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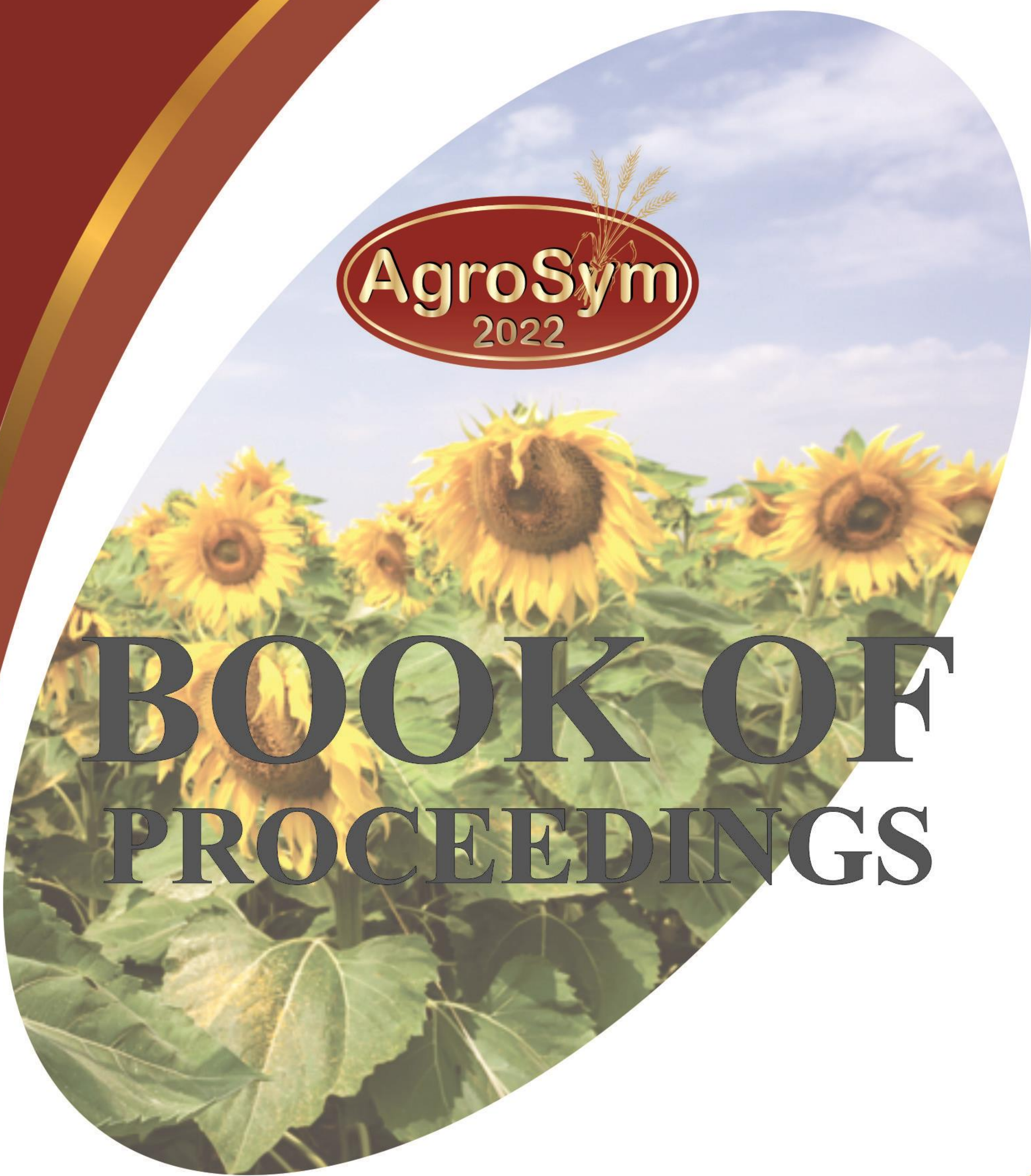

BOOK OF PROCEEDINGS

XIII International Scientific Agriculture Symposium
"AGROSYM 2022"
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USE OF CONTROLLED-RELEASE MINERAL FERTILIZER IN PRODUCTION OF POT GROWN *LEVISTICUM OFFICINALE* L.

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Abstract

Controlled-release mineral fertilizers (CRMF) have been developed and designed in order to improve the efficiency of fertilizers. Better efficiency in use of CRMF compared to conventional mineral fertilizers is mostly reflected in: decrease of chemical immobilization in soils which blocks uptake of nutrients by plants; lowering a fertilizer application frequency and rinsing out of nutrients in soil which consequently reduces a damaging effect on the environment. The aim of this study was to test if an application of CRMF will result in the improvement in development of aboveground biomass of pot grown lovage. The seedlings of lovage were produced in laboratory conditions, in containers placed inside a polyethylene tent (Grow Box), under the artificial lighting. With the development of the first true leaves, seedlings were transplanted into pots and submitted to treatments: CRMF- Osmocot Exact in formulation (NPK 15:9:12 +2MgO+TE), in which is gave 0,45 g N, 0,27 g P_2O_5 and 0,36 g K_2O per L of substrate (pot) and without adding fertilizer (control). After 60 days of growth in the non-heated greenhouse, for 30 plants of each treatment, the absolute dry mass of aboveground biomass (g/plant), number of branches and plant height (cm), were recorded. The highest yield of the aboveground biomass and the highest number of branches were obtained in CRMF (5.17± 0.72g and 6 to 13 branches/plant) compared to control (1.93±0.29g and 5 to 9 branches/plant), respectively. Regarding the plant height, better effect was achieved by CRMF (41.31± 3.43 cm) compared to control (29.37± 2.40 cm). Obtained results have shown positive effects of CRMF on development of aboveground biomass of pot grown lovage.

Keywords: *lovage, medicinal plant, controlled-release fertilizer.*

Introduction

Nutrient losses from mineral fertilizers have persisted at a high level for several years. This adverse phenomenon not only has economic implications, but also environmental consequences. As a result of ongoing attempts to eliminate environmental pollution, the issue of irreversible nutrient loss has lately attracted attention (Noh and Park, 2015). Some of the components are released into the atmosphere, which contributes to climate change. Carbon dioxide, nitrous oxide, and, indirectly, ammonia are gases generated by fertilizer application to soil (Wesołowska et al., 2021). According to sources, greater emission limits might result in decreased application rates or perhaps a complete prohibition on the use of urea-based fertilizers. Slow-release urea, on the other hand, may be an exception to this rule (Beig et al., 2020). Controlled-release mineral fertilizers (CRMF) have been created and designed to increase fertilizer efficiency by enabling delayed nutrient release that is timed to match plant nutritional requirements (Wesołowska et al., 2021). These fertilizers release biogenetic components over some period of time, depending on materials used for coating affected by temperature and soil moisture in decreasing coating thickness (Christianson, 1988; Morgan, Cushman and Sato, 2009). This prevents fertilizer activation at the time of application and/or planting, which is common when using basic mineral fertilizers. In this manner, a high concentration of salts in the substrate is avoided, which in the case of producing seedlings in containers and pots, frequently results in plants degradation (Jelačić, Beatović and Lakić, 2007a). Better efficiency in use of CRMF compared to conventional mineral fertilizers is mostly reflected in: decrease of chemical immobilization in soils which blocks uptake of nutrients by plants; lowering a fertilizer application frequency and rinsing out of nutrients in soil which consequently reduces a damaging effect on the environment (Lubkowski, 2016). *Levisticum officinale L.* is a perennial plant native to south-western Asia and southern Europe. It belongs to the *Apiaceae* family. It has a powerful flavor and has long been exploited in the culinary and food industries. Aside from its culinary interest, *L. officinale* has also been utilized as a medical plant due to its carminative, spasmolytic, diuretic effects, in treating urinary tract infections, and as an antiseptic for treating wounds (Spréa et al., 2020). The aim of this study was to test if an application of CRMF will result in the improvement in development of aboveground biomass of pot grown lovage.

Material and Methods

Production of seedlings. The seeds of lovage (*L. officinale* L.) used in this experiment originated from the MAP collection of the Institute for Medicinal Plants Research " Dr Josif Pančić", in Pančevo, Serbia (44° 52’20.0” N, 20°42’04.7” E). Production of seedlings started in February 2021 in the laboratory of the Institute’s Department for Research and Development in Agriculture, in Belgrade, Serbia (44°49′ N, 20°28′ E). The seedlings have been produced in styrofoam containers with 160 cells, filled with a substrate “Cultivo I SF” (Gramoflor, Romania) of following characteristics provided by the manufacturer: structure 0 - 5 mm, fertilizer NPK 18:10:20+Mg+me in dose of 1 kg/m3, RADIGEN®- Jost GmbH (slow-release micronutrient) in dose of 50 g/m3, hydrogel (wetting agent) in dose of 1 kg/m^3. After the sowing, the containers were kept inside a polyethylene tent (Grow Box), under the following growing conditions: the artificial lighting produced by cool fluorescent tubes with a 12-hour photoperiod; the relative humidity of 40 to 60 %; the air temperature was from 20 °C to 24 °C, while the substrate was kept moist and its temperature was 21±2 °C. Monitoring of the air temperature and relative humidity in the Grow Box was provided by the use of HAXO-8 Data logger and for substrate temperature by Testo 110 thermometer.

Hardening-off process. With the emergence and development of the first true leaves, in the beginning of the second week of March 2021, the 3 weeks long hardening-off process (adaptation) started, as recommended by Davies et al. (2017). Containers were taken outside the Grow box and left inside the laboratory, and were occasionally taken outside in order to ensure adaptation of seedlings to lower air temperatures, reduced relative air humidity and natural light irradiance. The plants were watered with tap water.

Applied treatments and plant growth in greenhouse. By the end of March, the containers were transferred to a greenhouse and seedlings were transplanted into plastic pots (ø 13 cm), filled with 1 L peat substrate (Cultivo I SF), and submitted to treatments: in dose of 3g per L of substrate of the controlled-release mineral fertilizer (CRMF)- Osmocot Exact in formulation

(NPK 15:9:12 +2MgO+TE), in which is gave 0,45 g N, 0,27 g P_2O_5 and 0,36 g K_2O per L of substrate(pot) and without adding fertilizer (control). The pots with plants were placed on a black “agrotextil” film covering the greenhouse ground. The plants grew in the non-heated greenhouse, at 30% shade, under the average daily T 24±2 ℃ and under drip irrigation with a flow rate of 1 liter per hour for each pot. Irrigation was applied every two days for 20 min.

Harvest, morphological parameters and statistical analysis. After 60 days plants were harvested and, in the laboratory conditions, the brunches number counting and plant’s height measuring (cm) were conducted. The absolute dry aboveground biomass (g/plant) was recorded after the harvested plant material have been dried at 105 °C to a constant mass. To compare the achieved yields, the mean values of plant’s height and aboveground biomass were compared by the use of Student’s t-test ($p<0.05$). The obtained results were statistically analyzed by the use of Data Analysis Tool package in Excel 2016 software.

Results and Discussion

The use of CRMF had a significant effect on the development of aboveground biomass in pot grown lovage, compared to the control (Figure 1). Plants in CRMF treatment had 63 % more mass than plants in control treatment, while plants in control treatment had 29 % less height than plants in CRMF treatment (Table 1). In CRMF, plants produced more branches, with the greatest number of plants having 8 branches in treatment and the greatest number of plants having 5 branches in control.

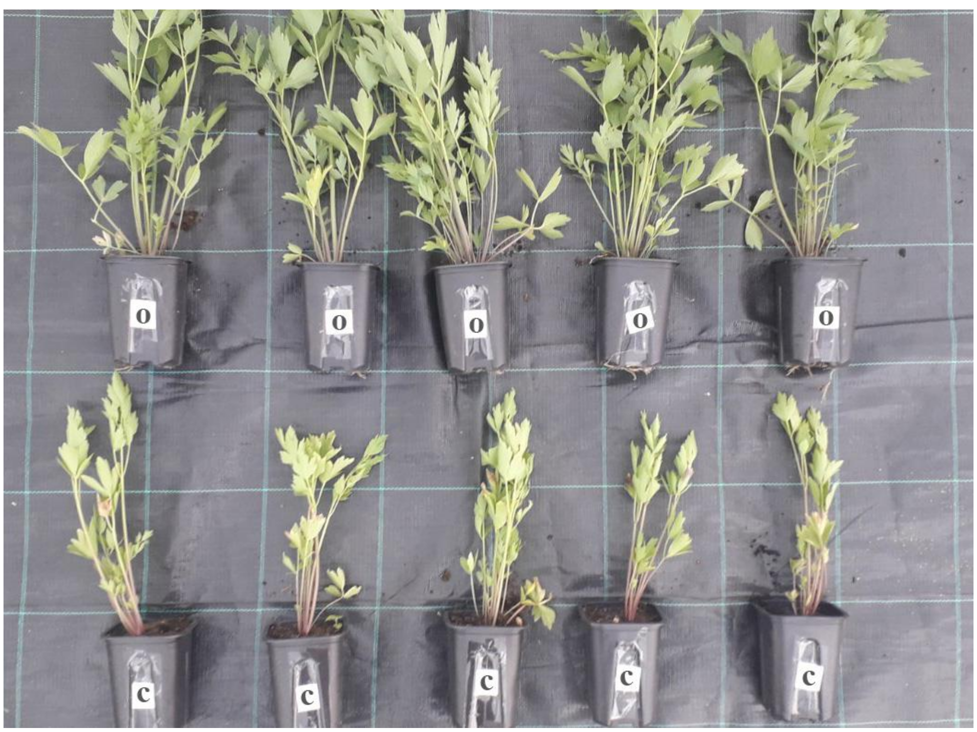

Figure 1. Effect of CRMF on development of aboveground biomass of pot grown lovage, after 60 days of growth in the non-heated greenhouse. Pots marked with o-CRMF; c-control treatment.

Table 1. The average values of plant height, aboveground biomass, and the interval of variation in branch number in potted *L. officinale* plants grown for 60 days.

Plant specie	**Treatment**	**Plant height** [cm]	**Number of branches** I_v (Min-Max)	**Plant mass** [g]
L.officinale	**CRMF**	41.31± 3.43*	6-13	5.17± 0.72*
	Control	29.37± 2.40	5-9	1.93±0.29

Mean values marked with * within the same column are significantly different according to the two-tail t-test ($p < 0.05$).

CRMF have been widely used for over three decades in the container production of seedlings (speedling method) and pots (pot system) in the development of vegetable and horticultural plants (Sharma, 1979). In example, Vujošević et al. (2007a) studied the impact of different dosages (0, 1, 2, 3, and 4 g per L of substrate) of CRMF (Osmocot Exact) in formulation (NPK 15: 9: 9: MgO + Me) on *Tagetes patula* L. and *Salvia splendens* L. seedlings. The obtained results revealed that a CRMF in rate of 4g/L of supstrate had the most impact on the seedling's height (cm), number of lateral branches and aboveground mass (g), followed by similar impact of used rate of 3g per L of supstrate. Reseach in use of CRMF (NPK 15: 9: 9: MgO + Me) in production of *Gazania rigens* L. (Vujošević, et al., 2007b) also sugested usage of dose of 4g per L of supstrate for producing seedlings with the highest plant aboveground mass (g) and number of buds. It is noticed that in both previosly metioned researchers, higher dosage (3g and 4g per L of substate) of used fertilizer resulted in redused number of flowers since applied fertilizer is reacher in N than in P. P is important element that improves flower formation and seed production (Kumar, Kumar and Patel, 2018). In our study, used CRMF (NPK 15:9:12 +2MgO+TE), in dose of 3g per L of substrate produced satisfactory results in the aboveground biomass development of *L. officinale* L., and this dose was indicated by manifactores as an optimal usege dose. Researchers have also investigated the influence of a CRMF on the quality of medicinal and aromatic pot seedlings. A study has been done by Jelačić et al. (2006) on the utilization of CRMF (Osmocote Exact), in the formulation NPK 16+11+11+3MgO+TE, in production of *Ocimum basilicum* L. and *Melissa officinalis* L. seedlings. Based on the results, it can be concluded that doses of 3 and 4g per L of a substrate are the most effective in terms of vegetative development of basil and lemon balm seedlings, which is in accordance with our results and also is recommended by manufacturers in the use of CRMF (Osmocote Exact), in formulations of NPK 16+11+11+3MgO+TE, NPK 15:9:12+2MgO+TE and NPK 15:9:9+MgO+TE. The applied 3 g per L dose of CRMF fertilizer in formulation of NPK 15:9:9 +MgO+TE as the optimal dose was also verified in studies conducted with other medicinal and aromatic species like *Salvia officinalis* L. (Jelačić et al., 2007a), *Rosmarinus officinalis* L. (Jelačić et al., 2007b) and *Hyssopus officinalis* L. (Beatović et al., 2007).

Conclusion

The results of the study demonstrate that CRMF has a considerable favourable influence on the development of lovage seedlings. The use of these fertilisers results in high-quality seedlings. The use of 3g per L of substrate of CRMF in the production of lovage provides the greatest results in terms of above-ground mass gain.

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