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RESULTS CONCERNING THE EFFECT OF FOLIAR FERTILIZERS AND GROWTH PROMOTERS TREATMENTS ON PRODUCTION AND QUALITY OF LETTUCE CULTIVATED IN PLASTIC TUNNELS

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Abstract

The work presents results obtained in protected crops of lettuce under different treatments with growth promoter P& R and foliar fertilizers Agriphyte and Folimax, which are cultivated in high tunnels in southern area of Romania. It were taken in experience three varieties of lettuce: May King, Great Lakes 118 and Lollo Rossa. These treatments shows positive influence on the production and quality of lettuce. Reffer to production the best variant was in the case of the variety May King which was treated with foliar fertilizer Agriphyte (175 g/ head, 28 t/ha). At the other two varieties the best results was obtained at variants treated with foliar fertilizer Folimax. The laboratory analyses shows that the nitrate content of leaves was clearly under the maximum admissible level (2000-3000 ppm) and depends by variety and variant. The content of vitamin C was positively influenced by the treatments, especially by the ecological growth promoter P& R.

Key words: *Agriphyte, Folimax, P&R, quality, production.*

INTRODUCTION

The lettuce is cultivated regularly at early in spring and in autumn late like successive cultures. This system of culture assure the needs of vegetables in these periods of the year, creates the possibility to use more intensive the constructions and assure more benefits to producers. Short vegetation period and reduced height of plants recommended lettuce like a very good associated culture (Ciofu et al., 2004).

The advantages of this system of culture are the following: possibility of obtaining of very early and early productions, possibility of obtaining good harvest long time during the year, good quality of the products, obtaining of big production/ha, avoiding of apparition of weather accidents.

Lettuce is cultivated for its heads, which are consumed mostly fresh like salads.

In recent times because of orientation of the population to a nutrition regime more close to nature, lettuce has begun one of the mostly consumed vegetable (Ciofu et al., 2004, Indrea and Apahidean, 1997). It has nutritional importance because of the high content of vitamins, mineral salts and nutritive substances as following: 100 g of lettuce contains 43 mg Ca, 32 mg P, 0.3 mg Fe, 350 mg K, 15 mg vitamin E, 4.2 mg vitamin A, 0.07 mg vitamin B_1, 0.08 mg vitamin B_2, 0.5 mg vitamin PP. It contains also in this quantity of leaves 0.1% sugar, 1.4% proteins, 0.5% cellulose. Lettuce is a good vegetable for remineralization, cleanser sedative, emollient. Its energetic value is of 16 calories. Lettuce juice has very good properties because of the high content in magnesium and iron. This species was cultivated long time ago. Egiptians, Greeks and Romans cultivate lettuce on large surfaces and appreciated this culture like a very valuable vegetable. In present, lettuce is spread on all continents, on large areas, especially in the countries from Western Europe, in USA and Japan. In the US, for example, this culture occupies over 100,000 ha and the consumption/inhabitant reached 10 kg/year. In our country, lettuce is grown both in pure culture and in the system of associated and successive culture, in all counties and especially around big cities and industrial centers, occupying 14,000-15,000 ha annually. Different authors recommended for prolongation of preservation of lettuce a big number of products. Relatively recent was discovered many regulators of growth and

fruiting with a large application in vegetables crops. They are natural or synthetic hormonal substances which influence the processes of growth and development of plants (Indrea et al., 2007). The authors shows that is possible to apply these products in combination with foliar fertilizers.
These foliar fertilizers are used on large scale in vegetable protected crops because of some advantages like: reduced concentration of mineral elements and quickly correction of nutrition deficiencies (Voican and Lacatus, 2002).

MATERIALS AND METHODS

The main objective of research was to determine the optimal variant of stimulation and foliar fertilization of the lettuce in protected crops for obtaining early and high quality production.
The experience was held in 2012 in village Poiana, Ialomita county, in high tunnels on a surface of 720 m^2.
The installation of trial was done in subdivided parcels, in three repetitions.

The experimental variants consist of three products used: two foliar fertilizers and one natural stimulator, which are compared with a untreated control (Table 1).
The technology used in the experiences was selected from the literature for lettuce (Ciofu et al., 2004).
Under climatic conditions of the year 2012, the culture has been established by planting of seedling on 15th of October. The seedling was by 28 days old and 5-6 leaves.

Figure 1. View with variety Great Lakes 118

Table 1. Experimental variants – 2012

Biological material	Treatments	Specification
May King Great Lakes 118 Lollo Rossa	V1 Control (untreated)	-
	V2 Folimax-0.3%	Foliar fertilizer with microelements; ensure steady growth, disease resistance, increase the number of fruits and production.
	V3 Agriphyte-0.3%	Foliar fertilizer with 33% phosphorus and 28% potassium; secondary has systemic fungicide properties.
	V4 P&R-0.5%	Organic product with role of protection and recovery of the plants from damage caused by extreme temperatures or diseases; help to a better use of the nutrients in different types of soils; increase the assimilation of some nutrients (Fe, Zn, Mn, B, Cu); may be used together with protective agents for plants (herbicides, insecticides, fungicides).

Biological material has been represented by two varieties: May King, Great Lakes 118 and Lollo Rossa, recommended for protected and open field crops. (Table 2, Figure 1).
The density used was 160,000 plants/ha.

Table 2. Description of the lettuce varieties from trial

Biological material	Characterization
May King	Early variety, for protected and open field crops, for autumn and spring, with compact medium head, blade present corrugating; resistant to flowering.
Great Lakes 118	Mid – early variety, for protected and open field crops; with head by round to oval shape, with curled leaves, crisp and of iceberg type.
Lollo Rossa	Forms a distinct compact rosette of blood violet fan -shaped leaves with a non-hearting pale green base. The leaves have a crisp, semi-succulent, hardy texture

At two weeks from planting it was applied treatments with growth promoter (P&R) and foliar fertilizers (Folimax and Agriphyte) in accordance with experimental variants.
Harvesting was done from the first half of December, by variants.
During the experimentation period has been carried out observations, measurements and determinations, which were used specific working methods namely:
Phenological determinations: sowing date, date of emerging, date of planting and date of harvest.
Production potential was determined by registering of the mass of each head/ rosette harvested by variants.
The results were interpreted statistically by analysis of variance - Student test (Ardelean et al., 2007).
Laboratory analysis at lettuce:
- agrochemical analysis: $N\text{-}NO_3^-$ and $N\text{-}NO_2^-$ content, $P\text{-}PO_4^{3-}$ content, K^+ content.
- biochemical analysis: vitamin C content (mg/100 fresh product), soluble carbohydrates (%), acidity (%), chlorophyll (mg/100 fresh product). Were harvested lettuce samples for laboratory analysis of three different harvests and results are average of these samples.

RESULTS AND DISCUSSIONS

From the analysis results can be observed that the average weight of the head of the May King lettuce ranged from 158 g (untreated control) to 175 g (Agriphyte). At variety Great Lakes 118 the average weight of the head ranged between 152 g (untreated control) to 168 g (Folimax). At Lollo Rossa the average weight of the rosette varied between 140 g (untreated control) to 157 g (Folimax) (Table 3, Figure 2).

Table 3. The influence of growth promoter and foliar fertilizers treatments on the production of lettuce-2012

Variety	Variant	Average weight of the head/ rosette, kg/pl.	Production t/ha
May King	Control	0.158	25.28
	Folimax	0.170	27.20
	Agriphyte	0.175	28.00
	P& R	0.163	26.08
Great Lakes	Control	0.152	24.32
	Folimax	0.168	26.88
	Agriphyte	0.166	26.56
	P& R	0.160	25.60
Lollo Rossa	Control	0.140	22.40
	Folimax	0.157	25.12
	Agriphyte	0.150	24.00
	P& R	0.146	23.36

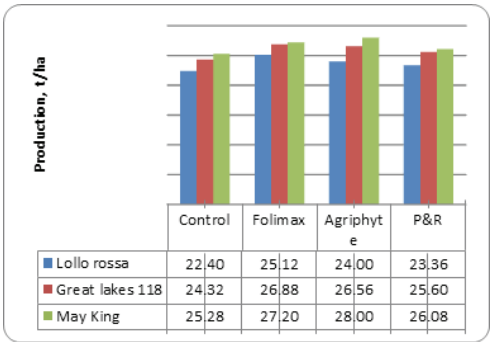

Figure 2. Production at lettuce experiences, 2012

Concerning the production of lettuce May King it was between 25.280 t/ha (control) and 28.000 t/ha (Agriphyte). It can be observed that the applied treatments favored average weight of the heads and the production. At Great Lakes 118 variety, on first place it was the variant treated with foliar fertilizers Folimax (26.880 t/ ha) compare to the control (24.320 t/ ha). At Lollo Rossa variety, on first place it was the variant treated with foliar fertilizers Folimax (25.120 t/ ha) compare to the control (22.400 t/ ha). If we take into account the influence of variety on the lettuce production (Table 4), it can be observed that both varieties Great Lakes 118 and May King have made a significantly distinct difference of production (2.120 t/ ha, respectively 2.920 t/ha) compare to Lollo Rossa .

Table 4. The influence of the variety on the lettuce production

Variety	Average poduction (t/ha)	%	Differences t/ha	Signi-fication
a1 Lollo Rossa	23.720	100	-	
a2Great Lakes 118	25.840	109	2.120	**
a3 May King	26.640	112	2.920	**
DL 5% 0.50609				
DL 1% 1.17459				
DL 0.1% 3.71916				

The influence of the treatment on the lettuce production it can be seen in the table 5. As it show in this table the variants treated with foliar fertilizers (Folimax, Agriphyte) exceeded the control with significantly distinct difference.

Table 5. The influence of the treatment on the lettuce production

Treatment	Average production (t/ha)	%	Differences t/ha	Signi-fication
b1Control	24.000	100	-	
b2 Folimax	26.400	110	2.400	**
b3 Agriphyte	26.187	109	2.187	**
b4 P& R	25.013	104	1.013	

If we take into account the influence of the treatments on the production at the same variety, it can be noticed different behavior of the three varities of lettuce. If varieties Lollo Rossa and Great Lakes 118 made the biggest differences for Folimax treatment, variety May King give best results at Agriphyte treatment (Table 6, Figure 3 and 4).

Figure 3. View with variety May King

Figure 4. View with variety Lollo rossa

Table 6. The influence of the treatment on the lettuce production from the same variety

Treatment	Average production (t/ha)	%	Differences t/ha	Signi-fication
a1b1 (Control)	22.400	100	-	
a1b2	25.120	112	2.720	**
a1b3	24.000	107	1.600	
a1b4	23.360	104	0.960	
a2b1 (Control)	24.320	100	-	
a2b2	26.880	111	2.560	**
a2b3	26.560	109	2.240	*
a2b4	25.600	105	1.280	
a3b1 (Control)	25.280	100		
a3b2	27.200	108	1.920	*
a3b3	28.000	111	2.720	**
a3b4	26.080	103	0.800	
DL 5% 1,77129				
DL 1% 2,48631				
DL 0.1% 3,51008				

If we take into account the both factors, variety and treatment, it can be seen that the variants treated with Agriphyte behaved consistently achieving highest differences to any control when is associated with variety May King (Table 7).

Table 7. The influence of variety and treatments on the lettuce production

Variant	Average production (t/ha)	%	Differences t/ha	Signi-fication	Variant	Average production (t/ha)	%	Differences t/ha	Signi-fication
a1b1	22.400	100	-		a1b3	24.000	100	-	
a2b1	24.320	109	1.920	*	a2b1	24.320	101	0.320	
a2b2	26.880	120	4.480	***	a2b2	26.880	112	2.880	**
a2b3	26.560	119	4.160	***	a2b3	26.560	111	2.560	**
a2b4	25.600	114	3.200	**	a2b4	25.600	107	1.600	*
a1b2	25.120	100	-		a1b4	23.360	100	-	
a2b1	24.320	97	-0.800		a2b1	24.320	104	0.960	
a2b2	26.880	107	1.760	*	a2b2	26.880	115	3.520	**
a2b3	26.560	106	1.440		a2b3	26.560	114	3.200	**
a2b4	25.600	102	0.480		a2b4	25.600	110	2.240	*
a1b1	22.400	100	-		a1b3	24.000	100	-	
a3b1	25.280	113	2.880	**	a3b1	25.280	105	1.280	
a3b2	27.200	121	4.800	***	a3b2	27.200	113	3.200	**
a3b3	28.000	125	5.600	***	a3b3	28.000	117	4.000	***
a3b4	26.080	116	3.680	***	a3b4	26.080	109	2.080	*
a1b2	25.120	100	-		a1b4	23.360	100	-	
a3b1	25.280	101	0.160		a3b1	25.280	108	1.920	*
a3b2	27.200	108	2.080	*	a3b2	27.200	116	3.840	***
a3b3	28.000	111	2.880	**	a3b3	28.000	120	4.640	***
a3b4	26.080	104	0.960		a3b4	26.080	112	2.720	**
DL 5% 1.58555						DL 5% 1.58555			
DL1% 2.30163						DL1% 2.30163			
DL0.1% 3.58707						DL 0.1% 3.58707			

If we take a look on the results of laboratory analysis we can see that none of the variants is poluted with nitrates/nitrites (Table 8).
The nitrates content is well below the maximum level (2000-3000 ppm). The highest nitrate level was recorded at Great Lakes 118 at variant treated with Agriphyte (345.45 ppm). The highest content of phosphorus was found at variant Great Lakes 118 treated with growth promoter P& R (166.38 ppm). The highest content of potassium was found at variant May King treated with Folimax (4020 ppm).

Table 8. Results of laboratory analysis at lettuce

Variety	Treatment	Content						
		$N\text{-}NO_3^-$	$P\text{-}PO_43\text{-}$	K+	Acidity %	Soluble carbohydrates	Vitamin C, mg/100g	Chlorophyll mg/100g
Lollo Rossa	Control	185.10	132.65	3000.00	0.19	2.09	4.28	60.51
	Folimax	186.10	126.91	3046.67	0.21	2.11	4.28	63.88
	Agriphyte	279.14	139.47	3083.33	0.21	2.11	4.25	60.02
	P& R	301.31	138.11	3060.00	0.21	2.27	4.27	59.27
Great Lakes 118	Control	190.41	144.19	3800.00	0.10	2.23	2.63	73.56
	Folimax	194.17	132.66	3903.33	0.13	2.18	2.60	76.27
	Agriphyte	345.45	124.97	3700.00	0.15	2.25	2.60	71.57
	P& R	335.27	166.38	3628.67	0.15	2.25	2.65	72.75
May King	Control	152.09	136.63	3593.33	0.15	2.13	2.98	66.89
	Folimax	179.38	124.31	4020.00	0.18	2.14	3.19	69.20
	Agriphyte	188.52	120.43	3820.00	0.18	2.09	3.32	66.98
	P& R	214.17	114.96	3466.67	0.19	2.12	3.30	65.68

The highest content of soluble carbohydrates was found at variant Lollo Rossa treated with P& R (2.27%). The biggest content of vitamin C was recorded at variant Lollo Rossa treated with Folimax (4.28%). The highest content of chlorophyll was found at variant Great Lakes 118 treated with Folimax (73.56%).

CONCLUSIONS

The highest average weight of the head/ rosette and the highest production was achieved by the variant May King treated with Agriphyte (175.0 g, 28.0 t/ha).

Foliar fertilizers Folimax and Agriphyte achieved the highest average productions on the experience of lettuce (26.400 t/ha respectively 26.187 t/ha).

The experimental results were verified statistically and differences from control was at least significantly.

None of these treatments had pollution effect with nitrates/ nitrites on the final product.

Foliar fertilizer Folimax favored the accumulation of chlorophyll in all varieties and the accumulation of potassium in Great Lakes 118 and May King varieties.

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