

THE INFLUENCE OF QUALITY OF PLANTATIONS AND AGRO-TECHNICAL MEASURES ON A YIELD OF LETTUCE (*Lactuca Sativa* L.)

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Abstract

The experiment has been set up in the plain of Zeta (in the region of Podgorica) with a goal to determine the influence of time of planting, fertilizers (Slavol, WUKSAL super 8:8:6+me i Poly-Feed MAR 20:20:20+me) and substrates (Profi-substrat i Blumenerde) on a cultivation of lettuce. The examined parameters were height of the head, diameter of the head, total leaf number of the head, the number of damaged head leaves and the dry matter inside of lettuce. When it comes to the lettuce treated with Poly-Feed MAR, on both substrates, the biggest height of a head (17,55cm), the biggest diameter of a head (25,7cm), the biggest mass of a head (173,2g) and the biggest number of damaged head leaves has been noticed. The dry matter inside of every examined lettuce ranged from 5,40% to 6,24%. The smallest amount of dry matter inside was measured on Profi-substrat with plants treated with Poly-Feed MAR (5,51%) and the biggest with plants treated with Wuksal (5,93%). Based on the obtained results for growing lettuce on an open field, in the examined specified climatic and edaphic conditions in the plain of Zeta, using 30 % of shadows, it is recommended to do the early planting (first time), to use Blumenerde substrate and for plantation nutrition the Poly-Feed MAR.

Key words: *lettuce, head, Nadine F1, yield, dry matter*

Introduction

The success of growing lettuce depends on many interrelated factors. To achieve high quality and yield, is very important to choose the optimal sowing period (planting), which provides optimal weather conditions. The choice of a suitable substrate or soil to normal root development and adoption of available nutrients while the type and composition of fertilizers impact on yield level and time of maturity for harvesting of lettuce. Lettuce is a culture that has special requirements in terms of length of day-light, and in the summer and autumn periods of sowing (planting) should choose a day-neutral types. If the sowing period (planting) does not adjust to lettuce varieties, leads to earlier efflorescence (sometimes they do not form a head) while improper choice of substrate and fertilizer decreases yield and quality of lettuce. To form a compact head optimum temperatures are 15-20⁰C, over 25⁰C appears slowed growth, and above 30⁰C growth stops and initiates a rapid transition in the generative phase (Matotan, 2004). Todorovic et al. (2003) reported that initiates blossoming with a lack of water and a temperature of 20⁰C. According to abilovski et al. (2009), yield and chemical composition depend on the variety, the conditions of production, mineral nutrition, planting dates and harvesting. According to Maksimovi (2007) the value of lettuce yield ranges from 15 to 20 t/ha. Matotan (2004) states that in Croatia lettuce yield is approximately 7 t/ha in gardens and yards, and intensive production is approximately 30-40t/ha. According to Gvozdenovi (2007), the yield of winter varieties is around 15t/ha, of spring 15-30t/ha, while of autumn 30-40t/ha.

Materials and methods

In order to determine the impact of sowing time (term), fertilizer and substrate on lettuce Nadine F1, the experiment is set up in the region of Zeta (near Podgorica). The experiment was three factorial and conducted by split-plot design with three repetitions.

Sowing was done on 3th VII and 1st VIII 2009 in containers with a 126 apertures (volume 22cm³). Planting seedlings was done four weeks after sowing as follows: 31.VII and 29.VIII 2009 in plots of 6 plants in 3 rows with distance 25x25cm in 3 repetitions in a split-plot design.

Treatment of Slavol consisted of pre-sowing seed treatment with a 3.3% solution and feeding seedlings twelve and seventeen days old with a 1% solution. WUKSAL is applied foliar twelfth and seventeenth day in the concentration of 1%, while Poly-Fed MAR is applied with 0.5% solution. After planting, fertilizing was done with same types and the same concentrations of fertilizers, on 10th and 17th day after planting with the crop overshadow using 30% overshadow. Control is irrigated with water without any fertilizers. Examined substrates were Profi-substrate and Blumenerde.

After 37 days of planting (65 day of seedling) from each repetition was taken the five plants and measured: the head height, head diameter, head weight, total leaf of head, number of damaged leaves, dry matter content. The influence of the applied measures was analyzed using the F-test.

Results and discussion

In the production of seedling should use very high quality seed with high biological value (Markovi , 2002).

For the height of lettuce head statistically significant effect had the factor of substrate, while the significant effect had a factor of term and fertilizer and the interaction of term/fertilizer.

Maximum height of the lettuce head was measured in the first term of planting on both substrates (16,5cm and 16,8cm), while the application of Poly-feed MAR gave the best results on both substrates (17,3cm and 17,8cm).

The lowest average value of the treatment was measured on both substrates with Slavol (14,4cm).

Table 1: The dependence the head height lettuce of term, substrate and fertilizers

Head height of lettuce Nadine F1(cm)							
Fertilizer	Profi-substrat			Blumenerde			Average
	I term	II term	Average	I term	II term	Average	
Slavol	16,0	12,2	14,1	15,8	13,4	14,6	14,4
WUKSAL super	15,6	14,8	15,2	17,2	14,6	15,9	15,6
Poly-Feed MAR	17,8	16,8	17,3	17,2	18,4	17,8	17,55
Control	15,2	14,6	14,9	16,8	15,0	15,9	15,4
Average	16,5	14,6		16,8	15,3		

	Term	Fertilizer	Substrat	Term / Fertilizer	Term / Substrat	Fertilizer / Substrat	Term / Fertilizer/ Substrat
F calculated	23,8**	19,5**	4,98*	4,78**	0,061	0,152	2,59

The largest diameter of the lettuce head was measured in the second term of planting on both substrates (25,3cm and 25,8cm) and the best results are provided by applying fertilizer Poly-feed MAR (25,7cm). According to Edelštajn (1950), varieties of lettuce occupy limited nutrient space up to 400-500cm², while in our research it was 295,5-598cm².

Table 2: The dependence the diameter lettuce head of term, substrate and fertilizers

The diameter lettuce head Nadine F1 (cm)							
Fertilizer	Profi-substrat			Blumenerde			Average
	I term	II term	Average	I term	II term	Average	
Slavol	22,2	23,4	22,8	23,0	25,2	24,1	23,5
WUKSAL super	24,2	25,6	24,9	22,8	23,6	23,2	20,1
Poly-Feed MAR	24,6	26,0	25,3	25,2	26,8	26,0	25,7
Control	19,4	26,0	22,7	23,4	27,6	25,5	24,1
Average	22,6	25,3		23,6	25,8		

	Term	Fertilizer	Substrat	Term / Fertilizer	Term / Substrat	Fertilizer/ Substrat	Term / Fertilizer/ Substrat
F calculated	38,2**	5,73**	3.9	6.48**	0,329	5,68**	0,859

Factors planting term, fertilizer, interaction of factors term/fertilizer and term/substrate have highly significant influenced on the diameter of the lettuce head. Towards *Gvozdenovic (2007)*, head size may be small (6-8 cm), medium (8-12cm) and large (over 12cm), so that in our case, all the heads belong to the group of large.

The minimum weight heads of lettuce was observed in the application of Wuksal on the Profi-substrate (88,3g) and Slavol gave on average lowest value of head mass on both substrates, the 95,38g. The highest weight of lettuce head Nadine F1 was measured in the first planting term (123,6g and 139,3g), and the use of Poly-feed MAR has given the highest yields of lettuce on both substrates (173,2g). Towards Maksimovic (2007), heads were usually weighing from 300 to 500 grams, while in our tests the hardest heads were about 204,95 grams which is below the the mentioned range.

Table 3: The dependence the weight of lettuce head of term, substrate and fertilizers

Weight of lettuce head Nadine F1 (g)							
Fertilizer	Profi-substrat			Blumenerde			Average
	I term	II term	Average	I term	II term	Average	
Slavol	100,64	80,08	90,36	107,62	93,21	100,4	95,38
WUKSAL super	95,11	81,39	88,3	137,13	111,95	124,5	106,4
Poly-Feed MAR	204,95	147,36	176,2	190,19	149,99	170,1	173,2
Control	93,50	117,64	105,6	122,32	125,84	124,1	114,9
Average	123,6	106,6		139,3	120,2		

	Term	Fertilizer	Substrat	Term / Fertilizer	Term / Substrat	Fertilizer/ Substrat	Term / Fertilizer/ Substrat
F calculated	7,93**	29,5**	5,29*	4,02*	0,028	1,91	0,448

Table 4. Lettuce yield Nadine F1 (t/ha)

Yield of lettuce Nadine F1 (t/ha)							
Fertilizer	Profi-substrat			Blumenerde			Average
	I term	II term	Average	I term	II term	Average	
Slavol	16,10	12,81	14,46	16,96	14,91	15,94	15,20
WUKSAL super	15,22	13,02	14,12	21,94	17,91	19,93	17,03
Poly-Feed MAR	32,79	21,58	27,19	30,43	24,00	27,22	27,21
Control	14,96	18,82	16,89	19,57	20,14	19,90	18,40
Average	19,77	16,56		22,23	19,24		

Factors term and fertilizer, also the interaction term/fertilizer have statistically highly influenced the the mass of lettuce head, while the factor of the substrate had a statistically significant effect.

In our research yields have been in the range between 12,81-32,79t/ha, which is in line with the results of Maksimovic (2007) and Gvozdenovic (2007).

Also, our tests have shown statistical dependence of yields of the substrate and the high dependence of factors: term, fertilizers as well as the interaction term/fertilizer, which is in accordance with the arguments of abilovski et al. (2009).

The results of the total number leaves per head of lettuce is in line with the values of the mass lettuce head, so the best results obtained following application of fertilizer Poly-feed MAR (30,1) in the first term of planting on both substrates (27 and 30.5) . Minimum number of leaves was observed in treatment with Wuksal (23,7).

Table 4: The dependence the total number of leaves of the lettuce head of term, substrate and fertilizers

Total number of leaves of the lettuce head Nadine F1							
Fertilizer	Profi-substrat			Blumenerde			Average
	I term	II term	Average	I term	II term	Average	
Slavol	26,4	20,8	23,6	29,0	20,0	24,5	24,1
WUKSAL super	23,0	20,6	21,8	29,2	22,0	25,6	23,7
Poly-Feed MAR	34,6	24,8	29,7	36,2	24,6	30,4	30,1
Control	24,0	23,4	23,7	27,6	22,6	25,1	24,4
Average	27,0	22,4		30,5	22,3		

	Term	Fertilizer	Substrat	Term / Fertilizer	Term / Substrat	Fertilizer/ Substrat	Term / Fertilizer/ Substrat
F calculated	93.0**	20.6**	6.56*	6.59**	7.36**	1.16	0.254

The total number of leaves of lettuce head (Nadine F1) is statistically is dependent of substrate, and highly dependent of factors: term, fertilizer, as well as the interaction of term/fertilizer and term/substrate.

The biggest number of damaged leaves of lettuce head Nadine F1 was observed in the second term on both substrates (2,9 and 2,6), as well as in variants of application Poly-feed MAR fertilizer (2,9).

Table 5. The dependence the number of damaged leaves of lettuce head of term, substrate and fertilizers

The number of damaged leaves of lettuce head Nadine F1							
Fertilizer	Profi-substrat			Blumenerde			Average
	I term	II term	Average	I term	II term	Average	
Slavol	1,4	2,4	1,9	2,8	2,6	2,7	2,3
WUKSAL super	2,0	3,2	2,6	1,2	1,8	1,5	2,1
Poly-Feed MAR	2,4	3,2	2,8	3,4	2,6	3,0	2,9
Control	1,4	2,8	2,1	1,0	3,2	2,1	2,1
Average	1,8	2,9		2,1	2,6		

	Term	Fertilizer	Substrat	Term / Fertilizer	Term / Substrat	Fertilizer/ Substrat	Term / Fertilizer/ Substrat
F calculated	11.3**	2.87*	0.012	2.84**	1.99	2.96*	1.3

Highly significant differences to the number of damaged leaves of lettuce were observed depending on the term, while statistically significant differences were caused by the application of various types of fertilizer and interaction by factors term/fertilizer and fertilizer/substrate.

The dry matter content in lettuce Nadine F1 was in the interval from 5,40% (control and plants fertilized with Poly-MAR feed on the Profi-substrate in the second term) to 6,24% (treatment with Slavol in the first term on Blumenerde substrate).

The lowest average dry matter content was measured on Profi-substrate at plants treated with Poly-Feed MAR (5,51%) and highest at plants treated with Wuksal (5,93%). On Blumenerde substrate application of Poly-Feed MAR (5,44%) also gave the lowest average value of dry matter, while the highest measured in the lettuce treated with Slavol (5,92%). In the first term, on both substrates are obtained higher average values of dry matter content (5,74% and 5,78%).

Table 6: The dependence the dry matter content of lettuce of term, substrate and fertilizers

The dry matter content of lettuce F1 (g/100g SvM)							
Fertilizer	Profi-substrat			Blumenerde			Average
	I term	II term	Average	I term	II term	Average	
Slavol	5,64	5,86	5,75	6,24	5,60	5,92	5,84
WUKSAL super	5,68	6,18	5,93	5,70	5,74	5,72	5,83
Poly-Feed MAR	5,62	5,40	5,51	5,26	5,62	5,44	5,64
Control	6,00	5,40	5,7	5,92	5,62	5,77	5,74
Average	5,74	5,71		5,78	5,65		

Towards *Maksimovic (2007)* lettuce leaf contains from 4,58 to 11,6% dry matter, while *Gvozdenovic (2008)* shows the data of 4,8%, *Djuric et al. (2005)* give the scope of dry matter content from 4 to 12%, which is in accordance with the data obtained in our tests (5,4 to 6,24%).

The dry matter content depends on the variety, growing conditions and term (*Djuric et al., 2005*), in our results, achieved higher content in the first term.

In studies *Djuric et al. (2005)*, the highest dry matter content of lettuce in both terms achieved in the variant without fertilization. In our tests the dry matter content was not significantly different between the treatment and control of fertilization.

Table 6. F test for the tested treatments and characteristics of lettuce head Nadine F1

Sources of variation	F-calculated				
	Height	Diameter	Weight	Total number of leaves	Number of damaged leaves
A	23,8**	38,2**	7,93**	93,0**	11,3**
B	19,5**	5,73**	29,5**	20,6**	2,87*
C	4,98*	3,9	5,29*	6,56*	0,012
A x B	4,78**	6,48**	4,02*	6,59**	2,84*
A x C	0,061	0,329	0,028	7,36**	1,99
B x C	0,152	5,68**	1,91	1,16	2,96*
A x B x C	2,59	0,859	0,448	0,254	1,3

Factor A- Term; Factor B- Fertilizer; Factor C- Substrat

Length of vegetation of lettuce varies from 30 to 90 days (*Gvozdenovic, 2007*) while in our research growing season was 65 days. According to *Edelštajn (1950)*, mineral fertilizer speed up production of lettuce and greatly increase the average weight of heads, which is in line with our results.

The application of microbial fertilizers achieved better results than the control and may be used as a replacement or supplement mineral fertilizers, which is in line with the results of *Illmer et al. (1995)*, *Djordjevic et al. (2005)*, *Simic et al. (2005)* and *Govedarica et al. (2002)*. Cardinal points of soil acidity (pH) within which is possible to cultivate lettuce are a

minimum (5.5), optimum (6.0-7.0) and maximum (7.5) (Parakovi et al., 2008; Gvozdenovic, 2008) so we provided excellent growing conditions on a plot of pH 7.

Conclusion

Results of the research impact of period, the substrate of fertilizer on growing of lettuce Nadine F1 show:

- In the first term is reached greater/higher height of heads, head mass, number of leaves and higher dry matter content.
- Application of Poly-Feed MAR has affected greater/higher height head, head diameter, head mass, number of leaves and number of damaged leaves.
- On Blumenerde substrate was observed significantly greater/higher head height, head diameter, head mass and number of damaged leaves of lettuce.

Based on the results obtained for the production of lettuce in the open field, in the investigated area using 30% overshadow, it may be recommended sowing of seed treated with Slavol, early sowing (first term), Blumenerde substrate and fertilization with Poly-Feed MAR.

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