

THE EFFECT OF LIQUID AND SOLUBLE FERTILIZERS ON LETTUCE YIELD*

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SUMMARY: The aim of this study was to examine the effect of five liquid/soluble fertilizers on yield and yield contributing characters in plastic house grown lettuce. Bioactiv, Hascon M-10 AD and Herbagreen were splashed onto the plants; Foliacon 22 was applied within watering and Drin was used in both ways. The yield was significantly increased by all treatments, except for Bioactiv. Considering both the yield and other traits analyzed, the best results have been achieved by application of Drin within watering and it could be recommended for plastic house grown winter lettuce.

Key words: lettuce, liquid and soluble fertilizers, yield.

INTRODUCTION

The optimized application of mineral fertilizers provides increased and stable yields in agricultural plants (Latković et al., 2009; Bogdanović et al., 2010). However, unnecessarily high rates of mineral fertilizers affect environment, since the excess that has not been used by crops remains in the soil or washes in groundwater and surface water (Moreno et al., 2003; Li et al., 2005; Fernandez-Escobar et al., 2011). In addition, inadequate fertilizing may affect the balance of soil micro and macro elements causing significant crop nutrient disorders (Boroujerdnia and Ansari, 2007; Oljača, 2008).

One of the possibilities for solving the problems related to excessive use of mineral fertilizers in vegetable crops production may be the use of liquid or soluble fertilizers, applied foliarly or within watering. Foliar fertilizing facilitates rapid absorption and

Original scientific paper / *Originalni naučni rad*

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*This work is a part of the project supported by the Ministry of Science and Technological Development of the Republic of Serbia "Integrating biotechnology approach in breeding vegetable crops for sustainable agricultural systems" TR-31059, 2011-2014.

efficient use of nutrients; therefore, it may be applied as both preventive and curative measure to compensate for nutrient deficiency (Fernandez et al., 2008; Hossain and Ryu, 2009; Seshadri, 2010; Del Amor and Cuadra-Crespo, 2011). Foliar nutrient supply may play significant role in intensive production of vegetables.

This study was undertaken in order to investigate the effect of five liquid and soluble fertilizers on yield and yield contributing characters in plastic house grown lettuce (*Lactuca sativa* L.), cultivar Neva. Applying the results of this study may enhance intensive lettuce production.

MATERIAL AND METHODS

The plastic house experiment has been set during the winter of 2008/09 at the Institute for Vegetable Crops, Smederevska Palanka, Serbia. The trial included five liquid and soluble fertilizers (Table 1) combined in six treatments (Table 2) and control (without fertilizing), which were applied on lettuce cultivar Neva. The cultivar has been developed at the Institute.

Table 1. Nutrient content in the applied fertilizers

Tabela 1. Sadržaj hranljivih materija u đubrivima koja su korišćena u ogledu

Fertilizer / Đubrivo	Nutrient content / Sadržaj hranljivih materija
Drin	Aminoacids / Aminokiseline 39%, C 19%, N 6.3%
Foliacon 22	CaO 15%, N 13.2%, MgO 7.5%
Hascon M-10 AD	K ₂ O 28%, P ₂ O ₅ 21%; B, Mn and Mo in traces / u tragovima
Bioactiv	Mixture of microorganisms / Smeša mikroorganizama
Herbagreen	CaO 44.1%, SiO ₂ 9.1%, MgO 2.2%, Fe ₂ O ₃ 1.2%, SO ₄ 0.11%, Mn 132 ppm, Zn 60 ppm, Cu 22.5 ppm, Ni 3.3 ppm, Cr 3.25 ppm

Table 2. The applied fertilizer treatments

Tabela 2. Primenjeni tretmani đubrivima

Treatment / Tretman	Application / Primena	Concentration / Koncentracija
Drin (1)	Foliar / Folijarno	0.2 %
Drin (2)	Watering / Zalivanje	17 ml/m ²
Drin + Foliacon 22 (3)	Watering / Zalivanje	0.1 % + 0.2 %
Hascon M-10 AD (4)	Foliar / Folijarno	0.15 %
Bioactiv (5)	Foliar / Folijarno	5 g/l
Herbagreen (6)	Foliar / Folijarno	5 g/l

The lettuce was planted as a subsequent crop, without previous fertilization. The main crop was tomato, which was fertilized following the standard procedures. Lettuce seedlings were transplanted from nursery on mulch foil on November 18th and harvested on March 11th. The plastic house was not heated during the experiment. Air temperature was recorded on the daily basis and compared to multiyear average (Figure 1). The main plot area was 5 m² and it consisted of 100 plants. The crop was watered by the micro irrigation system.

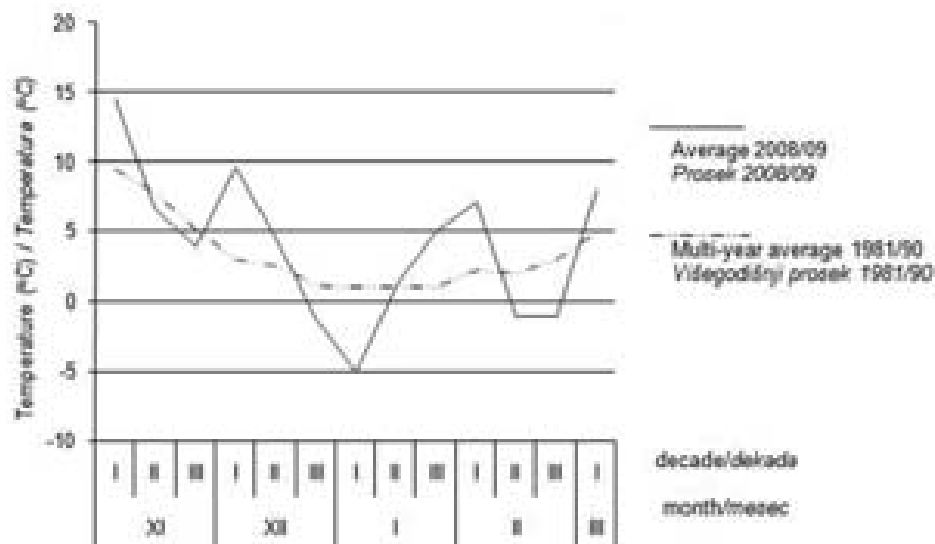


Figure 1. Plastic house air temperature recorded during the experiment
 Grafikon 1. Temperatura vazduha u plasteniku merena tokom ogloda

The treatments were imposed following the dynamics recommended by the producers (Table 3). Every main plot was treated with 2l of fertilizer solution. All treatments were replicated 5 times.

Table 3. Dynamics of treatment application
 Tabela 3. Dinamika primene tretmana

Treatment / Tretman	Date / Datum	Treatment / Tretman	Date / Datum
(1), (2)	December 04 th , 2008	(1), (6)	January 14 th , 2009
(1)	December 15 th , 2008	(6)	January 30 th , 2009
(1), (2), (3), (4), (5), (6)	December 24 th , 2008	(6)	February 10 th , 2009

The following traits have been analyzed: yield per plant (g), number of leaves per plant, leaf rosette weight (g), head weight (g) and head index, which was calculated as the ratio of head weight and leaf rosette weight. Samples included 10 plants per replication. The data was processed by ANOVA and LSD test was used for comparison of the means of treatments.

RESULTS AND DISCUSSION

The average effects of the applied liquid and soluble fertilizers on the analyzed lettuce traits are listed in Table 4. Significant differences have been found among the applied treatments for all investigated lettuce traits.

Table 4. The effect of the applied fertilizer treatments on lettuce yield per plant (g), number of leaves per plant, leaf rosette weight (g), head weight (g) and head index

Tabela 4. Uticaj primenjenih tretmana đubriva na prinosa salate po biljci (g), broj listova po biljci, masu listova rozete (g), masu glavice (g) i indeks glavice

Treatment <i>Tretman</i>	Yield <i>Prinos</i>	No of leaves <i>Broj listova</i>	Rosette weight <i>Masa rozete</i>	Head weight <i>Masa glavice</i>	Head index <i>Indeks glavice</i>
(1)	134.4**	15.4**	67.5**	66.9**	0.99
(2)	142.9**	15.4**	69.8**	73.1**	1.05
(3)	127.6**	12.2	66.8**	60.8	0.91**
(4)	132.8**	12.0	69.9**	62.9**	0.90**
(5)	119.6	12.2	62.2**	57.4	0.92**
(6)	136.0**	16.4**	72.1**	63.9**	0.89**
Control/ <i>Kontrola</i>	114.1	12.2	56.3	57.8	1.03
LSD _{0.05}	7.0	1.5	4.6	4.0	0.05
LSD _{0.01}	8.4	1.8	5.5	4.8	0.07

**significantly different with the respect to control (0.01 level of probability)

Yielding capacity of the lettuce cultivar Neva was not fully realized in this experiment (Marković et al., 1997); either on unfertilized, or on fertilized plots. Although the plants were grown in a plastic house, low temperatures during the vegetation slowed their development. The temperatures were extremely low in January (Graph 1). Nevertheless, the application of liquid and soluble fertilizers significantly increased lettuce yield per plant with respect to unfertilized control. Similar results have been reported by Saglam et al. (2002), Vetrano et al. (2009) and Luz et al. (2010). The only exception was fertilizer Bioactiv, which practically had no effect on yield. Therefore, the application of this fertilizer is not recommended for plastic house winter lettuce production.

Other lettuce traits had been analyzed primarily with the aim to investigate the possible effects of different fertilizers on the head and rosette weight ratio (head index). Since the lettuce with highly developed rosette is not preferred by the consumers, head index should be as high as possible.

Drin + Foliacon 22, Hascon M-10 AD and Herbagreen treatments significantly increased lettuce yield. However, Drin + Foliacon 22 increased leaf rosette weight and had no effect on head weight. Hascon M-10 AD and Herbagreen increased both head and rosette weight, however rosette weight was increased to the greater extent comparing to head weight. Consequently, head indexes calculated for the plots treated with Drin + Foliacon 22, Hascon M-10 AD and Herbagreen were significantly lower with the respect to the control. Out of three treatments mentioned, only Herbagreen increased the number of leaves, however, those were rosette leaves. Since lower head index may make lettuce less attractive to the consumers, fertilizing plastic house grown winter lettuce with the above substances may not be recommended.

On the other hand, treatment Drin increased significantly the yield per plant, the number of leaves per plant, leaf rosette weight and head weight, having no effect on head index. The increases in the studied traits have been observed for both foliar application and application by watering; however, the positive effects of fertilizer Drin on lettuce were more pronounced when applied by watering. Therefore, among the six studied liquid and soluble fertilizer treatments, application of Drin within watering could be recommended for plastic house grown winter lettuce. Yield per plant and head weight

were increased by Drin for approximately 25% with respect to the control, even in the conditions of unfavorably low winter temperatures.

CONCLUSION

Application of liquid and soluble fertilizers completes basic fertilization through the soil and it is especially useful in stress conditions (low temperature, physiological drought, lack of light, etc.). The best results have been achieved by application of fertilizer Drin within watering; therefore, it can be recommended for plastic house winter lettuce production. Application of microbiological fertilizer Bioactive is not recommended for the mentioned production system.

Further investigations on the levels and dynamics of fertilizer applications, as well as on the chemical composition of the lettuce fertilized with liquid and soluble preparations should be undertaken.

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UTICAJ TEČNIH I LAKO RASTVORLJIVIH SREDSTAVA ZA ISHRANU BILJAKA NA PRINOS ZELENE SALATE

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Izvod

Cilj ovog istraživanja bilo je ispitivanje uticaja pet tečnih i lako rastvorljivih sredstava za ishranu biljaka na prinos i svojstva u vezi sa prinosom kod zelene salate gajene u zaštićenom prostoru u toku zime. Bioactiv, Hascon M-10 AD i Herbagreen primenjeni su folijarno; Foliacon 22 je zalivanjem a Drin je korišćen na oba načina. Zabeleženi su značajno viši prinosi po biljci na svim ispitivanim tretmanima, izuzev na tretmanu Bioactiv. Uzevši u obzir prinos i druga ispitivana svojstva najbolji rezultati su postignuti primenom preparata Drin zalivanjem, te bi se ovaj tretman mogao preporučiti kod plasteničke proizvodnje zelene salate u toku zime.

Ključne reči: zelena salata, tečna i lako rastvorljiva đubriva, prinos.

Received / *Primljen*: 18.03.2011.

Accepted / *Prihvaćen*: 04.05.2011.