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ROOTING OF NORWAY MAPLE (*ACER PLATANOIDES* L.) CUTTINGS

Vladimir Tomov

Department of parks and landscape construction, University of Forestry, 10 Kliment Ohridski Blvd., 1797 Sofia, Bulgaria. E-mail: vladimirtomov@ltu.bg

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Abstract

Four-year-old container Norway maple seedlings were forced in a glasshouse and were shaded. Etiolation of the shoots, as well as banding their base with black electric tape, was used in order to increase the rooting ability of the softwood cuttings. IBA as a 0.8 % powder was used for root stimulation. Both methods and the combination of them resulted in high percentage of rooted cuttings, but those which were only etiolated stroke faster and developed a better rooting system. Further research with mature genotypes can be included in future studies.

Key words: etiolation, banding, donor plants treatment, shading.

Introduction

Numerous techniques of vegetative propagation are described and commonly used in order to provide trees from different species for afforestation or landscaping. It is well known that vegetative propagation has some advantages over sexual reproduction, such as reproduction of the exact same genotype with its preferable qualities (Kolev 1977, Kolarov 1979, Bonga 1982) or faster growth of young plants (Komisarov 1964, Bonga 1982). Propagation by cuttings is an inexpensive, rapid and simple method for improving desirable genotypes of plants, and does not require the special techniques necessary in grafting, layering, budding or micropropagation (Iliev et al. 2010).

The rooting capacity of cuttings is influenced by many factors such as genotype, age, phenological stage, temperature and light intensity etc. (Hartmann et al. 1997, Scaltsoyiannes et al. 2009, Osterc and Štampar 2011). A vital one is the plant species or genotype. It's known that some woody plants are difficult to root, such as those from genus *Acer, Quercus, Carpinus, Syringa, Olea, Prunus* etc. (Maynard and Bassuk 1985, Petridou and Voyiatzis 2002, Scaltsoyiannes et al. 2009). Etiolation and banding could improve the rooting percentage of softwood cuttings from such species (Amissah and Bassuk 2007; Maynard and Bassuk 1985, 1987, 1990; Maynard et al. 1996; Podaras and Bassuk 1996; Sun and Bassuk 1991; Miske and Bassuk 1985). Furthermore, etiolation of stock plants before the harvest of cuttings is claimed to be one of the simplest and the cheapest methods to increase the effectiveness of rooting in stem cuttings (Pacholczak et al. 2016).

Acer platanoides L. is a popular ornamental tree with a lot of ornamental cultivars (Krüssman 1984, Dirr 1998, Tomov 2015). It is easily propagated from seeds, but as seedlings show a wide variability in phenotypic characteristics, vegetatively propagated cultivars are preferable in urban areas. Norway maple cuttings are considered difficult to root (Chong and Daigneault 1986, Maynard and Bassuk 1987). For that reason most of the cultivars are grafted onto seedlings origin rootstock (Iliev and Tomov 2017). Furthermore, production of large quantities of grafts is limited by the season, the period for rootstock production and the success depends on the method of grafting and climatic conditions in the field (Krüssman 1984, Dirr and Heuser 1987, Iliev and Tomov 2017). The growing market for ornamental plants with unique ornamental features that are often not transmitted via sexual reproduction and thus have to be propagated vegetatively imposes on growers the need to increase the effectiveness of their production (Pacholczak et al. 2017). The low rooting capacity of *Acer platanoides* makes the propagation by stem cuttings an uncommon method. In order to root cuttings from Norway maple, unpopular techniques such as etiolation and banding need to be applied. The aim of the study is to investigate the effect of those techniques on the rooting ability of Norway maple softwood cuttings.

Materials and Methods

Four-year-old Norway maple seedlings in containers were placed in a heated glasshouse in February and were fertilized with 5 g of Osmocote per plant. After the first signs of bud development were noticed, the plants were covered with PPX foil (letting frequency of the photosynthetic photon flux no more than 0.0925 $\mu mol \cdot m^{-2} \cdot s^{-1}$), until the new shoots reached 5 cm. After that they were gradually uncovered, starting from the north side (Fig. 1). Parallel with the removal of

Fig. 1. Unfolding of the shaded plants, starting from the north side.

the cover the base of the new shoots was wrapped with black electric tape, dipped in 0.8 % IBA powder. In 4 weeks the shoots were cut below the tape, the tape was removed and 10–15 cm long cuttings (Fig. 2) were placed for rooting. The experiment was conducted through the following ways of treatment of softwood cuttings:

Fig. 2. Cuttings from taped shoots after 4 weeks of 0.8 % IBA amplification, just before placement in the substrate.

- Control 1 (non-etiolated, non-taped, without IBA);
- Control 2 (non-etiolated, non-taped, with IBA);
- Etiolated and taped;
- Etiolated, non-taped;
- Non-etiolated, taped.

Within the non-taped treatments the IBA was applied by dipping the base of the cutting in the powder.

All cuttings were placed in a substrate of peat and perlite 1:1 (v/v), following a net scheme 3×3 cm. The experiment was conducted in a glasshouse, at a temperature of 22–24 ºC and relative humidity of 85–95 %, maintained by an automatic mist irrigation system.

The percentage of rooted cuttings, as well as the number and length of the roots were evaluated after 4 weeks. The non-rooted cuttings were placed back in the substrate and evaluated after 4 more weeks.

All methods of treatment variants were done in 3 replications of 15 cuttings. All results were analyzed by Analysis of Variance (ANOVA) and Post Hoc LSD test using SPSS 19.0 (SPSS for Windows 7). Percentage values were transformed using arcsine square root ($\sqrt{p}$) (Compton 1994) to normalize error distribution prior variance analysis.

Results and Discussion

The rooting capacity of the Norway maple softwood cuttings was generally increased by all treatment variants of the donor plants. Moreover, after 56 days there was no significant difference of the rooting percentage between different treatment techniques. The highest percentage (84.4 %) of rooted cuttings was obtained by using non-etiolated taped shoots, however it didn't differ significantly and the number of shoots was lower, as well as no secondary roots were formed (Table 1). Furthermore, the rooting of the taped cuttings was slower than the rooting of the etiolated ones. Probably these differences are associated with the hormone amplification which was done in deferent parts of the cuttings and lasted substantially longer for the taped cuttings. The amplification of high concentration of auxins for a short period of time resulted in faster root formation for other species such as *Syringa vulgaris* L. The beginning of rooting process *in vitro* for all pulse treatments has been observed earlier in comparison with experiments without pulse treatment (Lyubomirova and Iliev 2013).

Table 1. Rooting of *Acer platanoides* cuttings, in relation with treatments of the donor plants and duration of the process.

Treatment variant	Rooted cuttings, %			Number of primary roots	Length of the primary roots, mm	Cuttings with secondary roots, %
Duration of rooting	28 days	56 days	total	28 days	28 days	28 days
Control 1	15.5 ± 2.3 a	28.4 ± 4.5 bc	44.5 ± 2.2 b	2.9 ± 0.6 a	34.2 ± 2.9 bc	27.8 ± 14.7 ab
Control 2 (IBA applied)	4.4 ± 4.4 a	9.2 ± 2.1 a	13.3 ± 3.9 a	3.5 ± 2.5 a	33.3 ± 6.8 abc	0.0 ± 0.0 a
Etiolated, non-taped	62.0 ± 5.9 c	18.0 ± 9.7 ab	80.0 ± 3.9 c	10.9 ± 1.0 b	21.2 ± 1.0 a	47.5 ± 18.4 b
Etiolated, taped	42.3 ± 2.3 b	37.7 ± 6.0 c	80.0 ± 3.9 c	4.3 ± 0.5 a	36.5 ± 3.0 c	53.1 ± 15.3 b
Non-etiolated, taped	51.3 ± 8.1 bc	33.1 ± 4.0 bc	84.4 ± 8.0 c	2.7 ± 0.4 a	29.8 ± 2.9 b	0.0 ± 0.0 a

Note: Mean values ± standard error of mean, followed by the same letter are not significantly different with level of significance ($p \leq 0.05$).

The etiolated non-taped cuttings (Fig. 3) formed highest number of roots (10.9 ±1.0). All the other ways treatments, including the controls, resulted in number of primary roots between 2.7 and 4.3, and didn't differ significantly from each other (Table 1).

The roots of etiolated and taped cuttings (Figs. 3B and 4) were longest. However, this index did not differ significantly from the controls (Table 1).

Girdling the shoots and auxin amplification is a similar rooting technique to the taping, which also gave good results with difficult to root species such as olive, walnut, wild cherry (Petridou and Vogiatzis

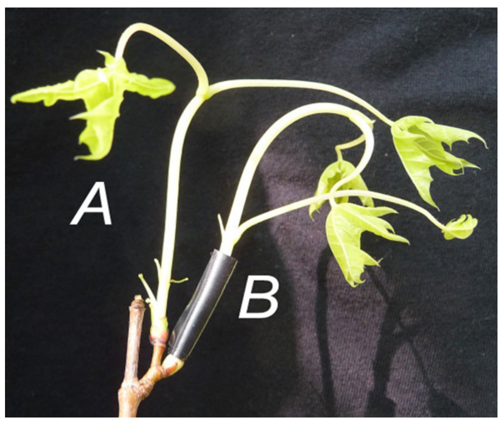

Fig. 3. Etiolated non-taped (A) and etiolated taped (B) shoots (cuttings) before placement in the substrate.

Fig. 4. Rooted cutting from etiolated and taped shoots.

1994, Tsoulpha and Scaltsoyiannes 1998, Scaltsoyiannes et al. 2009). Root initiation is promoted by root promoting substances, e.g. carbohydrates, amino acids, hormones, and various phenolic metabolites produced at the apex, which are accumulated above each girdling point, as suggested by many researchers (Stoltz and Hess 1966, Kozlowski 1971, Tsoulpha and Scaltsoyiannes 1998). Taping and the amplification of auxin caused similar changes at the taped point, which resulted in callus formation and subsequently to root formation (Fig. 2).

The effect of etiolation on the rhizogenic ability of the shoots has been proved for some tree species such as *Carpinus betulus* L. (96 %), *Castanea mollissima* Bl. (100 %), *Quercus coccinea* Muenchh. (46 %), *Quercus palustris* Muenchh. (50 %) and *Quercus rubra* L. (50 %) (Maynard and Bassuk 1985). Furthermore, shading of dogwood (*Cornus alba* L.) cultivars stock plants before harvest led to a statistically significant increase of rooted cuttings by 6–8 % (Pacholczak et al. 2017).

For *Acer platanoides* L. the best reported result is 75 % rooting of etiolated cuttings (Bassuk et al. 1986). The results of this experiment are identical with the findings of Bassuk et al. (1986) and confirm the positive effect of complete shading of the donor plants or different parts of the shoots (taping) on the rooting ability of the cuttings.

It is considered that this effect is caused by the amount of endogenous auxin in the etiolated tissues, but the conclusions are contradictorily (Bertram 1992). Tillberg (1974) reported that concentration of endogenous auxins in the *Phaseolus vulgaris* L. plants grown in a normal light is higher than in the etiolated plants. But there wasn't any change in the levels of concentration after exposure of the etiolated plants to light. However, Kawase and Matsui (1980) argue that etiolation doesn't affect the levels of endogenous auxin in the *Phaseolus vulgaris* tissues.

Some authors announce the hypothesis that the reason for increase in rhizogenic ability of the etiolated plants is not higher level of auxin, but higher sensibility of the cells in the etiolated tissues (Eliasson 1980, Maynard and Bassuk 1988). Anatomical investigations proved high presence of unidentified parenchymal cells in the etiolated tissues. Those cells are considered transient in formation of adventive roots (Maynard and Bassuk 1988). Although many studies proved the role of endogenous phytohormones in physiological stress response, still little is known about the absorption of exogenous phytohormones in plant tissues, how they affect cell differentiation, and the correlation between the effects of exogenous phytohormones in organogenesis and the changes in endogenous phytohormone levels (Golovatskaya and Karnachuk 2007, Zhang et al. 2012, Djilianov et al. 2013, Koike et al. 2017).

Conclusions

Etiolation combined with taping the base of the shoot with black tape dipped in 0.8 % IBA powder, only etiolation and only taping are good methods for increasing the rooting ability of softwood Norway maple cuttings. All these techniques give opportunities for successful vegetative propagation of the species. The investigation of the effect of the used methods and some others (girdling for example) on mature genotypes or cultivars of Norway maple can be subject of further studies.

Concerning practice, the combined treatment of the donor plants is not a lucrative choice, because it's more labour-intensive and expensive. Therefore, etiolation and application of IBA by dipping the bottom of the cutting in powder is the preferable technique. It provides high rooting percentage in shorter period of time and better root system. If it is difficult to apply that method due to the size of the donor plant, taping the base of the shoots could be applied instead.

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