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EFFECT OF THE CUTTING LENGTH AND PROPAGATION PERIOD ON THREE *THUJA OCCIDENTALIS* VARIETIES

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Abstract
Thuja occidentalis L. is originated from Eastern North America and it is cultivated in Europe as an ornamental tree. Thuja can be multiplicated generatively and vegetatively, however nurseries are propagating them by vegetative method because in this way the plants inherit the genetics from the mother plants. Furthermore, it is a faster method. Tree highly used Thuja occidentalis varieties: `Europa Gold` (TOE), `Smaragd` (TOS), and `Danica` (TOD) were selected for the research and were subjected to two different propagation periods (May and July). There were selected 5–10 cm, 10–20 cm, and 20–25 cm length stem cuttings. Our data showed different results at the selected varieties: at TOE, the 20–25 cm length cuttings reported a higher rooting at the July propagation period; at TOS were determined that the 10–20 cm cuttings and the May propagation period obtained the highest rooting percentage; in the case of the TOD an increase in rooting percentage was observed at the cuttings propagated in May, moreover the 5–10 cm length. It can be concluded that propagation time and stem cutting length could be an important factor, however is a variety-dependent process.

Keywords: propagation period, rooting percentage, varieties, vegetative propagation.

1. INTRODUCTION

Ornamental trees are used worldwide in the landscaping design, they can be found in private gardens, parks. Human made habitats are highly important hotspots of biodiversity (Čeplová et al 2017). Additionally, the use of trees and shrubs in cities are a major fact to reduce the environmental pollution (Abd El Aziz et al., 2015). Some of the used ornamental trees (deciduous trees), in the Autumn are leaving an undesirable waste after shedding on sidewalks and benches in city parks (Pňakovič and Dzurenda, 2015). Because of these facts, more and more landscapers and consumers demand are to plant evergreen trees, which are no making further mess. For this reason, nurseries and horticulturist are in need to propagate the evergreen trees with quicker method. The nurseries are trying to reduce the necessary propagation material quantity, because in this way they can produce a greater number of new plants. Most of them are propagated vegetatively by cuttings, because this is a quicker method, furthermore the plant retains the characteristics and genetics of the mother plants (Brown and Sommer, 1982; Stuepp et al., 2018).
The *Thuja* genus includes 60 species according to The Plant List, 2022. *Thuja occidentalis* L., commonly known as white cedar, belongs to the order *Pineales*, in the *Cupressaceaei* family (Silva

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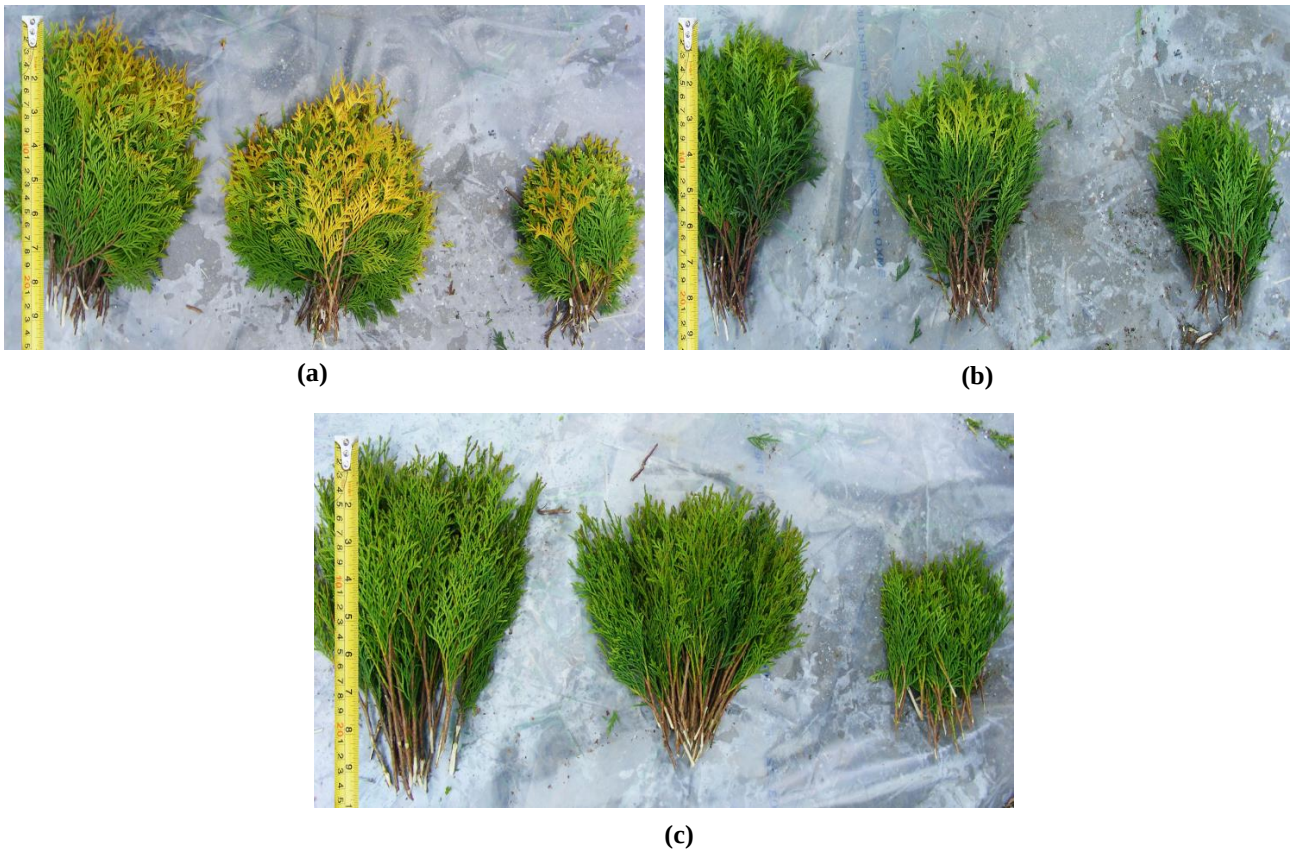
et al., 2017). Is is an evergreen tree growing between 3 and 60 m, originated from Eastern North America and East Asia (Caruntu et al., 2020), and it is cultivated in Europe as an ornamental tree. We aimed to determine if the stem cutting length and propagation period could have effect on the vegetative propagation of Thuja occidentalis L. varieties

2. MATERIALS AND METHODS

The study was conducted in the experimental greenhouse belonging to Sapientia Hungarian University of Transylvania of Târgu Mureș (46°31′17″ N 24°35′54″ E). The cuttings were obtained from a local nursery (Biota, Găiești village, Romania). The cuttings were immediately transported to the experimental sites to prevent desiccation. As plant material we have selected three varieties of *Thuja occidentalis*:

- *Thuja occidentalis* `Europe Gold` (TOE): slow-growing, evergreen small tree or large shrub, narrowly conical in habit, with scaly golden yellow foliage (Figure 1a);
- *Thuja occidentalis* `Smaragd` (TOS): an evergreen conifer making a slow-growing conical shrub with erect sprays of bright green foliage (Figure 1b);
- *Thuja occidentalis* `Danica` (TOD): slow-growing, evergreen, dwarf coniferous shrub forming a dense, globose bush of bright green upright sprays of foliage (Figure 1c).



(a) **(b)** **(c)**

Figure 1. Thuja occidentalis 'Repandes'– (Europe Gold), Thuja occidentalis 'Smaragd'– (b), and Thuja occidentalis 'Danica'– (c) cutting preparation.

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The first experiment started on 20 May, and the second on 6 July, with the same *Thuja* varieties. For each variety 30 sub-apical shoots (herbaceous spring and semi-hardwood summer cuttings) were used per replication, with three replications, so in total of 540 plants. Disease and pest-free propagation material was collected with a secateur from the nursery, with length of 5–10, 10–20, and 20–25 cm. The leaves on the lower one-third to one-half of the stems were removed. The cuttings were immersed in 0.8% of 1–Naphthaleneacetic acid (NAA) rooting hormone. After the rooting hormone was applied, the cuttings were planted in 50 × 40 cm plastic trays filled with perlite rooting medium. Planting distance was 3 cm between the cuttings. We had filled the plastic tray with perlite to a depth of 20 cm (granulation: 1–3 mm, density: 0.05 kg/L, and pH: 7–7.5) and this was well irrigated before planting the cuttings; no artificial lights were used. Propagation trays were placed in the greenhouse with an automatic humidifier controller in order to provide the 80–90% humidity required for rooting. Humidity and temperature were measured using a Testo 175H1; the average temperature was between 22–28 °C.

Rooting percentage (the percentage of cuttings that developed at least one root), root volume (cm^3—a measuring cylinder was filled with water, the plant was submerged in it and under the pressure of the cutting water, filled out), number of roots, root length (cm). Root length was measured with a tape measure.

Data were analzed using Past 4 statistical software (Oslo, Norway). Data were tested for normality of errors and homogeneity of variance. All data were normally distributed. The significance of the differences between the treatments was tested by applying ANOVA, at a confidence level of 95%. When the ANOVA null hypothesis was rejected, Tukey's post hoc test was carried out to establish the statistically significant differences at $p < 0.05$.

3. RESULTS AND DISCUSSIONS

According to the results, the propagation period influenced the rooting percentage of the *Thuja* varieties, however not in all every case. At TOE (Figure 2a) in the July propagation period can be clearly observed that the 20–25 cm length cuttings rooting percentage was highly increased compared to the other two. Furthermore, at TOS (Figure 2b) small decreases were determined at 5–10 cm cuttings. In the case of the TOD (Figure 2c) variety, significant differences were observed just at the cuttings propagated in July; at 20–25 cm cuttings decrease in rooting percentage was reported. On the other hand, the propagation period also reported some significant differences. The 5–10 and 10–20 cm cuttings propagated in July at TOE (Figure 2a) significantly decrease compared to the May propagation period. Interestingly, at TOS (Figure 2b) no differences were observed. Moreover, in the case of TOD (Figure 2c), high increases were determined when comparing the two propagation periods. In a previous study is mentioned that *Thuja* rooting percentage can be also increased by different rooting hormones uses, the authors concluded that the growth biostimulators could increase the adventitious root formation 3–4 weeks earlier (Lopachev et al., 2021). Furthermore, in a study is also mentioned that the rooting medium can have a beneficial influence on the root formation of *Juniperus* (Kentelky, 2011) and *Thuja* (Szász-Len et al., 2015a).

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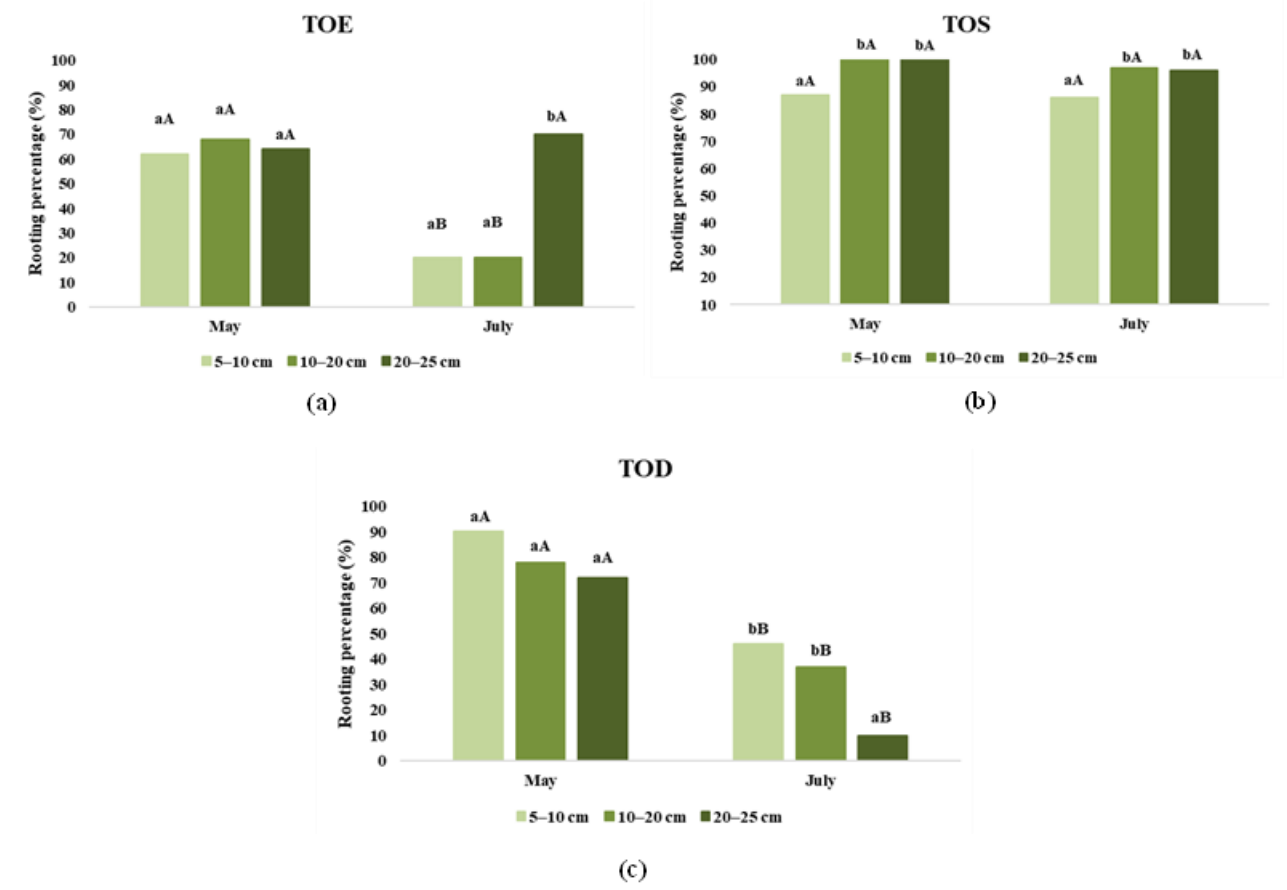

Figure 2. Effect of stem cutting length and propagation period on rooting percentage of the selected Thuja occidentalis varieties 'Europe Gold' (TOE)–(a), 'Smaragd' (TOS)–(b), and 'Danica' (TOD)–(c). Bars represent the means ± SE (n = 30). Different lowercase letters above the bars indicate significant differences between the length of the stem cutting, and different uppercase letters indicate the significant differences between the May and July propagation period, according to Tukey's test ($p < 0.05$).

Considering the number of roots, could be concluded that the increment was similar to the rooting percentage of the varieties (Figure 3). Significant differences between the cutting lengths at TOE (Figure 3a) were only observed at the cutting propagated in July, when root number increase at 20–25 cm. At TOS (Figure 3b) significant differences were similarly recorded at the July propagation period. In this case the greatest root number was reported at 20–25 cm cuttings, followed by the 10–10–20 cm and by the 5–10 cm. No significant differences were determined at TOD (Figure 3c). When comparing the propagation period, from the result could be determined that at TOE (Figure 3a) the 5–10 and 10–20 cm cuttings propagated in July were significantly decreased compared to the May propagation. At TOS (Figure 3b) only at 20–25 cm stem cuttings were observed significant changes, interestingly the July propagated cuttings root number increased compared to the May. Root number decreased at the TOD (Figure 3c) cuttings propagated in July compared to May propagation period. Szász-Len et al. (2015b) reported that 15 cm cuttings obtained the highest root number at *Thuja occidentalis* 'Columna'. Hormone treatments could also greatly increase the number of adventitious root formation (Panea and Blada, 2016).

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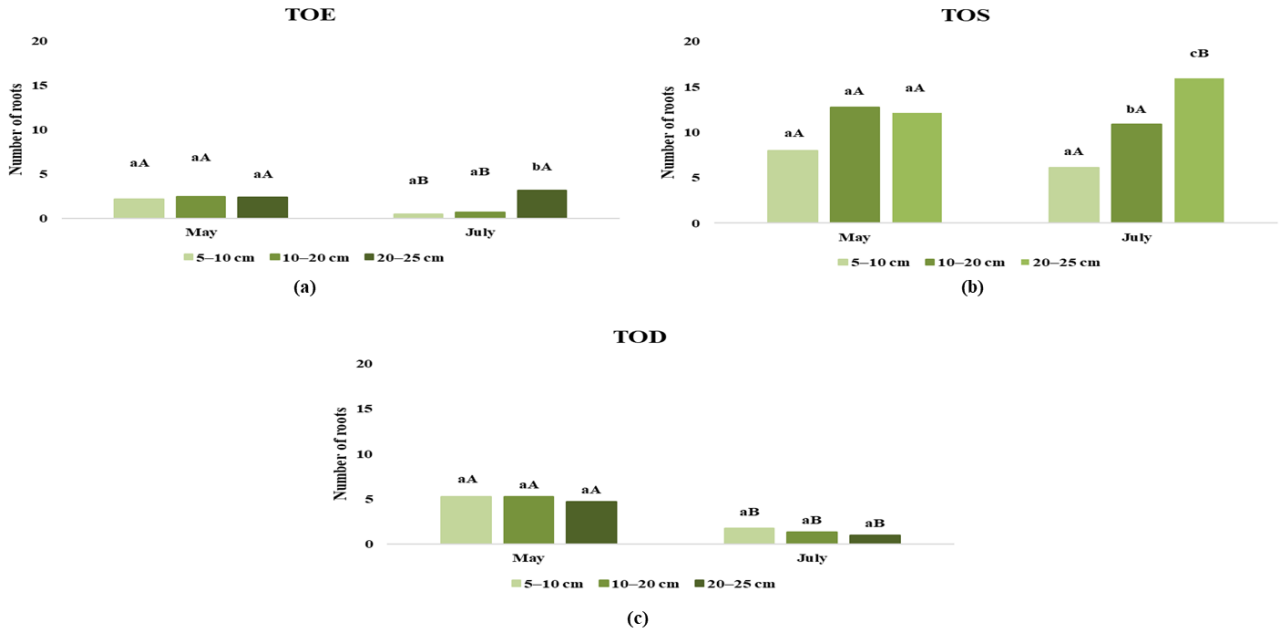

Figure 3. Effect of stem cutting length and propagation period on number of roots of the selected Thuja occidentalis varieties 'Europe Gold' (TOE)–(a), 'Smaragd' (TOS)–(b), and 'Danica' (TOD)–(c). Bars represent the means ± SE (n = 30). Different lowercase letters above the bars indicate significant differences between the length of the stem cutting, and different uppercase letters indicate the significant differences between the May and July propagation period, according to Tukey's test ($p < 0.05$).

Under our experimental conditions, root length was significantly different when comparing the two propagation periods (Figure 4). Furthermore, the stem cuttings length increased at 20–25 cm cuttings at the TOE variety (Figure 4a), concerning the July propagation period. At TOS (Figure 4b) root length was significantly improved using the 10–20 and 20–25 cm cuttings. Considering the TOD variety (Figure 4c), no significant differences were reported. Root length and number could be also influenced by the propagation period and the added hormones (Badawy et al., 2020). In our case at TOE and TOD a greater root length was determined in the May propagation period, nevertheless, at TOS only at the 20–25 cm cuttings were observed these changes.

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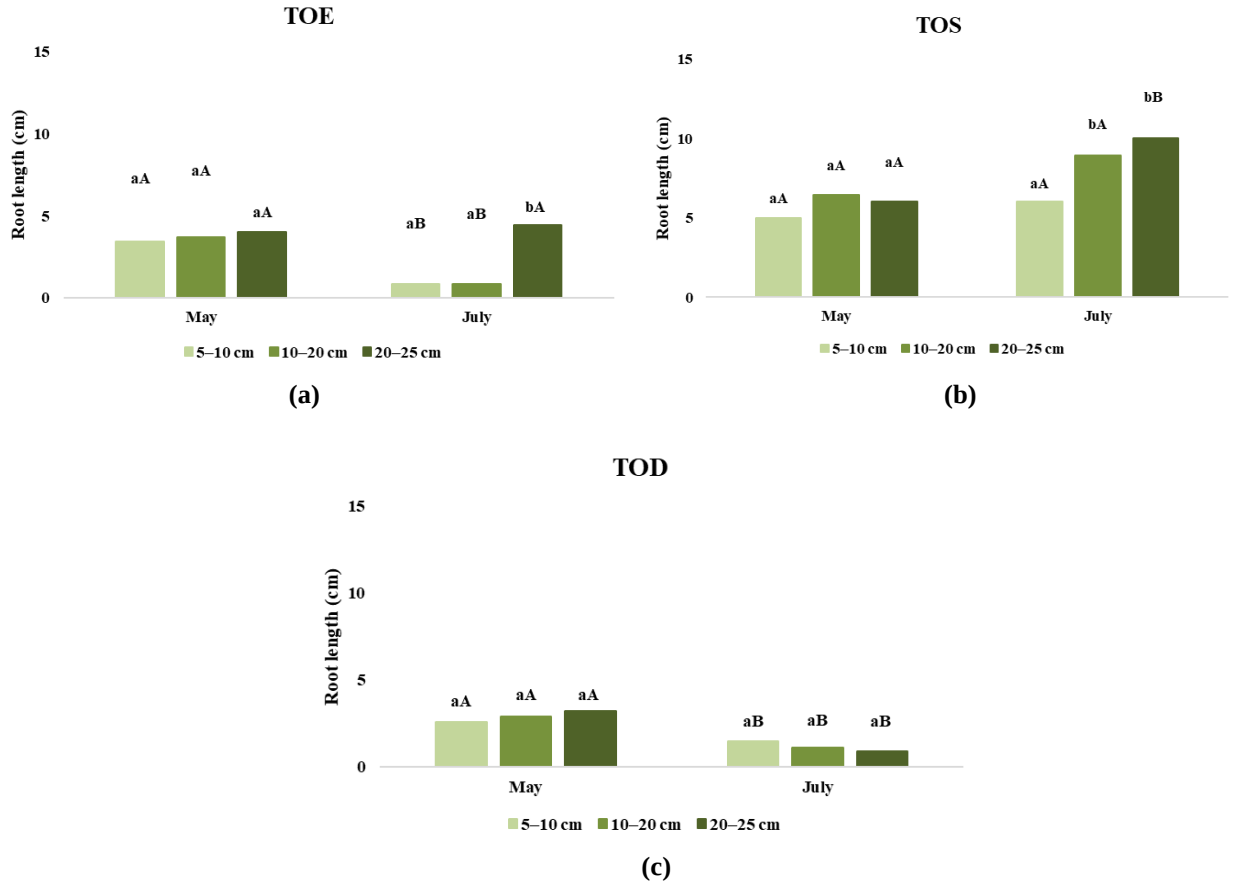

Figure 4. Effect of stem cutting length and propagation period on root length of the selected Thuja occidentalis varieties 'Europe Gold' (TOE)–(a), 'Smaragd' (TOS)–(b), and 'Danica' (TOD)–(c). Bars represent the means ± SE (n = 30). Different lowercase letters above the bars indicate significant differences between the length of the stem cutting, and different uppercase letters indicate the significant differences between the May and July propagation period, according to Tukey's test ($p < 0.05$).

Significant decreases were observed considering TOE (Figure 5a) when comparing the 5–10 and 10–20 cm and the 20–25 cm cuttings at the July propagation periods. In the case of TOS (Figure 5b), 5–10 cm root volume decreased in both propagation periods. However, in the case of TOD (Figure 5c) no significant differences were reported between the stem cuttings length. Furthermore, May propagation period increased the root volume of the cuttings compared to the July, at TOE. No significant differences were determined at TOS, and in the case of TOD could be concluded that the propagation periods affected greatly the root volume of the cuttings; the July cuttings root volume was significantly decreased compared to the May.

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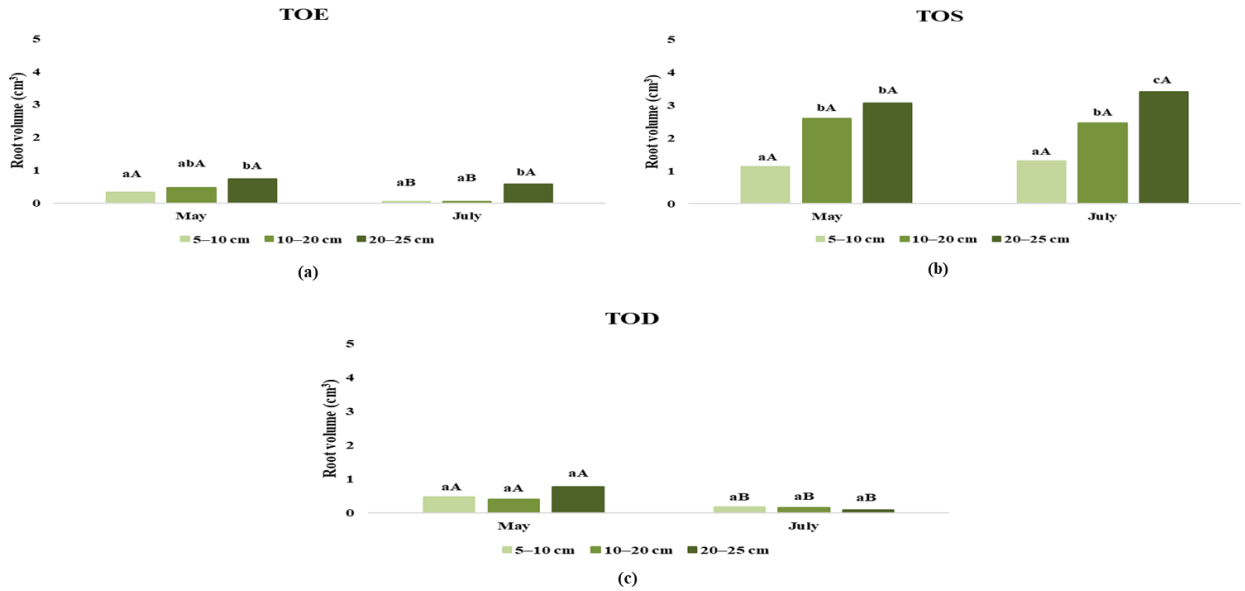

Figure 5. Effect of stem cutting length and propagation period on root volume of the selected Thuja occidentalis varieties 'Europe Gold' (TOE)–(a), 'Smaragd' (TOS)–(b), and 'Danica' (TOD)–(c). Bars represent the means ± SE (n = 30). Different lowercase letters above the bars indicate significant differences between the length of the stem cutting, and different uppercase letters indicate the significant differences between the May and July propagation period, according to Tukey's test (p < 0.05).

4. CONCLUSIONS

From the results could be concluded that the length of the stem cutting is not affecting significantly the rooting of the selected *Thuja* varieties, at the May propagation period. However, in some cases at the July propagation period were observed significant differences, caused by the length of the stem cutting. When comparing the two propagation periods, could be concluded that the May propagation period significantly increased the adventitious roots formation. It is important to mention that the adventitious root formation could be also a variety-dependent process, because the different varieties were affected differently.

5. ACKNOWLEDGEMENTS

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