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Research Article

EFFECTS OF CUTTING TIMES AND DOSES OF SOME AUXINS ON ROOTING OF THE HAIRY BROOM CUTTINGS [*Chamaecytisus hirsutus* (L.) LINK]

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ABSTRACT. In addition to developing ornamental plants, the world has focused on determining and promoting new genera and species that are not being produced. *Chamaecytisus hirsutus* is a deciduous shrub like this with high ornamental potential. The aim of this research was to determine the effects of different cutting excision times and different dose applications of some auxins on the rooting of *Chamaecytisus hirsutus* which is found naturally in the flora of the Mediterranean climate zone. Cuttings were taken in October, November, February, March, and April and were treated with 0.1%, 0.2%, 0.3%, 0.4% IBA or NAA solutions for 5 seconds. The results showed that the application of 0.1% (8.00), 0.2% (9.06), 0.3% (7.56), and 0.4% (8.39) NAA and 0.3% (6.89) IBA doses in April gave the best rooting rate. For the propagation of *Chamaecytisus hirsutus*, we recommend treating the cuttings with 0.1% NAA concentration to produce large amounts of planting materials economically for using less auxin levels.

Keywords: *Chamaecytisus hirsutus, cutting, IBA, NAA, propagation, timing, rooting*

INTRODUCTION

The diversity of native plant species plays a considerable role in rural and urban landscape planning [1]. Natural plants are very important and economic alternatives for landscaping, protection, and stabilization studies due to these features. When natural plants are used in landscaping and vegetation studies, they both render the studies efficient in terms of aesthetics and function and ensure a healthy eco-system by means of adapting to the natural surroundings and the surrounding flora, thereby increasing the success of the studies [2]. Increases in heat caused by global warming, which is one of the important effects in many geographies, increase the demand for drought-tolerant plants in the Mediterranean flora. Therefore, the usage of Mediterranean plants, their production, and cultivation need to be prioritized [3]. Cultivating natural genera should initially start by determining propagation methods [4]. According to Erwin [5], the initial work to be done regarding plants to be commercialized as ornamental plants are to collect data regarding the vegetative development of the plant and to work on their production.

Generative propagation techniques should be preferred in order to ensure tolerance of natural conditions and a natural adaptation to the conditions in which the material is found. However, the methods preferred for the reproduction of species produced commercially are vegetative propagation methods. Therefore, it is imperative to understand vegetative propagation as well as the generative propagation of every material to be presented to the ornamental plants producers, to encourage them to adopt these species [4]. Rooting of cuttings is the best efficient model of vegetative propagation and necessities for maintain and cultivation of wild threatened plant genetic resources [6].

Chamaecytisus hirsutus is a perennial, semi woody plant with yellow flowers (Fig. 1). It is 20-100 cm high and slightly wild; slowly and vertically grown shrub. *C. hirsutus* blooms in April to June. Naturally grows in the Aegean, Mediterranean, Marmara, and Western Black Sea Regions, ranging between 10 and 2000 m in altitude and is one out of ten *Chamaecytisus* species in the flora of Turkey [7, 8]. It is native to; Albania, Austria, Belgium, Bulgaria, Czech Republic, France, Greece, Hungary, Italy, Poland, Romania, Switzerland, Turkey and former Yugoslavia [10,11].

Chamaecytisus species which have high ornamental plant potential are also used as provender in some mediterranean countries . *C. hirsutus* can also be generatively produced, but germination rate ranges between 12.50-59.00 % [9]. These ratios are not sufficient for commercial production. For a higher rate and faster production of this species has to be produced vegetatively. It is clear that there is limited information about the propagation of *C. hirsutus* by cutting, effect of different cutting excision times, different auxins with different doses.

In this study, it is aimed to determine the effect of different cutting excision times and different dose applications of auxins on the rooting of cuttings the natural plant species *Chamaecytisus hirsutus* in line with the principles to ensure sustainable usage of natural genera in flora of the southern Europe and to convert natural resources into economic values.

MATERIALS AND METHODS

Cuttings taken from natural populations of *Chamaecytisus hirsutus* in Uludağ–Bursa as a material of this research. The map with the studied populations was given in Fig.2. The research was conducted in Atatürk Horticultural Central Research Institute' research field

Fig. 1. *Chamaecytisus hirsutus* (L.) Link

Fig. 2. *The natural population maps of* ***C. hirsutus*** *cuttings collected*

Rooting trials of cuttings excised in September, October, November, February, March, and April in the years of 2008-2009 and 2009-2010. The trials were conducted two factors (time and auxin applications) and 3 replicates, each replicate had 50 cuttings. Four doses (0.1%, 0.2%, 0.3% and 0.4%) of indole-3-butyric acid (IBA) and naphthalene acetic acid (NAA) were compared with control applications for rooting. The cuttings were collected from wild plants, grown in natural conditions at different ages in Bursa province. Cuttings were prepared as semi woody cuttings that were 18-20 cm long. 1-2 leaves were left on top of each cutting (Fig. 3a) and left in perlite as the rooting medium (Fig. 3c). The temperature was adjusted to 20±1 °C during the trials. Air humidification was ensured automatic fogging system adjusted with 10 seconds of mist which was sprayed every 30 minutes.

After the cuttings were prepared, they were soaked in 0.5% Captan solution for 30 minutes, left to dry for 5 minutes, and then treated with auxin applications for 5 seconds (Fig. 3b). Auxin solution was prepared 50% alcohol and 50% distilled water. NAA and IBA applications were applied as dipping to liquid solution onto cuttings that were planted on the 10th to 15th day of each month. The rooting of cuttings was evaluated 8 weeks after they were planted, and the cuttings that had developed at least one root were considered to be rooted (Fig. 3d). The rooting trays were alternately treated with 0.25% Captan and 0.1% Benomyl every 15 days [12].

Fig. 3. *The images of* ***C. hirsutus*** *reproductions works with cuttings*
a-cuttings, b-auxin treatments, c-rooting medium and fogging system, d-rooted cuttings

The means of two years observations or measurements were used for statistical analysis. The percentage values were analyzed after transformed arcsine square root transformation. The data were analyzed using analyzis of variance (ANOVA) according to the randomized complete block design. Least Significant Differences test (LSD) was used for multiple comparison analyzes, at 95% reliability limit (α=0.05). All statistical analyzes were conducted in the JMP 7.0 (SAS Institute Inc.) package statistic programme [13,14].

RESULTS AND DISCUSSION

The variance analysis shows that the time of cutting excision and auxin applications affected the rooting of the cuttings of the *C. hirsutus* plant. The interactions between the cutting time and applications were found to be insignificant.

In this study, the best rooting rate of *C. hirsutus* cuttings rooting was obtained in April. The rooting rate in April was 15.4% on average. September, October, November, February and March months had the same effect for *C. hirsutus* cuttings rooting and they were statistically in the same group. Considering the effect of time on rooting, while the rooting percentages were low in time applications conducted in September, October, November, and February, they started to increase in March. The rooting rate reached a peak point in April (Table 1, Fig. 4). These results showed that *C. hirsutus* cuttings had higher rooting potential in spring than autumn and winter. Giatromanolaki et al. [15] and Zencirkıran and Erken [16] reported contrast findings that, autumn (November) is the best time for the rooting of *Staehelına petiolata and Platanus orientalis* cuttings and than in April which none of the cuttings rooted. The same results of our findings were reported by Alsup et al. [17] and Nhung et al. [18]. Alsup et al**.** [17] found that rooting percentage was greatest in May (1999) and April (2000), of *Acer saccharum* cuttings. Nhung et al. [18] found that rooting percentage was higher in spring and autumn than summer and winter, best time for root length is the spring season for *Dalbergia tonkinensis* cuttings. Our findings can be explained that imparted knowledge by Mascarello et al. [19], In spring, during anthesis, the plant showed the highest rooting performance when the floral buds were excised and the presence of flowers strongly inhibited the rooting process. According to Enders and Strader [20], all of these results should be considered normally as they reported that endogenous auxin content of different species may vary at different times.

Table 1. *Effect of different time on the rooting of C. hirsutus (%)*

Time	Mean Rooting
	M ± se*
September	4.10 ± 0.23 b**
October	3.37 ± 0.23 b
November	4.57 ± 0.24 b
February	4.33 ± 0.23 b
March	8.10 ± 0.23 b
April	15.40 ± 0.23 a

*The means (M) ± standard error of 3 replicates (SE)
**within a column followed by the same letter are not significantly different by LSD multiple range test at p ≤ 0.05 (CV = 0.17)

According to our results 0.2%, 0.4%, 0.1%, 0.3% NAA and 0.3% IBA applications effected the rate of rooted cuttings and values are 9.06%, 8.39%, 8.00%, 7.56%, 6.89% respectively. All of NAA and 0.3% IBA doses were in the same group and had the rooting rate better than control. These applications were statistically different from others and had the best results (Table 2, Fig. 5) whereas IBA applications and doses were in the second and third groups exception of 0.3% IBA application. These findings shows that; all doses of NAA aplications are more efficient than IBA for rooting of *C. hirsutus* cuttings, during the 8 weeks of rooting time. IBA concentrations were not statistically important than control group (Table 2).

Table 2. *Effect of different auxins applications on the rooting of C. hirsutus (%)*

Concentration of Auxin and Doses	Mean Rooting M ± se*	
0.1% IBA	3.94 ± 0.13	d**
0.2% IBA	5.83 ± 0.13	bcd
0.3% IBA	6.89 ± 0.13	abc
0.4% IBA	6.67 ± 0.14	bcd
0.1% NAA	8.00 ± 0.14	ab
0.2% NAA	9.06 ± 0.13	a
0.3% NAA	7.56 ± 0.13	ab
0.4% NAA	8.39 ± 0.13	ab
Control	5.06 ± 0.14	cd

*The means (M) ± standard error of 3 replicates (SE)
**within a column followed by the same letter are not significantly different by LSD multiple range test at $p \leq 0.01$ (CV = 0.17)

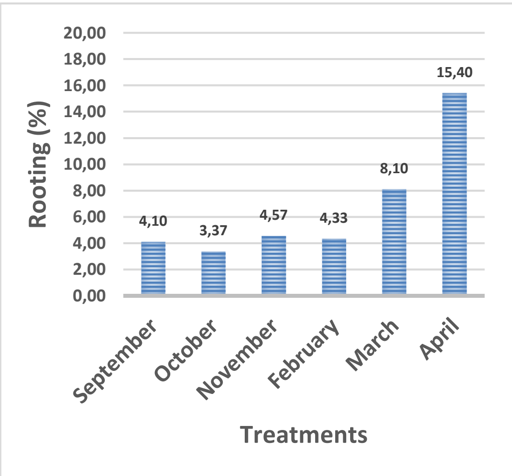

Fig. 4. *Effects of different cutting time on rooting of the C. hirsutus (%)*

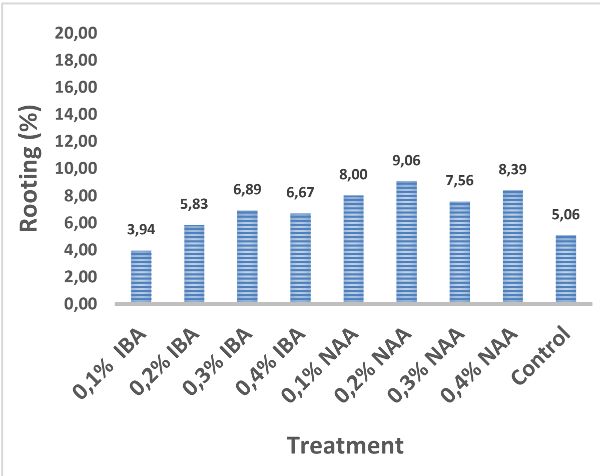

Fig. 5. *Effects of different auxin applications on rooting of the* ***C. hirsutus*** *(%) cuttings*

A similar study was carried out by Sedaghathoor et al. [21] in *Pinus mugo* cuttings and Song et al. [22] in *P. rupestris* cuttings. Sedaghathoor et al [21] conducted with the same plant growth regulators and treated same doses like our study, the best rooting was obtained from 4000 ppm NAA and 1000 ppm IBA applications. According to Song et al. [22], it was revealed that 5370 µM NAA and 4920 µM IBA applications were more effective than rooting Rooton preparations and control on rooting of *P. rupestris* cuttings.

Our observations are in compatible with announced findings of Yan et al. [23] and Yusnita et al. [24]. According to Yan et al. [23], NAA applications were found more effective in rooting hybrid Aspen cuttings than IAA and IBA applications. In the studies of Yusnita et al. [24], they reported that NAA is more effective than IBA in rooting of *Syzygium malaccense* cuttings and that the NAA doses of 2000 and 4000 ppm are the most effective.

Hartmann et al. [12], reported that IBA induced rooting in all species it was more effective than other auxins. These declarations are in contrast to ours.

Again some results were reported by the Gehlot [25], Bayraktar et al [26], Chaudharı et al. [27], Shao et al. [28] and Nhung et al [18] were contrast to our results. In the study of rooting *Azadirachta indica* cuttings, Gehlot [25] found that IBA was more effective than NAA and IAA; 500 mg L^{-1} dose was more effective than 100, 250, 750, 1000 and 1500 mg L^{-1} doses. In the study of Bayraktar et al [26], it was determined that IBA's more effective than NAA and 5000 ppm dose was more effective than 1000 ppm upon the rooting of *Taxus baccata* cuttings. Chaudhar et al. [27] reported that 4000 ppm dose of IBA was the most effective application for rooting *Euphorbia pulcherrima* cuttings. Shao et al. [28], reported that 1500 mg L^{-1} dose of IBA was the most effective application for rooting *Zizyphus jujuba* cuttings. In the studies of Nhung et al [18], it was found that IBA was more effective than IAA and NAA in the rooting of *Dalbergia tonkinensis* cuttings.

Azamal [29] on *Grewia optiva* cuttings, Pandey et al. [30] on *Ginkgo bloba* L. cuttings, Khosh-Khui and Kaviani [31] on M*elia azedarach* cuttings and Egbe et al. [32] on *Albizia zygia* cuttings, Zencirkıran and Erken [16] on *Platanus orientalis* cuttings observed that IBA and NAA treatments were able to induce rooting and the application of IBA was found to be more effective than NAA. Different researchers reported that the application of IBA increased the rooting percentage of cuttings in some ornamental plants [17, 33, 34, 35, 36] Tiwari and Das [37] found that, IBA and NAA had a similar effect to *Embelia tsjeiam* cuttings.

While the rooting percentages increased with applications of IBA rising from 0.1% to 0.2% and 0.3%, the rooting rate decreased once again at the dose of 0.4% and statistically took place in the same group as the 0.2% dose. In the NAA dose applications, however, rooting starting at 8% with 0.1% dose and decreased once again after rising to 9.06% with 0.2% dose (Fig. 5). In the study of Azad et al. [38], although the rooting rate of *Sterculia foetida* cuttings increased with the increment of IBA doses, contrary in our study rooting rate decreased while the dose increased.

In NAA applications, however, according to statistical groups, the positive effect of NAA on the rooting of *C. hirsutus* cuttings started to decline after the 0.2% doses were applied. Holloway et al. [39] and Han et al. [40] reported that treatment with a high concentration of IBA did not improve the rooting of cuttings. Rooting rate declined with the hormone concentration increasing and high hormone concentration has side effects on the root development. Tate and Page [41] found that 3000, 4000 and 8000 ppm doses of IBA were ineffective in their study on rooting of *Santalum austrocaledonicum* cuttings. While in Nhung et al. [18]'s study revealed the effect of a single dose (1.5 g L^{-1}-IBA) clearly, but in our study any single and clear dose could be revealed.

In our experiment the values of rooting rates were found between 3.94-9.06% with NAA and IBA treatments. Chunshan et al. [42] (2007) found that rooting rate of another *Chamaecytisus* species *C. palmensis* cuttings had the average rooting rate 5-20% with ABT rooting powder treated cuttings. It is not so much higher than our findings.

CONCLUSION

The rooting percentages obtained in this study are not applied commercially in terms of levels. The cuttings were taken from natural populations and elderly plants of different ages. It was not possible to find a sufficient number of standard cuttings. In some experiments, the rooting period was delimited for 8 weeks. Lyubomirova and Iliev [43] reported that IBA had an important influence on rooting after 75 days. Sulusoglu and Cavusoglu [44] recommended, 90 days rooting time for *Prunus laurocerasus.*

Rooting ability depends on a great extent upon the age of stock plants along with physiological condition of the cuttings. This means that, the young plants must be used in the autovegetative propagation [45, 46]. It is thought that the rooting rates have remained low for these factors in this study.

According to our findings it's obtained that, cutting collecting date is an important factor in rooting, best time for excision of *C. hirsutus* cuttings is April and NAA treatments are more effective than IBA treatments. All NAA treatment doses effect rooting of the hairy broom cuttings. The rooting rates of cuttings can be increased if we would take cuttings from younger and cultivated plants.

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