	480.32
Error	22.37	270	0.08	-

df - degrees of freedom; SS - sum of squares; MS - mean square; ** significance at 0.01 probability level; C - cultivar; T – treatments; E - environments

Table 2. Average lettuce yield (t ha^{-1}) depending on cultivar, treatment and year

	Years														
	2011					2012					2013				
	Cultivars														
Treatments	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar
CO	69.12	53.31	62.89	55.19	55.04	57.72	50.08	53.47	51.16	49.82	68.06	51.02	55.16	43.15	50.06
BF	91.75	68.29	86.14	63.76	63.09	73.86	57.01	62.58	58.87	58.11	85.44	56.23	59.61	52.15	55.17
WF	84.42	66.22	71.33	60.41	62.32	66.59	56.25	61.36	59.74	57.27	76.04	55.59	56.69	54.07	53.26
BFA	72.24	69.87	68.19	57.13	67.16	62.55	52.11	55.23	53.14	53.07	71.81	58.96	56.21	56.23	57.19
WFA	70.60	68.83	66.54	57.22	65.35	61.25	49.08	59.90	58.63	55.21	68.08	52.23	62.21	59.05	59.23
A	75.90	68.99	65.82	59.49	63.60	61.33	47.84	58.97	51.30	53.21	69.09	53.03	63.20	55.30	56.26

CO – control, BF – black foil, WF – white foil, BFA – black foil and agrotextile, WFA – white foil and agrotextile, A - agrotextile

Phosphorus belongs to the group of necessary macroelements that participate in important biochemical processes in the plant (photosynthesis, breathing and synthesis of reserve substances). It is the most important collector and transmitter of energy in the plant. The combination of black and gray mulch gives the highest productivity and maximum values of phosphorus accumulation in lettuce leaves (VERDIAL *et al.*, 2001). The highest P content was registered in 2011 and was 0.82%, while the lowest P content was registered in 2012 and was 0.52% (Table 3). VON BRUECKNER and KRUCK (1994), in their research on lettuce obtained phosphorus values ranging from 0.37% to 0.50%. Increasing soil temperature can affect the level of nutrients in plants. As the temperature rises, calcium and phosphorus are reduced, and potassium tend to increase.

Table 3. Phosphorus content (%) in lettuce leaves depending on cultivar, treatment and year

	Years														
	2011					2012					2013				
Treatments	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar
CO	0.66	0.98	0.89	0.76	0.85	0.56	0.52	0.55	0.44	0.52	0.60	0.61	0.64	0.57	0.73
BF	0.98	0.82	0.97	0.85	0.87	0.65	0.43	0.44	0.54	0.57	0.71	0.58	0.61	0.60	0.76
WF	0.79	0.82	0.79	0.81	0.81	0.49	0.58	0.54	0.56	0.67	0.63	0.68	0.69	0.48	0.69
BFA	0.97	0.93	0.94	0.68	0.84	0.51	0.53	0.50	0.48	0.51	0.73	0.72	0.71	0.56	0.70
WFA	0.87	0.88	0.84	0.66	0.88	0.45	0.46	0.53	0.52	0.61	0.68	0.55	0.59	0.60	0.71
A	0.58	0.83	0.71	0.65	0.86	0.38	0.43	0.51	0.43	0.61	0.52	0.57	0.58	0.50	0.68

CO – control, BF – black foil, WF – white foil, BFA – black foil and agrotextile, WFA – white foil and agrotextile, A - agrotextile

Phosphorus content in the three years of research was the highest in 2011, and the lowest in 2012. The highest phosphorus content of 0.71% was registered in the cultivar Sunstar, while the lowest content of 0.59% was registered in the cultivar Sunny. The cultivars Nizzy, Zeralda and Devonia had approximately the same P content in lettuce leaves. The P content, depending on the treatment, ranged from 0.59% (A) to 0.69% (BF and BFA).

These results indicate that lettuce contain the antioxidant minerals, especially Ca and Mn, which are important for antioxidant enzymes *in vivo* and hence protect the body from cancer. MARKIEWICZ and KLEIBER (2010) state that the calcium content in lettuce leaves ranged from 1.39% to 1.52%, which is not in agreement with the results of this study. The content of calcium below an optimal value of 1% can affect the occurrence of physiological disorders in plants (KIRKBY and PILBEAM, 1984). Depending on the year of research, the highest Ca content of 2.73% was registered in 2012, while the lowest Ca content of 2.70% was registered in 2013 (Table 4). The highest Ca content of 2.84% was registered in the cultivar Nizzi, while the lowest Ca content of 2.59% was registered in the cultivar Sunny. The Ca content, depending on the treatment, ranged from 2.39% (CO) to 3.02% (WFA).

Table 4. Calcium content (%) in lettuce leaves depending on cultivar, treatment and year

	Years														
	2011					2012					2013				
	Cultivars														
Treatments	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar
CO	2.17	2.49	2.41	2.08	2.36	2.42	2.30	2.54	2.61	2.61	2.41	2.53	2.43	2.41	2.53
BF	2.76	2.40	2.84	2.43	2.66	2.34	2.98	2.33	2.73	2.33	2.68	2.45	2.56	2.68	2.45
WF	3.04	2.69	3.13	2.77	3.00	2.90	2.73	2.79	2.96	2.62	2.27	2.75	2.35	2.27	2.75
BFA	3.00	2.89	2.97	2.92	2.87	2.61	2.73	2.65	2.17	2.98	2.79	3.33	2.86	2.79	3.33
WFA	3.51	2.30	3.03	2.65	3.28	3.48	2.96	2.97	2.77	3.06	3.52	2.63	3.61	3.52	2.63
A	2.90	2.03	2.74	2.42	2.76	3.14	2.58	3.11	2.73	2.86	3.18	2.18	3.05	3.18	2.18

CO – control, BF – black foil, WF – white foil, BFA – black foil and agrotextile, WFA – white foil and agrotextile, A - agrotextile

The three-year research has shown that the aplied treatments of mulching and plant covering have significantly affected the potassium content in lettuce. The results of the study indicate that the potassium content ranged from 6.66% in control treatment to 7.65% in treatment with agrotextile (Table 5). Depending on the year, the highest potassium content was 7.50% in 2012, and the lowest was 6.91% in 2011.The highest potassium content (6.70%) was recorded in treatment with white foil and the lowest (5.10%) in the control treatment (TOŠIĆ *et al.,* 2012). Many authors cite a lower K content in lettuce leaves (MATRASZEK *et al.,* 2002), compared to the results of this study. The applied mulching treatments had a significant effect on potassium content in all years of research. The observed differences in mulching treatments were significant at the level of 1%.

Table 5. Potassium content (%) in lettuce leaves depending on cultivar, treatment and year

	Years														
	2011					2012					2013				
	Cultivars														
Treatments	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar
CO	8.63	4.30	5.05	7.80	8.20	10.08	4.63	5.13	6.60	8.70	6.43	3.88	6.13	7.13	7.20
BF	7.83	4.90	5.18	7.15	8.73	11.10	4.68	6.30	7.53	8.58	5.96	4.68	6.30	6.80	6.70
WF	7.65	5.18	6.10	7.10	6.80	9.55	5.30	6.58	6.10	9.53	7.59	4.90	5.83	7.13	9.73
BFA	8.15	4.20	5.83	6.90	9.38	9.73	5.10	5.75	7.73	10.55	10.23	5.10	5.63	7.50	8.13
WFA	9.28	5.08	5.43	8.30	8.08	10.15	4.65	5.95	5.90	10.30	11.45	4.35	5.73	6.63	7.83
A	10.33	4.10	5.40	8.60	7.83	11.15	4.65	5.28	7.03	10.73	12.32	5.08	5.78	6.63	9.93

CO – control, BF – black foil, WF – white foil, BFA – black foil and agrotextile, WFA – white foil and agrotextile, A - agrotextile

The differences in mulching treatments were evaluated at the level of significance $p<0.01$, indicating that the color of materials for soil mulching and agrotextile for plant covering have an effect on the potassium content in lettuce leaves. KARIMAEI *et al.* (2004) state that the K content ranged from 4.6 to 8.9%. The highest potassium content was registered in the cultivar Nizzi (9.31%), and the lowest in the cultivar Zeralda (4.71%).

Table 6. Magnesium content (%) in lettuce leaves depending on cultivar, treatment and year

	Years														
	2011					2012					2013				
	Cultivars														
Treatments	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar
CO	0.25	0.37	0.63	0.57	0.43	0.18	0.31	0.38	0.43	0.31	0.28	0.42	0.42	0.34	0.46
BF	0.31	0.43	0.55	0.48	0.41	0.30	0.45	0.52	0.44	0.43	0.32	0.39	0.49	0.54	0.51
WF	0.35	0.42	0.68	0.53	0.63	0.22	0.28	0.61	0.38	0.39	0.44	0.42	0.52	0.46	0.44
BFA	0.37	0.52	0.52	0.42	0.48	0.31	0.37	0.48	0.34	0.48	0.52	0.34	0.41	0.55	0.58
WFA	0.61	0.45	0.59	0.59	0.52	0.30	0.35	0.54	0.41	0.62	0.75	0.37	0.61	0.68	0.52
A	0.41	0.38	0.52	0.38	0.41	0.22	0.32	0.49	0.30	0.37	0.53	0.31	0.57	0.44	0.57

CO – control, BF – black foil, WF – white foil, BFA – black foil and agrotextile, WFA – white foil and agrotextile, A - agrotextile

Depending on the color of mulch and agrotextile, the highest magnesium content was recorded in treatment with white foil and agrotextile (0.53%), and the lowest in control treatment (0.38%), (Table 6). In the research, (TOŠIĆ *et al.*, 2012) the magnesium content ranged from

0.46% in the variant with black foil to 0.70% in the treatment with white foil. In the cultivar Devonia the highest Mg content was recorded, which amounted to 0.53%, and the lowest in the cultivar Nizzi and amounted to 0.37%. The lowest Mg content was registered in 2012 and was 0.38%. MATRASZEK *et al.* (2002) state that the Mg content in lettuce leaves ranged from 0.50 to 0.63%. According to research by other authors, the Mg content in lettuce leaves is different. Some have reached lower values (GÜL *et al.*, 2007), and others a higher Mg values in lettuce leaves (JAROSZ and DZIDA, 2006).

The three-year research has shown that the applied treatments of mulching and covering have significantly affected the content of manganese in lettuce leaves (Table 7). The highest Mn content of 84.52 mg kg^{-1} was registered in treatment with white foil, and the lowest of 61.88 mg kg^{-1} in treatment with black foil and agrotextile. Depending on the year of research, the highest Mn content (72.91 mg kg^{-1}) was recorded in 2011, and the lowest Mn content (66.82 mg kg^{-1}) in 2013. The manganese content in lettuce leaves ranged from 60.99 mg kg^{-1} in the cultivar Zeralda to 81.79 mg kg^{-1} in the cultivar Devonia. According to MOHAMED *et al.* (1999) the processes of plant growth depend on the cycle of nutrients including trace elements, from soil to plant. Lettuce of accumulate larger amounts of heavy metals because they absorb these metals in the leaves (KOZIK *et al., 2008).* Average of cultivars, treatments and years is shown in Table 8.

Table 7. Manganese content (mg kg^{-1}) in lettuce leaves depending on cultivar, treatment and year

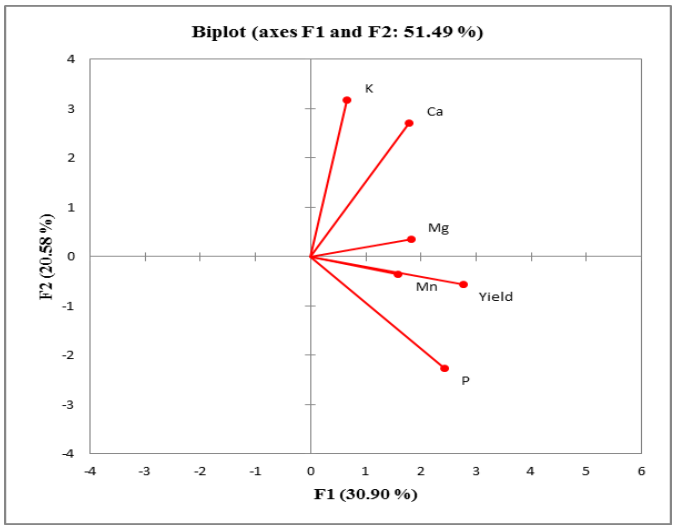
	Years														
	2011					2012					2013				
Treatments	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar	Nizzi	Zeralda	Devonia	Sunny	Sunstar
CO	63.25	62.25	90.75	57.00	81.75	78.00	60.75	85.25	71.00	70.00	92.50	56.25	75.25	56.50	62.75
BF	78.25	67.75	72.50	76.25	71.00	74.75	56.50	83.75	67.00	78.50	71.75	53.00	84.25	62.25	72.00
WF	94.50	56.50	105.50	84.75	89.25	98.75	71.75	97.75	81.25	91.75	72.50	72.75	87.00	78.75	85.00
BFA	59.00	70.75	66.75	48.50	65.50	68.50	51.25	75.25	56.50	62.25	65.00	64.75	71.00	47.00	56.25
WFA	93.25	58.25	84.75	57.75	60.25	87.75	55.25	82.00	66.00	55.00	67.50	51.25	71.75	49.00	63.75
A	61.50	64.75	81.25	77.75	86.00	64.75	68.00	77.00	74.25	51.25	58.00	56.00	80.50	73.50	46.75

CO – control, BF – black foil, WF – white foil, BFA – black foil and agrotextile, WFA – white foil and agrotextile, A - agrotextile

The relationship between studied properties (P, K, Ca, Mg, Mn and yield) was analyzed using a multivariate PCA analysis. In biplot analysis, the correlation coefficients between the analyzed properties are represented by the cosine of the angle between their vectors, so r = cos180° = -1, cos0° = 1, and cos90° = 0). On PCA biplot (Graph 2) the first main component explained 30.90% of the total variance, the other 20.58%. The first axis was related to the content of Mg, Mn and yield, while the second axis to the content of K and Ca. Based on this biplot, it can be noticed that the lettuce yield was in positive correlation with Mn, Mg and P content, while there was no relationship between the yield and the content of K. In addition, there was negative correlation between the content of potassium and P, as well as the content of Ca and P.

Table 8. Average of cultivars, treatments and years

	P	Ca	K	Mg	Mn
Nizzi	0.65 a	2.84 a	9.31 a	0.37 e	74.97 b
Zeralda	0.67 bc	2.61 c	4.71 e	0.38 d	60.99 e
Devonia	0.66 b	2.8 a	5.74 d	0.53 a	81.79 a
Sunny	0.59 d	2.59 c	7.14 c	0.46 c	65.83 d
Sunstar	0.71 a	2.74 b	8.72 b	0.47 b	69.39 c
CO	0.66 bc	2.39 e	6.66 e	0.38 e	70.88 b
BF	0.69 a	2.58 d	6.83 d	0.44 c	71.30 b
WF	0.67 b	2.74 c	7.00 c	0.45 b	84.52 a
BFA	0.69 a	2.82 b	7.33 b	0.45 bc	61.88 e
WFA	0.65 c	3.02 a	7.27 b	0.53 a	66.90 d
A	0.59 d	2.74 c	7.65 a	0.41 d	68.08 c
2011	0.82 a	2.72 ab	6.91 c	0.47 a	72.91 a
2012	0.52 b	2.73 a	7.50 a	0.38 b	72.06 b
2013	0.63 c	2.70 b	6.95 b	0.47 a	66.82 c



Graph 2. Biplot for cultivar and treatment in three production years

In conclusion, mulching had a significant impact on yield, as well as the content of P, Ca, K, Mg and Mn in lettuce leaves in the three-year experiment.

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PRINOS I SADRŽAJ HRANJIVIH ELEMENATA U RAZLIČITIM SORTAMA ZELENE SALATE U ZAVISNOSTI OD NAČINA PROIZVODNJE

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Izvod

U cilju ispitivanja uticaja sorte i procjene uticaja malčovanja i pokrivanja biljaka agrotekstilom na sadržaj P, Ca, K, Mg i Mn u listovima salate, uspostavljen je trogodišnji eksperiment. U eksperimentu je korišćena crna i bijela plastična folija za malčovanje prije sadnje i agrotekstil za pokrivanje biljaka nakon sadnje. Ispitivan je uticaj svakog od njih, kao i njihova kombinacija na sadržaj hranljivih elemenata i prinos salate. U eksperimentu je bilo šest tretmana: kontrola, crna folija, bijela folija, crna folija i agrotekstil, bijela folija i agrotekstil, i agrotekstil. Malčovanje je imalo značajan uticaj na prinos, kao i sadržaj P, Ca, K, Mg i Mn u listovima salate u trogodišnjem eksperimentu. Najveći prinos je registrovan kod sorte Nizzi u tretmanu sa crnom folijom, u poređenju sa svim sortama i tretmanima. Najveći prosječni sadržaj P registrovan je kod sorte Sunstar (0.71%), dok je najmanji sadržaj zabilježen kod sorte Sunny (0.59%). U prosjeku, sadržaj Ca se kretao od 2.59% (Sunny) do 2.84% (Nizzi). Sadržaj Mg se kretao od 0.46% u tretmanu sa crnom folijom do 0,70% u tretmanu sa belom folijom. Sadržaj Mn u listovima salate kretao se od 60,99 mg kg^{-1} u sorti Zeralda do 81.79 mg kg^{-1} u sorti Devonia.

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