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# INFLUENCE OF APPLIED AGRICULTURAL MEASURES ON THE SEEDLING QUALITY OF LETTUCE

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## Abstract

In the region of Zeta and BjelopavliCi mostly two varieties of lettuce are cultivated: cabbage lettuce (*Lactuca sativa var. capitata)* and leaves of lettuce (*Lactuca sativa var. Acephala)*. With a goal to determine the influence of time of sowing (3.VII and 1.VIII), 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 experiment has been set up in the plain of Zeta (in the region of Podgorica). The examined parameters were the beginning of germination, the percentage of emerged plants, the time of the first leaf appearance, rosette leaf number at the time of planting, the mass of the plant seedling.
By using the microbiological fertilizers one gets the better germination and the earlier springing up of lettuce plantations. The seed of the Nadine F1 lettuce, treated with Slavol before sowing, has sprung up two days earlier than the seed that hasn't been treated at all. The plants of lettuce plantations have big needs for nutrients because of the intensive growth, therefore the higher yield has been gained by using the fertilizers that provide more nutrients. Blumenerde substrat has, in the both times of sowing, showed better results than the Profi-substrat, where the mass of a plantation was 1,97g i 2,19g.

**Key words:** lettuce, Nadine F1, times of sowing, fertilizer, substrat

## Introduction

Lettuce is an annual vegetable crop with the spindle, well-developed root which mainly develops in the surface layer of soil, and especially shallow rooted lettuce produced from seedlings. The stalk of lettuce in the vegetative stage has shortened internodes that gush leaves forming a rosette. The leaves are sessile, wide, relatively thin, with soft oily tissue. The outer leaves of the rosette were horizontal and darker, while the leaves of head are vertical and brighter in color ***(Prohens and Nuez, 2008).***
The seedling is a plant from germination to the formation of 4 to 10 permanent leaves or passing four or five stages parthenogenesis ***Markovic (2002)***. According to the same author, the seedlings provides an earlier harvest and better use of space. Plant height depends on the quality of seedlings, leaf arrangement, root widespread, flowering and amount of yield.
According ***ParađikoviC et al. (2007)***, germination of seeds is affected by heat, humidity, soil pH and the presence of the organic and inorganic components in growing media, and the optimum temperature during germination and emergence are between 15-20°C. Adoption of some elements depend on environmental factors, developmental stage of the plant and the genotype ***(Djuric et al., 2005)***.
Application of biofertilizers contribute to the stability and quality of yields, preserve the ecological balance, which reflects on the food safety and a favorable economic effect ***(Milosevic et al., 2003)***. Treatment of seeds and of seedlings of vegetable crops with a Slavol

has affected growth of seedlings height and dry matter, as well as increased adoption of nutrients from the soil ***(Djordjevic et al., 2004; Simic et al., 2005)***.
The highest quality seedlings are produced in containers ***(Filkovic et al., 2009)*** because the root is not intergrowths and sufficient aeration of the substrate stimulates the development of lateral roots, ***Markovic (2002)***.
Lettuce (*Lactuca sativa L.*) is a vegetable with low energy value (18 cal/100g fresh eatable part). The water content is up to 94%, carbohydrates 2.9%, 1.2% protein and 0.2% fat. In the 100g fresh lettuce, by ***Tranevski (2008)***, is vitamin C (10mg), B1 (0.08 mg), B2 (0.12 mg), B6 (0.2 mg), PP (0.6 mg) , carotene (1 mg) and vitamin E (0.6 mg).
According to ***Prohens and Nuez (2008)***, the objectives to further lettuce breeding need to be developed in three directions: resistance to pests and diseases, increasing of yields and improvement of quality.

## Materials and methods

In order to determine the impact of agrotechnical measures applied to lettuce seedlings Nadine F1 experiments have been conducted in the region of Zeta (near Podgorica). The experiment was set up as a three factorial and examined factors were sowing time (term), fertilizer and substrate. The experiment was conducted by split-plot design with three repetition. Four weeks after sowing, from each repetition has been taken five plants on which we have measured mass of the whole plant and roots of seedlings.
Sowing was done on 3th VII and 1st VIII 2009 in containers with a 126 apertures (volume 22 $cm^3$). The examined fertilizers were Slavol (nitrogen fixing and phosphate mineralizing bacteria, natural vitamins, enzymes and growth stimulants Agrounik-doo, Belgrade), Poly-Feed MAR 20:20:20 + I (Haifa Chemicals Ltd., Israel) and WUKSAL Super 8: 8:6 + I (Chemical Agrosava).
Treatment of Slavol consisted of pre sowing seed treatment with a 33.3% solution and feeding seedlings old twelve and seventeen days with a 1% solution. WUKSAL is applied foliar twelfth and seventeenth day in the concentration of 1%. Treatment of Poly-Feed MAR was performed twelfth and seventeenth day with 0.5% solution. Control is irrigated with water without any fertilizers.
Examined substrates were Profi-substrate (GRAMOFLOR) and Blumenerde (NATURAHUM). Profi-substrate composition was 60% white peat, black peat 40% and a pH value of 5.2 to 6.0. Blumenerde substrate composition is 100% white peat and pH 5.4 to 6.0.
The influence of observed factors was assessed by monitoring of the start of germination, the percentage emerged plants and timing of the first full leaf, the number of rosette leaves at the time of planting, the mass of the whole plant and root mass of lettuce seedlings. The influence of the applied measures was analyzed using the F-test.

## Results and discusion

In the production of seedlings should be used very high quality seeds, high biological value (high germination and vigor) ***(Markovic, 2002)***. Larger number germinated seeds and emerged plants is potentially larger number of plant of seedlings. With faster germination can be achieved shorter period of seedling production. The seeds treated before sowing by Slavol has begun to sprout second day after seeding, while the seeds of the other treatments began springing fourth day after sowing. Recorded results are consistent with the allegations of ***Djordjevic et al. 2004***.

Table 1. *Time and the percentage of germination and time to the first full leaf depending on planting date, type of substrate and type of fertilizer*

| Cultivar | Inoculation by Slavol | Substrate | Days from sowing to emergence | | % emergence | | The appearance of the first full leaf | |
|---|---|---|---|---|---|---|---|---|
| | | | I term | II term | I term | II term | I term | II term |
| **Nadine F1** | Inoculated | Profi-substrat | 2 | 2 | 100 | 77 | 6 | 6 |
| | | Blumenerde | 2 | 2 | 92,9 | 77 | 6 | 6 |
| | Not inoculated | Profi-substrat | 4 | 4 | 85,47 | 75,5 | 7 | 8 |
| | | Blumenerde | 4 | 4 | 88,89 | 72,2 | 7 | 8 |
| ***Average*** | | | | | ***91,82*** | *75,43* | | |

| | Sowing time | Fertilizer | Substrate | Sowing time / Fertilizer | Sowing time / Substrate | Fertilizer / Substrate | Sowing time / Fertilizer / Substrate |
|---|---|---|---|---|---|---|---|
| F calculated (% emergence) | **18,4**** | 2,38 | 0,367 | 0,924 | 0,012 | 0,124 | 1,14 |

Sowing date was statistically significant effect on the percentage emerged plants.
On plants treated by Slavol appearance of the first full leaf is spotted 6 days after sowing (in both term). In the other treatments, the plants have formed the first full leaf 7 days after the seeding (first sowing term), and 8 days after the seeding in the second term.

Table 2. *Number of leaves of seedlings depending on sowing date, type of substrate and type of fertilizer*

| Cultivar | Fertilizer | Substrate | Number of leaves at the time of planting | | *Average* | *Average* |
|---|---|---|---|---|---|---|
| | | | I term | II term | | |
| **Nadine F1** | Slavol | Profi-substrat | 6,6 | 6,6 | *6,6* | *6,9* |
| | | Blumenerde | 7,4 | 7,0 | *7,2* | |
| | WUKSAL super | Profi-substrat | 6,2 | 7,4 | *6,8* | ***7,1*** |
| | | Blumenerde | 7,0 | 7,6 | ***7,3*** | |
| | Poly-Feed MAR | Profi-substrat | 6,0 | 7,0 | *6,5* | *6,8* |
| | | Blumenerde | 7,2 | 6,9 | *7,1* | |
| | Control | Profi-substrat | 5,8 | 6,4 | *6,1* | *6,4* |
| | | Blumenerde | 6,2 | 7,2 | *6,7* | |
| ***Average*** | | | *6,55* | ***7,01*** | | |

| | Sowing time | Fertilizer | Substrate | Sowing time / Fertilizer | Sowing time / Substrate | Fertilizer / Substrate | Sowing time / Fertilizer / Substrate |
|---|---|---|---|---|---|---|---|
| F calculated | **9,48**** | **4,14**** | **14,5**** | **3,53*** | 3,97 | 0,120 | 2,22 |

All three examined factors had a significant effect on number of leaves, and the interaction of sowing date / fertilizer significant effect on the same characteristic. The number of formed leaves at the time of transplanting was higher in the second sowing date compared with the first sowing date. The lowest average number of leaves was observed in the control (6.4 leaves/plant), while the highest number of leaves was recorded in the treatment with WUKSAL and get better results pointed at Blumenerde substrate.Mass of plant seedlings directly depends on the leaves number formed until the moment of transplanting.

Table 3. *Mass of plant lettuce seedlings depending on the sowing date, type of substrate and type of fertilizer*

| **Mass of plant lettuce seedlings** (g) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Profi-substrat** | | | **Blumenerde** | | | ***Average*** |
| **Fertilizer** | **I term** | **II term** | ***Average*** | **I term** | **II term** | ***Average*** | |
| Slavol | 1,90 | 1,52 | 1,71 | 2,20 | 2,52 | *2,36* | *2,04* |
| WUKSAL super | 1,23 | 1,33 | 1,28 | 1,82 | 1,72 | *1,77* | *1,53* |
| Poly-Feed MAR | 2,11 | 1,47 | **1,79** | 2,49 | 2,51 | ***2,50*** | ***2,15*** |
| Control | 1,20 | 0,68 | 0,94 | 1,37 | 1,99 | *1,68* | *1,31* |
| ***Average*** | *1,61* | *1,25* | | ***1,97*** | ***2,19*** | | |

| | Sowing time | Fertilizer | Substrate | Sowing time / Fertilizer | Sowing time / Substrate | Fertilizer / Substrate | Sowing time / Fertilizer / Substrate |
|---|---|---|---|---|---|---|---|
| F calculated | 0,468 | **15.3**** | **39.6**** | **39.6**** | **7.82**** | 0.307 | 1.88 |

In our studies, statistically significant effect on seedlings plant mass had factors: fertilizer and substrate, interaction sowing date / fertilizer, as well as the interaction sowing date / substrate. Blumenerde substrate in both sowing date gave better results than the Profi-substrate, and the average mass of seedlings was 1.97g and 2.19g. Treatment with Poly-Feed MAR fertilizer showed best results in the first sowing date (2.30g) on the both substrates, and treatment with Slavol in the second sowing date for both substrates (2.02g). At seedlings treated with Poly-Feed MAR detected the largest plant mass on the both substrates (1.79g and 2.50g).

Table 4. *The root mass seedlings lettuce depending on the sowing date, type of substrate and type of fertilizer*

| **The root mass seedlings lettuce** (g) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Profi-substrat** | | | **Blumenerde** | | | ***Average*** |
| **Fertilizer** | **I term** | **II term** | ***Average*** | **I term** | **II term** | ***Average*** | |
| Slavol | 0,16 | 0,17 | 0,17 | 0,16 | 0,77 | *0,47* | 0,32 |
| WUKSAL super | 0,14 | 0,21 | 0,18 | 0,19 | 0,54 | *0,37* | 0,27 |
| Poly-Feed MAR | 0,44 | 0,43 | **0,44** | 0,38 | 0,67 | ***0,53*** | **0,48** |
| Control | 0,15 | 0,25 | 0,20 | 0,23 | 0,36 | *0,30* | 0,25 |
| ***Average*** | 0,22 | **0,27** | | 0,24 | **0,59** | | |

| | Sowing time | Fertilizer | Substrate | Sowing time / Fertilizer | Sowing time / Substrate | Fertilizer / Substrate | Sowing time / Fertilizer / Substrate |
|---|---|---|---|---|---|---|---|
| F calculated | 1.88 | **12,6**** | **32,1**** | 2,26 | **25,3**** | **2,78*** | **3,75*** |

At root mass, similarly to the mass of of the whole plant lettuce seedlings, a highly significant effect had fertilizer and the substrate, and the interaction sowing date / substrate. Interactions of fertilizer / substrate and sowing date / fertilizer / substrate significantly affected the mentioned characteristic.

Seedlings treated with Poly-Feed MAR had significantly greater root mass in both sowing date on both substrates, compared to treatment with other fertilizers. In the second sowing date on the both substrates were recorded better results in comparison to the first sowing date.

Table 5. *F test for examined treatments and the characteristics of lettuce seedlings*

| Sources of variation | F calculated | | | |
|---|---|---|---|---|
| | Mass of plant lettuce seedlings | The root mass seedlings lettuce | % emergence | Number of leaves at the time of planting |
| A | 0,468 | 1,88 | **18,4**** | **9,48**** |
| B | **15,3**** | **12,6**** | 2,38 | **4,14**** |
| C | **39,6**** | **32,1**** | 0,367 | **14,5**** |
| A x B | **39,6**** | 2,26 | 0,924 | **3,53*** |
| A x C | **7,82**** | **25,3**** | 0,012 | 3,97 |
| B x C | 0,307 | **2,78*** | 0,124 | 0,120 |
| A x B x C | 1,88 | **3,75*** | 1,14 | 2,22 |

Factor A- Sowing date (term); Factor B- Fertilizer; Factor C- Substrate

***Djordjevic et al. (2004)*** suggest that the selection of quality seeds is very important, and our seed by Nadine F1 in certain treatments showed excellent germination of 100%. ***Markovic (2002)***, the length of emergence is 3-6 days, the seeds that were treated with Slavol has sprung up after 2 days, and other treatments after 4 days.

During the first and second term of growing seedlings, mean daily temperatures were higher than 25˚C, and ***ParađikoviC et al. (2007)*** suggest that such a temperature in the lettuce can cause secondary dormancy, postpone germination and reduced germination percentage of the seeds germinated. In the second term of growing temperatures were average higher by 1.1˚C than in the second term and accordingly with that percentage of seedlings in the second term was lower average 17.9%.

Plants of lettuce seedlings has a great need for nutrients because of a short growing season and intense growth ***(Markovic, 2002; Djuric et al., 2005)*** and better results were obtained by applying fertilizers that provide more nutrients. Microbial fertilizers can be used as a replacement or supplement of mineral fertilizers ***(Illmer et al., 1995; Djordjevic et al., 2005; Simic et al., 2005; Govedarica et al., 2002)***. In our experiment, all fertilizers gave better results than the control. ***Jarak et al. (2004)***, the abundance and activity of microorganisms was higher in soils and substrates with good structure, favorable aeration and moisture and neutral pH value. The optimum of pH of substrate for the most bacteria is 6-7,5 ***(Loncaric et al., 2005)***, that we provided the Blumenerde and Profi-substrate (5.2 to 6.0). Mass of plant lettuce seedlings treated with Slavol (containing *Bacillus suptilis* and *Bacillus megaterium var. Phosphaticus*) was higher for 35.8% and root mass of for 21.9% compared to the control. According to the ***Djordjevic et al. (2004)***, by treating the the seed of onion with *Bacillus suptilis* was greater root mass for the 13-100%, and treating the land by bacteria *Bacillus megaterium var. phosphaticus* was increased tomato yield for 35%.

In accordance with the recommendation of ***Vavrina (1998)***, containers with 126 apertures are suitable for the production of lettuce seedlings and the seedlings ready for planting after a period of 20-30 days from sowing, ***Markovic (2002)***.

## Conclusions

The research results of agricultural practices infulence on the quality of lettuce showed that:
Examined factor sowing date:
• No effect on lettuce seeds germination time.
• The percentage of seedlings was significantly higher in the first sowing date.
• Before sowing treatment with Slavol has accelerated emergence of the first leaf in both sowing date.
• Number of leaves at the moment of transplanting was significantly higher in the second sowing date.
• The maximum mass of plant and roots was recorded in the second sowing date.
Examined substrate factor:
• No effect on lettuce seeds germination time.
• The percentage of seedlings was higher in the Profi-substrate
• The appearance of the first full leaf is not dependent of the substrate.
• There has been a significantly higher number of leaves on the Blumenerde substrate.
• A significantly greater mass of whole plants and roots was found on the substrate Blumenerde
Examined fertilizer factor:
Seed pre sowing treated with Slavol it was sprung up two days earlier.
For pre sowing treatment with Slavol was noticed the highest percentage of germination and the shortest time to the appearance of the first full leaf
Number of leaves at the moment of transplanting was significantly higher in seedlings treated with WUKSAL.
A significantly greater mass of plants and roots was recorded in the treatment of Poly-Feed MAR
Based on the results for the production of lettuce seedlings in the examined area may be recommended pre sowing seed treatment with Slavol, early sowing (first term), Blumenerde substrate and seedlings fertilization with WUKSAL or Poly- Feed MAR.

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