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Science Journal of University of Zakho

Vol. 5, No. 2, pp. 193 –197, June-2017

p-ISSN: 2410-7549
e-ISSN: 2414-6943

THE EFFECT OF IBA AND CUTTING DIAMETER ON INDUCING ROOTS OF *COTINUS COGGYGRIA* SCOP. AND *RHUS CORIARIA* L. (ANACARDIACEAE)

Hassan Najman Muhamed [a,*], and Nasser Abdusalam Dawod [b]

[a] Dep. of forestry, College of Agriculture, University of Duhok, Kurdistan Region, Iraq - hassan.muhamed@uod.ac
[b] Directorate of forestry and rangelands, Duhok, Kurdistan Region, Iraq

Received: Dec. 2016 / Accepted: Apr. 2017 / Published: Jun. 2017 ***https://doi.org/10.25271/2017.5.2.367***

ABSTRACT:
Because of the difficulty in their vegetative propagation, both *Rhus coriaria* L. and *Cotinus coggygria* Scop. (*Ancardaceae)* are rarely introduced into the forest nursery trade. Vegetative propagation is practiced in forestry to produce seedlings of desired genetic properties within a short period and when seeds displaying a status of complex dormancy. In the present study, the possibility of the multiplication by stem cuttings was studied for Sumac, the high ethnobotanical shrub value and for Cotinus, the endangered shrub, to give more insight into their propagation technique. Between January-July 2014, using complete randomized block design (C.R.B.D) in four replicates, we evaluated the effectiveness of applying four different Indole-3-Butyric Acid (IBA) concentration to two stems cutting diameters in producing *C. coggygria* and *R. coriaria*. However, the former species due to the poor survival percentage (lower 5%) excluded from the analysis. Optimum results of *C. coggygria* were obtained with IBA 20000 mg.l $^{-1}$ and cutting diameter more than 1 cm. (rooting % 60, number of roots 17.33, number of branches 3.75 and the number of leaves 19.33 while nonsignificant increase was recorded in root length. 16.33 cm.). The results indicated that Cotinus is relatively easy to propagate by stem cutting in comparing with Sumac with rootability increases significantly with increasing of IBA concentration and stem cutting diameter. Further studies are needed for more reasonable rooting results to meet the large quantity demand of elite seedling material that could be later used to restore the natural populations of *C. coggygria* and *R. coriaria*.

KEYWORDS: Sumac, Cotinus, Rooting, Stem cuttings, Vegetative propagation, IBA.

1. INTRODUCTION

There is an urgency to develop measures for restoration of depleted natural populations. The reproductive success of the endangered shrubs or those difficult to propagate sexually recently became concerned by nurserymen (Deepak *et al.*, 2015). Vegetative propagation considered a conservation way of those species which are economically and ecologically important and difficult to grow from seed and other reproductive means **i**n forest nurseries, for most tree species, the sexual propagation takes longer time to get plantable seedling size and doesn't guarantee the same traits of donor plant (Barbuti *et al.*, 2012).
Vegetative propagation is commonly used with species that have short and low seed viability, or hard seed dormancy. All new produced individuals from vegetative propagation are genetically a copy of the donor plant. The uses of stem cuttings are considered the most applied technique due to its practicability and simplicity for mass production within a short time (Yong and Ki, 1996). However, the rooting ability of cuttings varies with species and types of cuttings (Hartmann *et al.*, 2002). In the vegetative propagation, the rooting process plays a key role, where poor rooting causes considerable losses in the propagation industry. This is can be critical, particularly with rare and endangered species where small of plant material can be available.
It has long been known that adventitious roots develop in cuttings influenced by auxins. Usually, Indole-3-Butyric Acid (IBA) auxin is recommended to promote the produce of adventitious roots in cuttings of shrubs (Kaul, 2008 and Husen and Khatoon, 2012). Furthermore, a large body of articles recommended that the root initiation and survival rates can be increased by applying endogenous rooting hormones before plantation. Tracz (1983) reported that rooting and sprouting of *Rhus aromatica* Ait. was more after treatment with 1 g/l IBA. Nokes (1986) also displayed that semi-hardwood cutting of evergreen Sumac treated with an auxin-talc preparation of 0.8 g/l IBA has rooted better than control. Tipton (1992) recorded (24%) rooting percentage of *Rhus virens* cuttings taken 16 weeks after bud break and treated with 5 gl-1 of IBA. Pacholczak *et al.*, (2013) found that IBA positively affects rhizogenesis in *Cotinus coggygria* in conventional stem cuttings and in microcuttings. In same line Dunn (1999) found that *C. coggygria* softwood cuttings under glass house condition had 92% when took in 25 May and treated with 10000ppm IBA+5000 NAA quick dip with a number of roots 51.5 and average of longest three roots 13.9 cm., 20000ppm IBA reduce the rooting capacity, indicating the negative effect of high auxin concentration.
Researchers have correlated the survival rate of some species with the amount of the accumulated starch in the cuttings. High amounts of starch result in more energy for the growing roots and thus better survival rates. Hartman *et al.*, (2002) and Muhamed and Sarhan (2016) they attributed such effect to the size of the used cuttings and the number of the presence of vegetative buds. An understanding of the factors affecting the rootability of stem cuttings such as cutting size and response to auxins is essential (Hartmann *et al.*, 2002). Hence, this study was intended to show the effects IBA application and stem cutting diameter on the rootability of Sumac harder to root and germinate shrub and Cotinus the endangered shrub for reintroducing them later into depleted natural population's sites.

* Corresponding author

2. MATERIALS AND METHODS

2.1 Study species

Sumac (*Rhus coraria* L.) and Smoke tree (*Cotinus coggygria* Scop.) both are species of the cashew family (Anacardiaceac). Sumac is a shrub used in pharmaceutical preparation, food coloring and preservations. Sumac is a shrub with a long history application in traditional medicine and Kurdish cuisine (Shahbaz, 2010; Mohammadi *et al.*, 2010). Ecologically, this species is well known in controlling soil erosion where root system tends to be shallow and wide-spreading conserving soil on sloping sites (Ogle *et al.*, 2000). *C.coggygria*. is a multi-stemmed shrub. It is cultivated primarily for landscape purposes because of its ornamental features like purple foliage and flowers and its adaptability to widely divergent soils and pH ranges (Dirr, 1990). Vegetative propagation of this species by conventional cutting, although used, can be slow, difficult, and cultivar-dependent. Shahbaz (2012) listed *C. coggygria* as an endangered species existing as small and isolated populations in Babery –Duhok area under climate and human disturbances. The durable wood of *C. coggygria* has been used for fence posts. Also, this species have anti-inflammatory, antibacterial, and wound-healing properties (Tsankova *et al.*, 1993).

2.2 Treatments and experiment design

The study was carried out in a plastic house in Malta nursery - Directorate of Forests and Rangelands-Duhok, Kurdistan Region- Iraq (N36◦ 51' 28", E42◦ 51' 06") during 14 January to 22 July 2014. The hardwood cuttings of *Cotinus coggygria* were taken from mother shrubs (diameter 8-10 cm) in a very limited locality of about 1 square km in the Baberey village (N 37 11.836, E 43 11.423), at an elevation range of 864.1, 999.79m, along the upper side of the road on a steep slope of a northern exposure. The hardwood cuttings of *Rhus coriaria* L were collected from parent shrubs naturally distributing in Warmely village (N 37 11.43, E 43 11.28).The cuttings of both species were prepared with a length of 20 cm containing 4-5 buds and given slanting cut at base end, then the cuttings sorted out according to two thicknesses (1-2 cm diameter) and small sized (0.5 - less than 1cm diameter) using a digital caliper. The bases of *Rhus coriaria* L cuttings were wounded longitudinally with the length of 2 cm; two opposite wounds for each cutting end. The bases of all cuttings were treated with four concentrations of IBA solution (0, 10.000, 15.000, and 20.000 mg1-1) where dipped quickly for 10s. After that planted 15 cm deep into the soil at a spacing of 10 cm x 10 cm in high nursery beds under semi-controlled conditions of a plastic house. A light overhead watering was given immediately after planting so that cuttings get settled. Afterwards, the planted cuttings were irrigated regularly as and when required.

The cuttings were removed after 23 weeks of planting beds and the experimental measurements were recorded as follows:

1. Rooting percentage (%).
2. Root's number/ cutting.
3. Root's length (cm).
4. Branches number
5. Leaves number / cutting.

The experiment was applied by using Randomized Complete Block Design (R.C.B.D) with two factors in four replicates. Each replicate included eight cuttings. The angular conversion was done for the results of rooting percentage then analyzed statistically by using SAS program. Mean values were compared by Duncan test at 0.05 level (SAS, 2001) regardless of the significance of ANOVA test (Al-Rawe and Khalaf, 1980).

3. RESULTS

Due to the poor obtained results from Sumac stem cuttings which almost less than 5% it's excluded from the analysis. Generally, from the findings, it has been found that IBA concentrations had a significant effect on the rooting capacity of Cotinus stem cuttings. The size of the cuttings represented by the diameter has shown also a significant correlation with the percentage of sprouted root cuttings. In this experiment, it was visually noted that all the emerged roots were generated from the buried buds not from the cutting bases.

Duncan's test in table (1) showed that applying auxin significantly influenced most rooting traits, the values increased with increasing the IBA concentrations up to 20000 mg.l $^{-1}$ IBA compare to non-treated cuttings. The higher values have been recorded were R%, NR, NB and NL (54.16%, 16.65, 3.02 and 16.3) respectively, with no significance increasing in the root length RL over all the used IBA.

Table 1. Effect of IBA on rooting and vegetative characteristics of hard hardwood stem cuttings of *Cotinus coggygria*

IBA concentrations mg.l $^{-1}$	Rooting percentage %	Roots numbers	Roots Length (cm)	Branches number	Leaves number
control	15.333 d	9.333 d	13.667 a	2.25 b	12.958 b
10,000	31.167 c	12.291 c	14.388 a	2.855 a	14.368 ab
15,000	41.25 b	14.166 b	15.82 a	2.583 ab	14.958 ab
20,000	54.167 a	16.625 a	16.167 a	3.0217 a	16.375 a

Similar trends were obtained with the used diameters of stem cuttings; generally the rooting increased with increasing cutting stem diameters from less than 1cm to up to2 cm. The Duncan test in table (2) showed a significant difference for most measured parameters between the diameters of stem cuttings. The cuttings with more than 1cm diameter produced significantly higher R%, NB, and NL (38.8%, 3.35 and 17.57 respectively). However, both NR, RL did not differ significantly.

Table 2. Effect of cutting diameter on rooting and vegetative characteristics of hardwood stem cuttings of *Cotinus coggygria*

Treatments	Rooting percentage %	Roots numbers	Roots Length (cm)	Branches number	Leaves number
Cutting diameter less than 1 cm	32.125 b	12.9167 a	14.4375 a	2 b	11.757 b
Cutting diameter more than 1 cm	38.833 a	13.2917 a	15.5833 a	3.3542 a	17.573 a

The interaction effects of both IBA concentrations and stem cutting diameters significantly magnified the values of the most studied parameters except root length. All of the parameters value increased with increasing the IBA concentrations up to 20000 mg.l $^{-1}$ IBA and stem cutting diameter more than 1 cm. the values were R% 60, NR 17.33, NB 3.75 and NL 19.33 while no significant differences were found for RL 16.33 cm (Table 3).

4. DISCUSSION

Vegetative propagation is important for the preservation of both *Rhus corriaria* and *Cotinus coggygria* species, particularly in depauperate populations, with low seed set and have a deep dormancy that causing slow and irregular germination.

Table 3. Effect of the interaction treatments between cutting diameter and IBA on rooting and vegetative characteristics of hardwood stem cuttings of *Cotinus coggygria*

Treatments	IBA concentrations $mg.l^{-1}$	Rooting percentage %	Roots numbers	Roots Length (cm)	Branches number	Leaves number
Cutting diameter less than 1 cm	control	13.167 d	8.75 f	14 ab	1.583 d	8.83 d
	10000	30.167 c	12.583 de	12.11 b	2.21 cd	11.443 cd
	15000	36.833 c	14.416 b	15.64 ab	1.9167 d	13.33 bc
	20,000	48.333 b	15.916 b	16 ab	2.293 cd	13.417 bc
Cutting diameter more than 1 cm	control	17.5 d	9.917 f	13.3 ab	2.9167 bc	17.083 ab
	10,000	32.167 c	12 e	16.667 a	3.5 ab	17.29 ab
	15,000	45.667 b	13.916 cd	16 ab	3.25 ab	16.583 ab
	20,000	60 a	17.33 a	16.333 ab	3.75 a	19.33 a

4.1 *Rhus corriaria*

The poor rootability results of sumac (below 5 % survival) at the end of the experiment did not allow to running the statistical analysis, therefore this species excluded from the analysis. The poor rooting of sumac stem cuttings can be understandable; this species is well known as a hard to root species. There is a general agreement that the lack of the rootability of Anacardaceae species is due to the presence of extensive resin that usually flow from the bases of prepared cuttings, such extract resin could physically cause significant inhibition of the stem cuttings rootablity (Edwards and Thomas, 1980). Despite the fact that the wounding treatments in certain species increase the penetration of IBA by breaking the sclerenchyma bands that constitute a mechanical barrier for callus formation and emerging adventitious root primordia (see Wilson and Grange, 1983 and Oezkaya, 1998), wounding treatment did not serve such function under our experimental conditions likely for one or both of the following reasons: first, the wounding maybe increase the bleeding of the resin and formed an impenetrate solid ring around the base of the cutting lead to unattached the IBA and prevent it to act properly, second, the wounding was just slightly made where some researchers believe that in hard to root woody species such barriers can only overcome by making a deep wounding or splitting the base of the cuttings (Newman, 2014).

Indeed, our results are in line with previous studies showed poor outcome of sumac stem cuttings e.g., Porter (1963) with *Rhus lancea* 31.7% at 4000 ppm IBA, Tipton (1992), with *Rhus virens* 24% 5000ppm IBA and more recently Media (2016) who found maximum rooting percentage 11.67 when cuttings treated with 15000 IBA in media of Sand + Sandy loam + Peat moss) with the proportion of (2:1:1).

4.2 *Cotinus coggygria*

There is some urgency to conduct experiments dealing with the propagation technique for the restoration of depleted natural populations, finding a way to produce good quality seedlings, later can be used to restore natural populations of Cotinus was the objective of this experiment. However, because of the low population of Cotinus in Babery site (the only site where this species coexist) represented by the small number of disturbed shrubs due to human interference (heavily pruned were shown on the shrubs) it was not possible to enlarge the size of this experiment by increasing the number of the study factors or increase the factor levels. Therefore, we considered that our experiment a first attempt to gain information may help to increase the propagation of this endangered species. According to Leakey (2004), internal and external factors governing root intonation. Auxins play a critical role in the formation and increasing initiation of the root primordium and growth via cell division (Fogaca and Fett-Neto 2005). Auxins stimulate starch hydrolysis and drive sugars and nutrients to the cutting base (Das *et al.,* 1997).

The significant influence of IBA in rooting ability and growth of Cotinus cuttings was expected since IBA is well-known as a root promoter in cuttings of many shrubs (Husen and Mishra, 2001and Hartmann *et al.,* 2002). IBA auxin normally acts by signaling the proteins to stimulate new cell and resulting in the initiation of numerous lateral roots (Saifuddin *et al.,* 2003). In the context of root initiation, it is worth to mention that we observed that all the initiated roots were emerged from the buried buds of cuttings not from the cutting base, almost because of the physical barrier that formed from the bleed resin at cuttings bases which is common in Anacardiaceae. (Macdonald, 1986).

In this experiment we considered the cutting diameter alone (Burgess *et al.,* 1990; Foster *et al.,* 2000). The results showed that the cutting diameter significantly influenced the rooting ability in Cotinus. The optimum rooting results were obtained for thicker cuttings (cuttings of more 1 cm diameter). This is in line with Doroudi *et al.,* (2008) who found that the best result can be obtained for *Rhus corriaria* stem cuttings by use of high diameter cuttings in sand. See also Burgess *et al.,* (1990) in *Salix alba*; Foster *et al* (2000) in *Loblolly pine* and OuYang *et al.,* (2015) *in Picea abies*. Initial cutting size is considered as an important factor influencing the rooting ability and growth performance, cuttings with a larger diameter result in better survival and growth under normal conditions (Leakey 1983; Hannerz *et al.,* 1999; Vigl and Rewald 2014). Leakey and Mohammed (1985) found that *Triplochiton scleroxylon* cuttings of the same length but largest diameter have the greatest rooting percentages, indicating that cutting storage capacity represented by diameter may be more critical than length. The effectiveness of rooting by larger cuttings can be attributed to the level of endogenous auxins which may be lower in smaller cuttings lead to reduced rooting percentage (Palanisamy and Kumar, 1997), or larger cuttings store more stem carbohydrates (Tchoundjeu and Leakey, 1996). However, Muhamed and Sarhan (2016) found contrast that finding with *Rhus corriaria* but with root cuttings type. In Table 3, Duncan's multiple-range test showed that the effect of the interaction between the IBA at 20000 **$mg.l^{-1}$** and cutting diameter more than 1cm increased the most cutting traits showing a synergistic effect as a result of the accumulation of the positive effect of each factor separately.

5. CONCLUSION

According to our knowledge, no sufficient information is found about the response of the *C. coggygria* to vegetative propagation. This study considered as an attempt to show how far the growth hormones and cutting size influence the rootabilty of this species. The results indicated that *C. coggygria* is relatively easy to propagate by stem cutting in comparing with *R. corriaria*. From the nurseryman's standpoint, the rooting percentage–of this experiment are of high importance since it exceed fifty percent which is a reasonable rate to produce cuttings economically, despite that, costs may be less important with endangered species as the case with *C. coggygria*. However, to meet a large scale demand and ensure easy supply of elite *C. coggygria* and *R. corriaria* seedlings further studies should be followed. Here, one can propose using stem cuttings with abundant bud numbers (cutting length) since, observationally in this study all roots initiated were from buried buds not from the cutting bases.

ACKNOWLEDGEMENTS (OPTIONAL)

We would like to thank the technical staff of the Forest and Rangeland – Duhok directorate for their assistance in the practical and financial issues of this study.

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کارتێکرنا تیراتیا هرمونێ ترش اندول بیوتریك (IBA) و ستویراتیا قەلمێن چەقی لسەر رویهدانێن وشینبونا قەلمێن سماقێ Rhus coriaria و کوتینوسێ Cotinus coggygria

کورتیا لێکولینێ:

ژبەر زحمەت زێدەکرنا هەردو تراشیوکیێت سماقێ *Rhus coriaria* و کوتینوسێ *Cotinus coggygria* ئەڤ هەردو جورە تا نوکە نەهاتینە دبازارێ نەمامگەهیێن دارستانێ دا. مەرەم ژ زێدکرنا تراشوکا بریا قەلەمێن چەقی بو بدستڤەئینانا نەمامێن زیدە باش لدەمەکێ کێمدا یان دەمێ زێدکرنا بریا تووڤی یابزحمەتبیت ژ ئەگەرێ دورمانسی. ئەڤ ڤەکولینە هاتیە ئەنجامدان ژ بو بدەسڤەئینانا نەمامێن سماقێ *Rhus coriaria* و کوتینوسێ *Cotinus coggygria* کو دوو جورێن گرنگن ژ لایێ ژینکەهی ڤە و ئابوری ڤە. دناڤ بەرا ١٤ کانوینا ئێکێ تا کو ٢٢ تیرمەها سالا ٢٠١٤ ڤەکولینك هاتە رێکسختن ل دویف دیزاینێ R.C.B.D - ب چوار ریبلکێتا لبن خانیەکێ پلاستیکی ل نەمامگەهاا مالتا- دهوك- ژبو هەلسنگاندنا کارتێکرنا چوار تیراتیا ترشێ IBA (٠ ، ١٠٠٠٠ ، ١٥٠٠٠ ،٢٠٠٠٠) ملغ/لتر وستویراتیا قەلەمێ چەقی (پتر وکێمتر ژ ١سم)لسەر ریژا روهدانێ - ژمارا روها – ژمارا تایا - ژمارا بەلکا – درێژاهیا روها. ئەنجامێن ڤەکولینێ هاتنە شروڤەکرن بریا بوگرامێ ساسی. ژبەر هشکبوونا زوربەی قەلەمێن سماقێ ژ ئەگەرێ نە رهدانێ (کێمتر ژ ٥%) ئەڤ جورە هاتە لادان ژ شروڤەکرنێ. پاشترین ئەنجام یێن کوتینووسێ هاتنە بدەستڤەئینان لدەڤ تیراتیا ترشێ IBA 2000 ملغ/لتر وستیراتیا پتر ژ ١ سم (ریژا روهدانێ ٦٠% - ژمارا روها ١٧,٣٣– ژمارا تایا ٣,٧٥-ژمارا بەلکا ١٩,٣٣ – درێژاهیا روها ١٦,٣٣ لێ بێ کارتێکرن). ئەنجاما دیارکر کو روهدانا کوتینوس بزێدکرنا تیراتیا ترشێ وقەلەمێن ستویر ئاسان ترە ژ سماقێ بو زێدکرنێ بریا قەلەمێن چەقی.پتر ڤەکولین پیتڤینە ژ بو زێدکرنا رێژا روهدانێ د هەردوو جورادا بتایبەتی لسەر کارتێکرنا درێژاهیا قەلمێن چەقی پشتی دڤێ ڤەکولینێ دا مەدیتی کو زوربەی رها ژ بشکوژێت لبن ئا خێ پەیدادبووینە نە ژ بنێ قەلەمی.

تأثير المعاملة بتراكيز مختلفة من حامض الاندول بيوترك (IBA) وقطر القلم على قابلية التجذير والنمو للعقل الغصنية للسماق *Rhus coriaria* L. و شجرة الدخان *Cotinus coggygria*

خلاصة البحث:

نظرا لصعوبة اكثار كل من السماق *Rhus coriaria* L. و شجرة الدخان *Cotinus coggygria*، فان كلا هذين النوعيين لم يدخلا بشكل واسع النطاق التجاري لمشاتل الغابات. الهدف الاساسي في اكثار الشجيرات خضريا باستخدام العقل الغصنية هو الحصول على شتلات بمواصفات وراثية جيدة وبفترة قصيرة او عندما تكون هناك مشاكل في الاكثار من خلال البذور بسبب ظاهرة سكون البذور. لذلك هذه الدراسة حاولت البحث عن أمكانية استخدام العقل الغصنية في إنتاج شتلات كل من السماق وشجرة الدخان ذاتا القيمة البيئية والاقتصادية. الدراسة بدات من ١٤ كانون الاول الى ٢٢ تموز لسنة ٢٠١٤ تحت ظروف البيت البلاستيكي في مشتل مالطا –دهوك- وفق تصميم القطاعات العشوائية باربع مكررات لاجل دراسة تاثير اربع تراكيز من حامض الاندول بيوتريك (٠،١٠٠٠٠،١٥٠٠٠ و٢٠٠٠٠) ملغم /لتر و قطريين للعقل المستخدمة (اقل واكبر من ١ سم) .الدراسة تضمنت دراسة الصفات التالية: نسبة التجذير % ،عدد الجذور لكل عقلة، طول الجذور كمعدل لثلاث اطول جذور ، عدد الأفرع وعدد الأوراق لكل عقلة. نتائج الدراسة أظهرت أن المعاملة بحامض الاندول بيوترك بتركيز ٢٠٠٠٠ ملغم/لتر عند قطر اكبر من ١ سم للقلم والتداخلات بينها اختلفت معنويا و أثرت بشكل كبير على الصفات المدروسة (نسبة التجذير ٦٠%، عدد الجذور ١٧,٣٣، عدد الافرع ٣,٧٥، عدد الاوراق ١٩,٣٣ وزيادة غير معنوية بطول الجذور ١٦,٣٣سم). هناك حاجة لدراسات اخرى لرفع نسبة التجذير في كلا النوعين، وهنا يمكن الاشارة الى استخدام عدد البراعم (طول العقلة) كعامل يمكن ان يوثر على التجذير خاصة وانه خلال هذة الدراسة لوحظ ان الجذور تكونت من البراعم المدفونة بالتربة وليس من قواعد الاقلام.