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INFLUENCE OF ROOTING POWDER ON PROPAGATION OF SAGE (*SALVIA OFFICINALIS* L.) AND ROSEMARY (*ROSMARINUS OFFICINALIS* L.) WITH GREEN CUTTINGS

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Preliminary communication
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SUMMARY

Vegetative propagation of medicinal and aromatic herbs with green cuttings is mainly used because of seed low germination percentage and duration of such reproduction. The aim of this investigation was to determine the effect of commercial rooting powder Rhizopon I on the sage rooting (Salvia officinalis L.) and rosemary (Rosmarinus officinalis L.) green cutting. The investigation was conducted in the greenhouse of the Faculty of Agriculture, University of Banja Luka during April till July of 2012. The experiment consisted of two variants. Cuttings of sage and rosemary were treated with rooting powder or planted directly into the substrate without being previously treated. Morphological properties such as plant height, number of leaves, root length, fresh weight and dry weight of plants were recorded. The treatment with rooting powder resulted in significantly higher values of all morphological parameters tested. Therefore, it is highly recommendable to use it in transplants production thus ensuring the proper rooting of cuttings for earlier transplanting.

Key-words: propagation, Rhizopon, Salvia officinalis L., Rosmarinus officinalis L.

INTRODUCTION

Use of natural medicine is increasing rapidly and medicinal plants are getting more importance each day. By the World Health Organization (WHO), estimate approximately 80% of the world population use traditional medicine for the treatment of various diseases (Farnsworth et al., 1986). The incorporation of fresh herbs into foods has become more and more popular amongst consumers due to their growing expectation of the richness of flavour in everyday meals (Capecka, 2012). Sensory impressions connected with fresh and dried herbs are often different, which results from differences in quality and quantity of specific chemical compounds determining taste and aroma (Jambor and Czosnowska 2001).

The genus *Salvia* (sage) of the family Lamiaceae (Labiatae) comprises of nearly 900 species spread widely throughout the world (Chalchat et al., 1998). The species of *Salvia* took place in the 13th row as one of the richest medicinal plant variety (Davis, 1982; Nakipoglu, 1993). Sage has been known for its medicinal and aromatic properties since ancient times (Rivera et al., 1994). *Salvia officinalis* L. has widespread usage because of its medical purposes as well as a spice in Europe. *Salvia* spp. are either herbaceous or shrubby perennials and are also used as ornamentals or garden plants (Clebsch, 1997). Preparations of the leaves of *Salvia officinalis* L. are commonly used in folk medicine as an effective antiseptic and anti-inflammatory remedy and possess anticancer activity (Bauer et al., 2012).

Rosemary (*Rosmarinus officinalis* L.) is a member of the mint family, Lamiaceae. It has opposite, simple, entire, evergreen leaves that are a shiny green on top and whitish below. The plant begins to bloom in the late spring and continues through the summer. Flowers are usually blue although there are cultivars with pink or white blooms. Rosemary is an evergreen, perennial shrub that is endemic to The Mediterranean region and has been cultivated since ancient times (Simon et al., 1984). The aromatic, resinous leaves are used for

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culinary flavouring while the oil distilled from leaves and flowering shoots is used in pharmaceutical industry and medicine (Hyde Bailey, 1976). The results of the oxidative stability in the investigation of Cordeiro et al. (2013), demonstrated that the extract of *Rosmarinus officinalis* displayed a more effective protective action in the PDSC technique, when compared with the synthetic antioxidant TBHQ indicating that it is a promising source of natural antioxidants for edible vegetable oils. Medicinal and aromatic herbs are characterized by low seed viability and low germination capacity as a result of the lack of seed selection and processing programs (Nicola et al., 2005), although application of some biostimulants can increase seed germination (Parađiković et al., 2008). Therefore, the vegetative propagation is widely preferred rather than propagation by seeds. Cutting is one of the most important means of vegetative plant propagation. Cutting propagation is fast, simple and does not require special techniques and methods use such are used in grafting, budding or micropropagation. Also, one parent plant can provide great number of quality cuttings. Furthermore, each cutting can become a plant with desirable genetic properties same as a parent plant (Hartmann et al., 1997). In Labiatae family, a lot of species had stems able to form roots in cases of contacts with soil or water which enables the propagation with cuttings to be performed (Craker and Simon, 1987). For the successful rooting of cuttings, the quality substrates must be used with good water-air relations as well as good water retaining capacity to minimize the risk of the root zone becoming dry. It was previously recorded that different types of substrates have influence on morphological and physiological properties of flowering plants (Parađiković et al., 2008).

Root promoting compounds such as rooting hormones are used to increase the percentage of cuttings which form roots, reduce the time to root initiation, increase number of roots produced per cutting and to increase uniformity of rooting. Indole-3-butryc acid and 1-naphthalenacetic acid are commonly used in commercial propagation because of their consistency in promoting adventitious root formation on cuttings (Boyer and Graves, 2009).

The aim of this study was to determine the influence of rooting powder on the root length, fresh and dry weight of *Salvia officinalis* L. and *Rosmarinus officinalis* L. cuttings.

MATERIAL AND METHODS

The investigation was carried out in a greenhouse at the Department of Horticulture, Faculty of Agriculture, University of Banja Luka in Bosnia and Herzegovina during the period from April till July of 2012.

Plant cuttings of sage (*Salvia officinalis* L.) and rosemary (*Rosmarinus officinalis* L.) were used as a material (Figure 1 and 2). The experiment was set out for each species according to split plot scheme and consisted of two variants with 3 repetitions where each repetition had 10 plants. Softwood terminal cuttings of each species were harvested and pruned to a 6-7 cm length. About two third of the leaf surface of each cutting were removed to limit the transpiration.

Figure 1. Rosmary cutting (Photo: Dervić, I., 2012)
Slika 1. Reznica ružmarina (foto: Dervić, I., 2012.)

Figure 2. Sage cutting (Pfoto: Marić, M., 2012)
Slika 2. Reznica kadulje (foto: Marić, M., 2012.)

Afterwards, plant cuttings were treated with the rooting powder Rhizopon I® containing rooting powder auxin IBA (indol-butyric acid 0,5%) (variant A2) and planted in substrate or cuttings were planted in substrate without being treated with rooting powder (variant A1). Plants were planted at the beginning of April in 9 cm diameter plastic pots filled with commercial substrate Fruhstorfer Erde - Aussaat und Stecklingserde (Hawita EU, Deutschland). Plants were irrigated regularly by hand depending on weather conditions and development stage of plants. The average daily air temperature during rooting period of the investigated plants ranged from

15.7 to 28.3°C, while relative humidity ranged from 42 to 62%. After 14 weeks plants were taken out of the pots. Roots of each plant were cleaned and washed with distilled water and dried with paper towels. During this stage, root length, rooting percentage, plant fresh weight, plant height and number of leaves were recorded. Plant dry weight was recorded after plants were being dried at 70°C during 48 h to a constant weight.

Analysis of variance was carried out and differences between treatments were judged by the Fisher LSD test ($p<0.05$; $p<0.01$) using SAS 9.0 statistical package.

RESULTS AND DISCUSSION

Number of leaves was recorded only on sage (*Salvia officinalis* L.) because its leaves are true leaves, while rosemary (*Rosmarinus officinalis* L.) has needles. Number of leaves was under significant influence of rooting powder treatment ($P\leq0.05$). The highest average number of leaves was 8.34 recorded on treated plants (A2), whereas significantly lower number of leaves 6.59 was recorded on the control plants (A1) (Table 1).

Table 1. Average values of investigated parameters of *Salvia officinalis* L. under the influence of rooting powder treatment

Tablica 1. Prosječne vrijednosti ispitivanih svojstava Salvia officinalis L. pod utjecajem hormona za ožiljavanje

Treatment variant *Varijanta* (A)	Number of leaves *Broj listova*	Plant height *Visina biljke* (cm)	Root length *Dužina korijena* (cm)	Plant fresh weight *Svježa masa biljke* (g)	Plant dry weight *Suha masa biljke* (g)
Control (A1)	6.59	5.81	14.37	0.85	0.37
Treatment (A2)	8.34	9.80	16.03	2.17	0.55
Average	7.46	7.81	15.20	1.51	0.46
LSD 0.05	1.4856	0.8437	1.6553	0.7240	0.0873
LSD 0.01	Ns	1.3993	ns	1.2007	0.1448
Standard error	0.3784	0.2149	0.4216	0.1844	0.0222

ns =*not significant*

Plant height of sage and rosemary ($P\leq0.01$; $P\leq0.05$) was under significant influence of rooting powder treatment (Table 1 and 2). The highest average plant height on both species was recorded in the treated plants (A2). Average plant height of control plants of sage was 60% lower compared to treated plants height. Further, the highest average height of rosemary was 7.79 cm recorded on treated plants and was significantly higher compared to the control plants where average recorded height was 6.35 cm. Root length of the both investigated species was also under significant influence of rooting powder treatment ($P\leq0.05$).

Figure 3. Development of treated with hormone (RA2) and untreated (RK2) cuttings of *R. officinalis* (Photo: Marić, M., 2012)

Slika 3. Razvoj tretiranih renica (RA2) R. officinalis s hormonom i netretiranih (RK2) (Foto: Marić, M., 2012.)

Figure 4. Root development of treated with hormone (ŽA2) and untreated (ŽK2) cuttings of *S. officinalis* (Photo: Dervić, I., 2012)

Slika 4. Usporedba razvijenosti korijena tretiranih renica (ŽA2) S. officinalis s hormonom i netretiranih (ŽK2) (*Foto: Dervić, I., 2012.)*

The highest average root length recorded on sage was 16.03 cm and 10.23 cm on rosemary compared to significantly lower average values of 14.37 cm and 8.60 cm in the control plants, respectively (Figure 3 and 4). Kumar and Arumugam (1980) reported that dipping terminal cuttings of rosemary in 5000 ppm NAA solution gave the highest percentage of rooted cuttings, the highest number of roots per cutting and the longest roots. In the study of Ayanoğlu and Özkan (2000), three different treatments, 100 ppm, 200 ppm IBA application and no IBA application (control) were used on *S. officinalis* L. cuttings and on the 15 th and 30th days their rooting ability was investigated. The 100 ppm IBA treatment had the highest rooting ratio (78.75%), number of roots (22.35) and the longest roots (10.66 cm).

Fresh and dry weights of sage plant were under significant influence of rooting powder treatment ($P \leq 0.01$). The highest average fresh weight of plant of 2.17 g was recorded in the treated plants, whereas significantly lower fresh weight of plant was recorded in the control plants (0.85 g). The highest average weight of dry plants 0.55 g was also recorded in the treated plants compared to significantly lower dry weight of the control plants (0.37 g) (Table 1).

The weight of fresh rosemary plants was under significant influence of the rooting powder treatment ($P \leq 0.05$). The treatment resulted in significantly higher plant fresh weight (1.51 g) compared to untreated plants (1.24 g) (Table 2). Plant dry weight of rosemary was not significantly influenced by rooting powder treatment (Table 2).

Table 2. Average values of investigated parameters of *Rosmarinus officinalis* L. under the influence of rooting powder treatment

Tablica 2. Prosječne vrijednosti ispitivanih svojstava Rosmarinus officinalis L. pod utjecajem hormona za ožiljavanje

Treatment variant *Varijanta (A)*	Plant height *Visina biljke (cm)*	Root length *Dužina korijena (cm)*	Fresh weight of plant *Svježa masa biljke (g)*	Dry weight of plant *Suha masa biljke (g)*
Control (A1)	6.35	8.60	1.24	0.68
Treatment (A2)	7.79	10.23	1.51	0.75
Average	7.07	9.42	1.37	0.71
LSD 0,05	0.9439	1.2955	0.1980	Ns
LSD 0,01	Ns	ns	ns	Ns
Standard error	0.2404	0.3300	0.0504	0.0409

ns =*not significant*

Rooting percentage of sage was 100% and for rosemary 93% with application of rooting powder *Rhizopon I* containing rooting powder auxin IBA. Kuris et al. (1980) in their research reported that approximately 100% of cuttings from all 3 species rooted but the number of roots per cutting varied as follows: oregano > balm > peppermint. Treatment of the cuttings with IBA (500-4000 mg/litre), IAA (500-2000 mg/litre) and Hormex (1% IBA) increased both the number of roots/cutting and the rate of root formation in all 3 species. The rooting capabilities of the cuttings of Karabaş Lavender which were gathered from different locations, one on the coast

of Mediterranean and the other one near Antakya, were investigated by Ayanoğlu et al. (2000). The cuttings were treated by 1000, 2000 and 4000 ppm IBA doses and the cuttings with no IBA treatment were used as a control. The hormone doses positively affected the rooting of cuttings gathered from both places, and the rooting ratios, the length of roots and the number of roots per cutting increased with the hormone doses. The highest rooting ratio (70%) was obtained from the cuttings gathered from IşİKlİ, treated with 4000 ppm IBA dose.

In the research of Iapichino et al. (2006) the vegetative propagation of *T. capitatus*, *T. serpyllum* and *T. vulgaris* was investigated. To verify the rooting response to exogenous application of auxin, softwood cuttings were either treated with a 500 ppm 1H-indol-3-butyric acid (IBA) solution, or not treated (control). The study demonstrated that exogenous application of IBA generally improves rooting in *Thymus* species. *T. capitatus* grown in pot showed a long and abundant flowering period comparable to that of other *Thymus* species already exploited as pot plants. Nicola et al. (2005) determined that the use of rooting products had a positive effect on root system development, both in terms of root number and root length. Moreover, usage of rooting products has been reported as necessary to guarantee the rooting of cuttings for earlier transplanting (Kaçar et al., 2009).

CONCLUSION

Application of rooting powder containing hormone auxin IBA positively affected on sage and rosemary cuttings growth and development. Thus, treated plants had significantly higher values of each parameter investigated compared to untreated plants. The average number of sage leaves was higher by 26.55% compared to the control plants. The average plant height was higher by 68.67% for sage and 22.68% for rosemary in the treated plants compared to the control plants, respectively. Also, significantly higher root length was recorded in the treated plants of both species with relatively increased values up to 11.55% for sage and 18.95% for rosemary. Fresh and dry weight of sage plant increased by 155.28% and 48.65%, respectively. Finally, fresh and dry weight of rosemary plants increased under the influence of rooting powder by 21.74% and 10.29%, respectively. It can be concluded that application of commercial rooting agents (*Rhizopon I*) positively affects the growth and development of sage and rosemary cuttings. Therefore, it is highly recommended to use it in transplants production of non-edible plants thus ensuring the proper rooting of cuttings for earlier transplanting. It should be noted that further research should be extended with more experimental plants as well as several IBA concentrations.

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UTJECAJ SREDSTVA ZA UKORJENJAVANJE NA RAZMNOŽAVANJE KADULJE (SALVIA OFFICINALIS L.) I RUŽMARINA (ROSMARINUS OFFICINALIS L.) ZELENIM REZNICAMA

SAŽETAK

Vegetativno razmnožavanje ljekovitoga i aromatičnoga bilja provodi se onda kada je postotak klijavosti sjemena nizak te zbog skraćivanja postupka dobivanja presadnica. Cilj je ovog istraživanja utvrditi utjecaj komercijalnoga sredstva za ukorjenjivanje Rhizopon I na ukorjenjivanje zelenih reznica kadulje (Salvia officinalis L.) i ružmarina (Rosmarinus officinalis L.). Istraživanje je provedeno u periodu od travanja do srpanja 2012. na Agronomskome fakultetu Sveučilišta u Banja Luci. Pokus se sastajao od dvije varijante. Reznice kadulje i ružmarina tretirane su sredstvom za ukorjenjivanje ili direktno posađene u supstrat bez prethodnoga tretiranja. Tijekom istraživanja zabilježeni su sljedeći parametri: visina biljke, broj listova, dužina korijena, svježa masa biljaka i suha masa biljaka. Statističkom analizom podataka utvrđeno je da su biljke tretirane hormonom Rhizopon I imale statistički značajno veće vrijednosti svih istraživanih parametara. Stoga, preporučljivo ga je koristiti prilikom vegetativnoga razmnožavanja reznicama te tako osigurati pravilno ukorjenjivanje reznica za ranije presađivanje.

Ključne riječi: razmnožavanje, Rhizopon, Salvia officinalis L., Rosmarinus officinalis L.

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