INFLUENCE OF BIOSTIMULANT AND SUBSTRATE VOLUME ON ROOT GROWTH AND DEVELOPMENT OF SCARLET SAGE 
(Salvia splendens L.) TRANSPLANTS

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Abstract: The influence of biostimulant and substrate volume on scarlet sage transplants growth and development was examined in this investigation. There was one cultivar of scarlet sage used in trial which was transplanted in pots of two different volumes. Plants were treated with biostimulant (Radifarm) in concentration of 0.25% or left untreated (control). During the trial, root and above-ground fresh and dry mass were recorded. Treatment with biostimulant and bigger substrate volume showed good results by increasing investigated parameters. Investigation shows how biostimulant application to scarlet sage transplants production improves growth and development of root and above-ground mass which is important for faster plant adaptation to stress during transplanting.

Key words: scarlet sage, biostimulant, substrate volume, roots mass, above-ground mass.

Introduction

Demands and needs for flower transplants production, especially of annual flower species, are constantly growing in Bosnia and Herzegovina. The reason for this trend is that local authorities are paying more attention to landscape architecture and better care of public green areas. Consequentially, transplants producers have to improve their production daily in order to obtain transplants of

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high quality. In most cases in Bosnia and Herzegovina, classic production of “naked roots” transplants is being used (Hanić, 2000) which results in poor quality transplants.

However, modern flower production is based on flower transplants production in different container systems (Latimer, 1991), usage of specialized substrates and application of different controlled release fertilizers (Nelson, 2003), as well as application of growth biostimulants. The positive effect of biostimulants, amino acids and controlled release fertilizers during growth of plants was confirmed by Vernieri et al. (2002), Nahed et al. (2007), Jelačić et al. (2007), Vujošević et al. (2007a, b, c, d), Vujošević et al. (2008), Beatović et al. (2006), Beatović and Jelačić (2007), Beatović et al. (2007a, b), Paradiković et al. (2008a), Paradiković et al. (2009) and Zeljković et al. (2009).

For decoration of public areas and home gardens numerous annual and biannual flower species are used, among which one of the most commonly used is scarlet sage or tropical sage (*Salvia splendens* L.). Scarlet sage belongs to a group of annual seasonal flowers, which in climate of Bosnia and Herzegovina begins flowering at the beginning of May to the very late autumn. Growth and survival of plants on open field strongly depends on flower transplants quality. Scarlet sage transplants are produced in protected spaces where it is necessary to provide specific climatic conditions for optimal growth and development. It is well known that plants survive a certain abiotic stress during transplanting by changing growth conditions (Mena-Petite et al., 2006; Kijne, 2006).

By application of biostimulants to transplants growth and development stage it is possible to create better plant stress tolerance by direct input of active compounds such as polysaccharides, proteins, amino acids and glycosides. At the same time, plants treated with biostimulants increasingly develop their organs such as roots, stems and leaves, which is a basic postulate for better plant adaptation after transplanting. Biostimulants which contain these active compounds are new on the market as well as their application to transplants production. As the danger of plant death is greatest after transplanting, such product stimulates growth of root system and helps the plants in overcoming the stress (Maini, 2006).

The aim of this investigation was to determine the influence of biostimulant application on growth and development of scarlet sage transplants.

**Materials and Methods**

Investigation was carried out during 2009 in the glasshouse of the Faculty of Agriculture in Banja Luka and in the greenhouses “Lotus” Banja Luka, Bosnia and Herzegovina. Seeds of *Salvia splendens*-Red Hot Sally were used as a material.
Seeds were sown on 5th February 2009 in polystyrene containers filled with Klasmann-Deilmann substrate. A substrate was the mixture of white and black peat, pH 5.5-6.5. During the next 6 weeks plants were kept in greenhouse with mean daily temperatures from 18-22°C, and by night from 15-18°C with relative air humidity from 60-65%. Greenhouse was regularly ventilated to avoid plant disease manifestation. Plants emerged after 14 days, and after six weeks, in the time of two true leaves development, plants were transplanted in PVC pots. Pots of two different diameters were used, diameter of 9 (factor B2) and of 10.5 cm (factor B1). At the same time, biostimulant Radifarm® (Valagro s.p.a., Italy) which contains amino acids (arginine and asparagine), polysaccharides, glycosides, proteins, vitamins and microelements (Fe and Zn) was applied. His formula is specialised for increasing root mass and development of lateral roots in the first growth stage and after active compounds, it stimulates constant renewal of the root system. This helps the plants to overcome the stress caused by transplanting sooner and easier. Biostimulant was applied by watering in concentration of 0.25% (treatment; factor A2) or plants left untreated were watered just with water (control; factor A1).

There were 160 plants of scarlet sage-Salvia splendens cv. Red Hot Sally in the experiment. The experiment was designed by split plot method in 4 repetitions using 10 plants per repetition.

For determination of plant adaptation, root growth and development under influence of biostimulant, plants were taken out of the pots 7 weeks after transplanting, which matched with the planting time in the open field. Roots were cleaned from substrate, rinsed in distilled water and dried with paper towels after which root and above-ground fresh mass of each plant were recorded. Dry mass was recorded after drying the plant material at 70°C until the constant mass was obtained. Both fresh and dry mass were expressed in grams (g) with two decimal places accuracy.

Data obtained were statistically analysed using ANOVA (LSD, F-test, t-test) using standard computer programs and VVSTAT (Vukadinović, 1994).

Results and Discussion

Above-ground fresh mass was under significant influence of pot diameter (substrate volume) and biostimulant treatment (P<0.01). The highest above-ground mass was recorded in plants, transplanted in bigger volume pots and treated with biostimulants (A2B1) and averagely weighed 27.76 g/plant. The lowest recorded mass weighed averagely 10.87 g/plant and belonged to variant A1B2 (control plants transplanted in smaller volume pots) and also was significantly lower comparing to treated plants in the same pots (A2B2) (Table 1).
Above-ground dry mass was under the same influences as fresh mass. The highest and lowest mass belonged to same variants like in the fresh mass. The highest recorded mass weighed averagely 4.43 g/plant (A2B1) and the lowest was 1.85 g/plant (A1B2) (Table 1).

Table 1. Above-ground fresh and dry mass of scarlet sage under influence of biostimulant treatment (A) and pot diameter (B).

<table>
<thead>
<tr>
<th>Treatment (A)</th>
<th>Pot diameter (B)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10.5 cm (B1)</td>
<td>9 cm (B2)</td>
</tr>
<tr>
<td>Above-ground fresh mass (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated substrate (A1)</td>
<td>22.42</td>
<td>10.87</td>
</tr>
<tr>
<td>Treated substrate (A2)</td>
<td>27.76</td>
<td>12.25</td>
</tr>
<tr>
<td>Average</td>
<td>25.09</td>
<td>11.56</td>
</tr>
<tr>
<td>Above-ground dry mass (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated substrate (A1)</td>
<td>3.84</td>
<td>1.85</td>
</tr>
<tr>
<td>Treated substrate (A2)</td>
<td>4.43</td>
<td>2.20</td>
</tr>
<tr>
<td>Average</td>
<td>4.13</td>
<td>2.02</td>
</tr>
</tbody>
</table>

LSD - "least significant difference"

Root fresh mass was under significant influence of pot volume and biostimulant treatment ($P \leq 0.01$). The highest recorded mass weighed averagely 12.95 g/plant in plants treated with biostimulant and grown in bigger pots (A2B1). The lowest mass had control plants in smaller pots with average mass of 6.10 g/plant (A1B2). Biostimulant effect was more efficient in bigger pots where average difference was 4.43 g/plant comparing to 1.27 g/plant in smaller pots but in both cases on the side of biostimulant treatment (Table 2).

Root dry mass was again under the same influences as fresh mass. Same as in fresh mass, the highest recorded dry mass belonged to treated plants in bigger pots (A2B1) and weighed averagely 1.21 g/plant. The lowest mass of averagely 0.69 g/plant belonged to variant A1B2.

Also, biostimulant efficiency was more pronounced in bigger pots where average difference amounted to 0.29 g comparing to 0.04 g in smaller pots. Totally, average difference between treated and untreated plants was 0.17 g which was significantly higher dry mass in treated plants which justified biostimulant application (Table 2).
Table 2. Root fresh and dry mass of scarlet sage under influence of biostimulant treatment (A) and pot diameter (B).

<table>
<thead>
<tr>
<th>Treatment (A)</th>
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<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10.5 cm (B1)</td>
<td>9 cm (B2)</td>
</tr>
<tr>
<td>Root fresh mass (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated substrate (A1)</td>
<td>8.52</td>
<td>6.10</td>
</tr>
<tr>
<td>Treated substrate (A2)</td>
<td>12.95</td>
<td>7.37</td>
</tr>
<tr>
<td>Average</td>
<td>10.73</td>
<td>6.73</td>
</tr>
<tr>
<td>Root dry mass (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated substrate (A1)</td>
<td>0.92</td>
<td>0.69</td>
</tr>
<tr>
<td>Treated substrate (A2)</td>
<td>1.21</td>
<td>0.73</td>
</tr>
<tr>
<td>Average</td>
<td>1.06</td>
<td>0.71</td>
</tr>
</tbody>
</table>

LSD - “least significant difference”

Biostimulants contain amino acids and humic acids which positively affect germination, root growth and above-ground mass growth (Thi Lua and Böhme, 2001). Positive influence of amino acids arginine and proline on growth and development of lateral roots as well as on cotyledons formation in young pea plants was described by Fries (1951). Biostimulant application can positively influence seed germination and vigour of older seeds, as it is proved in maize and soya bean (Vinković et al., 2007), celery, parsley, lettuce and leek (Yıldırım et al., 2007). Also, it can lower the stress symptoms caused by suboptimal temperatures by increasing the yield and it can reduce damages caused by drought, freezing, mechanical and chemical damage as well as in case of virus infection of plant (Maini, 2006) which is also proved in this investigation. Further, in the phase of seed germination, biostimulants can increase seedlings fresh and dry mass of some flower species (Paradiković et al., 2008b). Paradiković et al. (2009) determined, similar to this investigation, that biostimulants significantly affect increasing of above-ground and root fresh and dry mass of Mexican marigold. Moreover, similar results with influence of pot volume and shape on leaves and root growth of Mexican marigold were obtained in investigation by Latimer (1991). Pot size affects vegetable and flower transplants development and later adaptation capability (Scott NeSmith and Duval, 1998). Vujošević et al. (2007d) examined and provided justification of natural biostimulants application and controlled release fertilizers in commercial production of Mexican marigold and scarlet sage transplants. Their application significantly affects fresh mass increase, bud number, flower number and root length. Also, positive effect of biostimulants and controlled release fertilizers on Begonia was confirmed by Zeljković et al. (2009) and Vujošević et al. (2007c).
Conclusion

Application of biostimulants and bigger pot volume showed a positive effect by increasing root and above-ground mass of scarlet sage transplants.

Above-ground fresh mass was higher and up to 96% under the influence of pot volume and up to 24% under the influence of biostimulant. Root fresh mass was 40% higher under the influence of pot volume and up to 52% under the influence of biostimulant treatment. Root dry mass also increased under the influence of pot volume for 33% and 32% under the influence of treatment. Based on these results it can be concluded that biostimulant application and bigger pot volume are considered desirable in this kind of production. In the end, these results were obtained in one-year investigation from which arises a need for further investigation into growth and development as well as vegetation length of scarlet sage after planting it on open field or permanent place in parks under the influence of biostimulant treatment.

References


Influence of biostimulant and substrate volume on root of scarlet sage transplants


UTICAJ BIOSTIMULATORA NA RAST I RAZVOJ KORIJENA RASADA SALVIJE (Salvia splendens L.)

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Rezime
U ovom istraživanju ispitan je uticaj biostimulatora i veličine posuda (saksije) na rast i razvoj korijena rasada salvije (Salvia splendens L.). U ogledu je korišten rasad salvije (Salvia splendens L.) koji je pikiran u dvije različite veličine posuda (saksija) promjera 9 cm i 10,5 cm, a biljke su tretirane sa biostimulatorom u koncentraciji 0,25% ili netretirane (kontrola). Tokom ogleda izvršeno je mjerenje svježe i suhe mase korijena i nadzemnog dijela biljke. Cilj ovog istraživanja je utvrditi može li, u kojoj mjeri i na koju način primjena biostimulatora poboljšati adaptaciju mladih cvjetnih biljaka na abiotski stres nakon presađivanja, odnosno utvrditi uticaj biostimulatora na adaptaciju, rast i razvoj korijena kod rasada salvije (Salvia splendens L.). Rezultati ovog istraživanja s tretmanom biostimulatorom kod salvije ukazuju na pozitivan efekat biostimulatora na adaptaciju i ukorjenjavanje biljaka nakon presađivanja što se može vidjeti iz povećanja mase korijena i nadzemnog dijela. Istraživanje ukazuje da primjena biostimulatora u proizvodnji rasada salvije poboljšava rast i razvoj korijena i nadzemnog dijela što je preduslov brže adaptacije biljaka na stres uslijed presađivanja.

Ključne riječi: salvija, biostimulator, veličina posuda, masa korijena, masa nadzemnog dijela.


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