# Effects of cutting origin and exogenous auxin treatment on the rooting of *Rosa damascena* (Mill) cuttings from the M'goun-Dades valleys in Morocco

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## Abstract:

The *Rosa damascena* (Mill), commonly known as Damask rose, is one of the most important Rosa species with great economic interest on a national and international scale. In Morocco, especially in M'goun and Dades valleys, the Damask rose is mainly propagated by replanting rooted shoots. However, this method is presenting several constraints. Considering this fact, this study was undertaken to investigate the influence of two major factors: the origin of cutting and the effect of the auxin treatment on *Rosa damascena* cutting. For this purpose, the cuttings from seven localities were cultivated in a greenhouse under controlled conditions after soaking treatment in different concentrations of Butyric Indole Acid (0; 2000 and 4000 ppm). The obtained results revealed a significant ($P<0,01$) difference between the seven localities for the focused parameters. In fact, the individuals belonging to the same morphotype act in the same way with regard to cutting. The rooting rate varies between 10% and 70% depending on the origin of cuttings and the applied concentration of IBA. The results of this study showed that propagation of *Rosa damascena* by cuttings can promote this culture. However, the optimization of this method is linked to the choice of the plant, the origin of cuttings in particular to the chosen ecotypes.

**Keywords:** Cutting; Butyric Indole Acid; *Rosa damascena* (Mill); rooting rate.

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## Résumé:

Rosa damascena (Mill.), communément appelée rose de Damas, est l'une des espèces du genre Rosa ayant un grand intérêt économique à l'échelle nationale et internationale. Au Maroc, notamment dans la zone de M'goun-Dadès, la rose de Damas se multiplie principalement par replantation des rejets racinés. Cependant, cette méthode présente plusieurs contraintes. Compte tenu de ce fait, cette étude vise à étudier l'influence de deux facteurs majeurs : l'origine de la bouture et l'effet du traitement à l'auxine sur l'enracinement des boutures Rosa damascena. Pour cela, les boutures de sept localités ont été cultivées sous serre dans des conditions contrôlées après un traitement de trempage rapide dans différentes concentrations d'AIB (0 ; 2000 et 4000 ppm). Les résultats ont révélé une différence hautement significative (P<0,01) entre les différents paramètres étudiés entre les sept localités. En effet, les individus appartenant à un même morphotype agissent de la même manière vis-à-vis du bouturage. Le taux d'enracinement varie entre 10% et 70% selon l'origine des boutures et la concentration d'AIB appliquée. Les résultats de cette étude ont montré que la propagation de Rosa damascena par bouturage, peut favoriser cette culture. Cependant, l'optimisation de cette méthode est liée au choix de plant, son origine et en particulier aux écotypes choisis..


**Mots clés:** Bouturage ; Acide-indole butyrique ; *Rosa damascena* (Mill) ; Taux d'enracinement

## 1. Introduction

The genus *Rosa* includes many species of great economic interest which belong to the *Rosaceae* family. These species are used throughout the world in ornaments for cut flower production or in gardens for the exploitation of their extracts in the pharmaceutical and perfume industry (Antonelli et al. 1997; Hmamouchi 1999 ; Hmamouchi 2016). Roses are propagated by seeds, or by vegetative methods (Nivot 2005). Vegetative propagation allows maintaining desirable characteristics in a superior cultivar ensuring the sustainability of individuals, in particular in an heterozygous and polyploid species as is the case of *Rosa damascena* (Mill.) (Widrlechner 1981; Ginova et al. 2012).

The *Rosa damascena* (Mill), commonly known as Damask rose, is one of the most important *Rosa* species (Jabbarzadeh and Khosh-Khui 2005). However, the propagation of this species is generally asexual and is done by budding, cutting, grafting, cutting-grafting (stenting) or by micropropagation (Hartmann et al. 2002; Ginova et al. 2012; Rusanov et al. 2020). The growth and development of damask rose are affected by a variety of agricultural agents (Hatamian et al. 2015). The success of vegetative propagation techniques depends on several factors such as the cultivar, the origin of the cuttings (or explants in the case of *in vitro* culture), the culture conditions (temperature and humidity), the substrate and the exogenous supply, including auxin treatments (Rout et al. 2006; Ginova et al. 2012; Rusanov et al. 2020).

In Morocco, the cultivation of *Rosa damascena* occupies a considerable place and it is one of the specific assets of the M'gouna region. Its culture is located in the M'goun and Dades Valleys. It currently covers more than 4200 Km linear or the equivalent of more than 10% of the cultivated agricultural area in Ouarzazate province (Hmamouchi 1999 ; Hmamouchi 2016 ; Zrira, 2017; Ait Hida, 2020). The Damask rose is mainly propagated by replanting rooted shoots. However, this technique delays flowering and affects the flower buds yield (Oussoulous 2019). In addition to these constraints, the cultivation of *Rosa damascena* (Mill) in M'goun-Dadès suffers from soil salinity, which continues to increase in the arid and semi-arid regions and is amplified under the impact of climate change (Ibriz et al.2005; Aziz et Elquaoumi 2016), hence the need to improve current farming techniques.

Cutting is a method of vegetative propagation which is not rapid but remains the simplest and optimal method for producing new plants similar to parents (Ruchala et al. 2002; Ginova et al. 2012). Thus, the objective of this study is to improve the cutting of the M'goun-Dadès rose under greenhouse conditions. This study was undertaken to investigate the influence of two major factors: the origin of cutting (locality) and the effect of the auxin treatment by rapid soaking of cuttings in IBA solutions before cultivation.

## 2. Materials and Methods

### 2.1. Sampling zone

Plants (samples) were collected from the Kelâat M'gouna region (31 ° 13'22 "North latitude and 6 ° 13'21" West longitude) in the province of Tinghir (Morocco). This region belongs to the arid bioclimatic stage with continental tendency. Rainfall is irregular and decreased from North to South, with an annual average of 148 mm, and average temperatures which vary between -5 °C and 20 °C in winter and between 30 °C and 40 °C in summer (Taïbi and El Hannani 2004; Ait Hida et al. 2019). The characteristics of the sampling localities are presented in **Table 1**.

**Table 1**. Geographical location and soil characteristics of localities in the sampling zone

| Localities | Locality names | Altitude (m) | Latitude | pH | EC25°C*10 (ms/cm) | % Organic matter | $CaCO_3$ | $Na^+$ (ppm) | $K^+$ (ppm) | Ca2+ (ppm) | $P_2O_5$ (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **L1** | Timeskelte | 1400 | N31°13'54.1'' W6°6'30.7'' | 8,17 | 2,93 | 2,78 | 5,9 | 9,1 | 12,1 | 452,5 | 13,23 |
| **L2** | Mirna | 1450 | N31°15'3.4'' W6°7'50.9'' | 8,27 | 3,17 | 2,47 | 6,3 | 11,6 | 9,1 | 502,5 | 21,15 |
| **L3** | Domaine les Arômes du Maroc | 1500 | N31°15'37.5'' W6°6'25.00'' | 8,58 | 2,97 | 1,39 | 7,3 | 4,1 | 27,1 | 475 | 11,70 |
| **L4** | Kelaat M'gouna | 1450 | N31°14'24.1'' W6°7'36.00'' | 8,18 | 5,54 | 1,70 | 5,9 | 28,3 | 29,4 | 410 | 20,61 |
| **L5** | El Khémis Dades | 1600 | N31°17'59.5'' W6°2'16.0'' | 8.21 | 3.16 | 2.47 | 3.4 | 9.1 | 5.6 | 407.5 | 15.75 |
| **L6** | Ait Ihya | 1550 | N31°20'26.4'' W6°10'24.8'' | 8,09 | 3,76 | 2,43 | 3,3 | 9,4 | 7,0 | 242,5 | 10,35 |
| **L7** | Hdida | 1400 | N31°11'42.6'' W6°12'51.1'' | 8,02 | 6,66 | 1,70 | 6,1 | 11,0 | 12,3 | 525 | 18,00 |

## 2.2. Plant material

Semi-woody cuttings were taken in December 2017, at the end of the dormancy period, from plantations maintained regularly in seven localities. The middle part of the stem was recovered. Then a few leaves were removed immediately to reduce transpiration (Hartmann et al. 2002). The cuttings were then stored in zipped plastic bags marked to recognize their origin. The bags were placed in a cooler before storing them at the laboratory in a dark cold room (4 °C) to avoid dehydration until transplanting. The diameter of the collected cuttings is between 0.5 cm and 1.5 cm. The replanted cuttings have at least three shoots and are between 15 cm and 20 cm long.

## 2.3. Greenhouse conditions

The tests were carried out in a controlled experimental greenhouse at the Hassan II Agronomic and Veterinary Institute, Horticultural Complex of Agadir (**Fig. 1**).

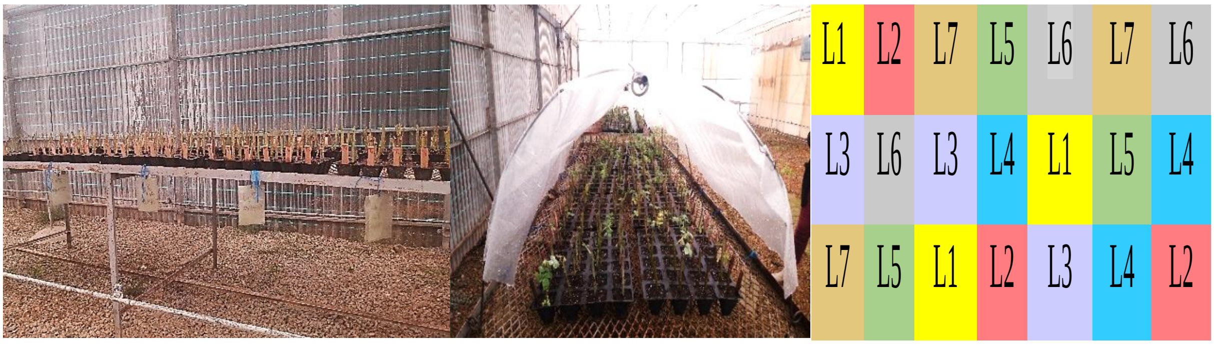


**Fig. 1:** Experimental greenhouse with the culture blocks and representation of the completely randomized experimental block.

The greenhouse is made up of several systems which optimize and regulate the growing conditions:

- A misting system « mist » ensuring the turgescence of the cuttings by producing fine droplets covering the leaves with a thin film of water without wetting the substrate.
- A « fog» system that maintains a saturated relative humidity inside the greenhouse.
- A system ensuring ventilation and temperature regulations.

These systems are linked to the "Mithraclimat" program installed on a computer, thus enabling regulation and control of greenhouse conditions to have a relative humidity (RH) ≥ 90°% and a temperature (T) of 25 ± 2 ° C.

### 2.4. Preparation and planting of cuttings

The cuttings were rehydrated in basins of water for a few minutes before removing the thorns and leaves. Only the top leaf was kept to initiate photosynthesis.

The cuttings were then soaked in different concentrations of Butyric Indole Acid solutions (IBA), 2000 ppm (T1) and 4000 ppm (T2). Untreated cuttings (T0) were soaked in distilled water. The cuttings are planted in 24 cell plant trays containing a peat/perlite mixture (2:1, v/v). The experiment was carried out in a completely randomized block design with three replicates, and each replicate consisted of eight cuttings, for a total of 504 cuttings from seven localities. The cuttings from the same locality are cultivated in the same tray and are subdivided into three groups: T0 (control without auxin treatment), T1: (cuttings treated with 2000 ppm IBA) and T2: (cuttings treated with 4000 ppm IBA).

### 2.5. Measured parameters

For each group of cuttings belonging to the same locality, five agronomic parameters were measured after 45 days of cultivation. The main parameters evaluated include survival and rooting rates, number of roots, number of shoots and number of newly formed leaves. After 45 days, the healthy cuttings are transplanted into plastic pots of 1.5 liters in volume. After transplanting, the cuttings are kept in a greenhouse under the same conditions of humidity and temperature for 15 days before acclimatizing the seedlings by reducing gradually the humidity.

### 2.6. Statistical analysis

The data were subjected to analysis of variance (ANOVA 1) using IBMSPSS software (version 23). The mean values were compared by using Tukey’s multi-range test at the significance level of 5%. Data are presented as a mean value. Statistical analysis makes it possible to assess the variability of the various parameters between the localities and in particular to determine the homogeneous groups.

# 3. Results

## 3.1. Effect of locality on the success of the cuttings of the M'goun-Dades rose

The effect of the origin of the plant material on the Damask rose cuttings was investigated in this study. The obtained results are presented in **Figs. 2-5**. The highest survival rates were observed in the L1, L2, L3 and L4 localities compared to other origins with a percentage of plant survival exceeding 70%. They are followed by L6 locality with a survival rate of 63%. Whereas, L5 and L7 localities have almost similar survival rates which are 46% and 50% respectively (**Fig. 2**).

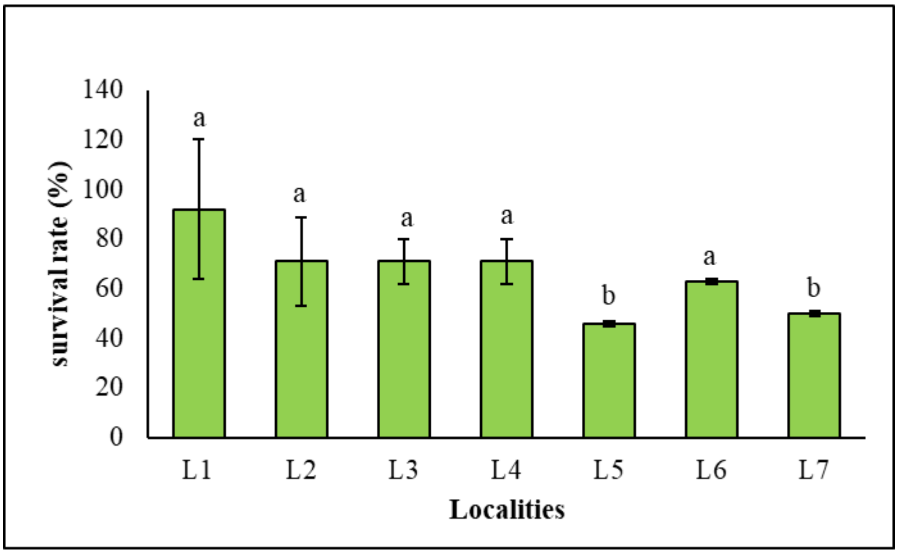


**Fig. 2.** Effect of locality on the survival rate of *Rosa damascena* cuttings after 45 days of transplanting. Values are mean ± SE and histograms with the same letters are not significantly different (p <0.05) according to Tukey's test

Analysis of variance (ANOVA) revealed a significant (P<0,01) difference between localities in the survival rate of cuttings. Tukey's test allowed us to identify two homogeneous groups. The first group consists of cuttings from L5 and L7 localities expressing the lowest values; While, the second includes the other localities (L1, L2, L3, L4 and L6).

For the rooting rate, the obtained results show a maximum rooting percentage of 71%, 63% and 58% respectively in cuttings from L3, L6 and L4 localities. They are followed by cuttings from L5 and L7 localities with rooting rates of 29% and 26% respectively. While no roots were observed in the cuttings from L1 and L2 localities (**Fig. 3**).

Analysis of variance (ANOVA) revealed a significant (P<0,01) difference between localities for the rooting rate. Tukey's test allowed us to identify three homogeneous groups. The first regroup includes the L3, L4 and L6 localities and the second regroup the L5 and L7 localities. While L1 and L2 localities constitute a distinct group without roots as can be seen in **Fig. 3**.

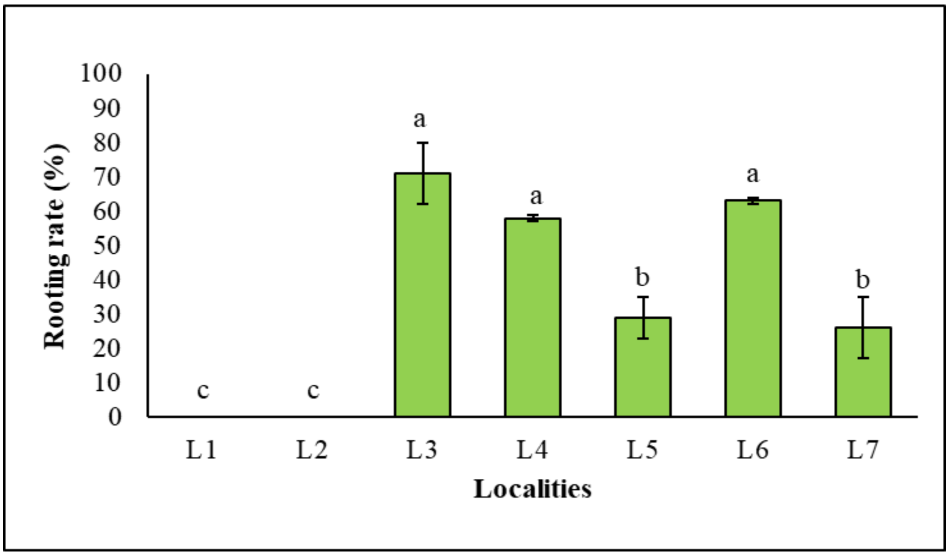


**Fig. 3.** Effect of locality on the rooting rate of *Rosa damascena* cuttings after 45 days of transplanting. Values are mean ± SE and histograms with the same letters are not significantly different ($p$ <0.05) according to Tukey's test

Regarding the development of shoots on cuttings, ANOVA analysis revealed a (P<0,01) significant difference between localities for the number of emitted shoots. The cuttings used for cultivation have emitted new shoots from the second week. However, after 45 days of cultivation, the highest number of shoots was obtained with cuttings from the locality (L7) with an average number of 5.9 shoots/cuttings (**Fig. 4**), followed by L3 locality with an average of 5 shoots/cutting. Whereas, the localities L1, L2, L4, L5 and L6 come in the 3$^{rd}$ position with an average number of 3.3 to 4.1 shoots/cuttings (**Fig. 4**).

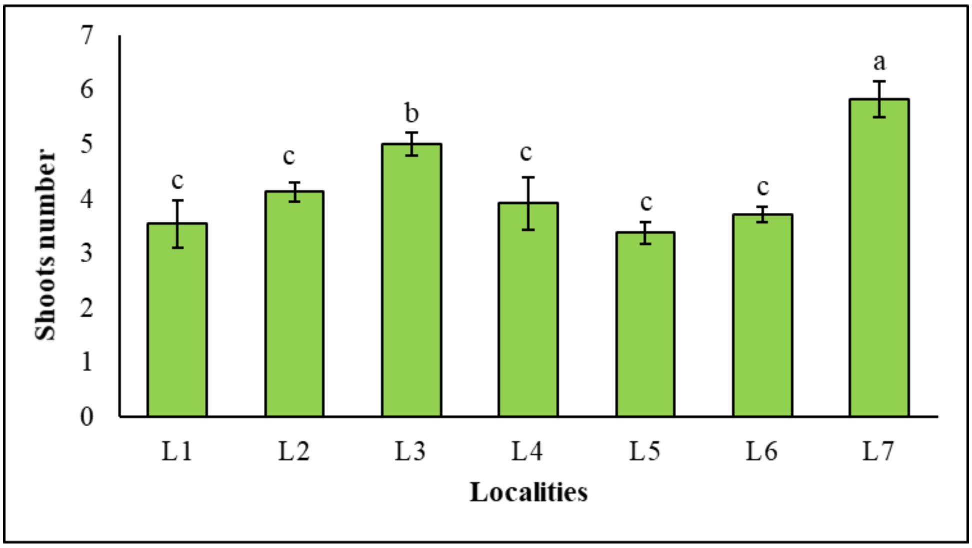


**Fig. 3.** Effect of locality on the shoots number of *Rosa damascena* cuttings after 45 days of transplanting. Values are mean ± SE and histograms with the same letters are not significantly different (p <0.05*)* according to Tukey's test

For leaf growth, cuttings from locality L7 have the highest number of leaves compared to other localities with an average of 2 leaves/cuttings, followed by localities L1 and L4 with 1.5 and 1.3 leaves/cuttings respectively **(Fig. 5)**. Whereas localities L2, L3, L5 and L6, have an average number of leaves which varies from 0.9 and 1 leaves/cutting. Analysis of variance and Tukey's test identified the homogeneous groups shown in **Fig. 5**.

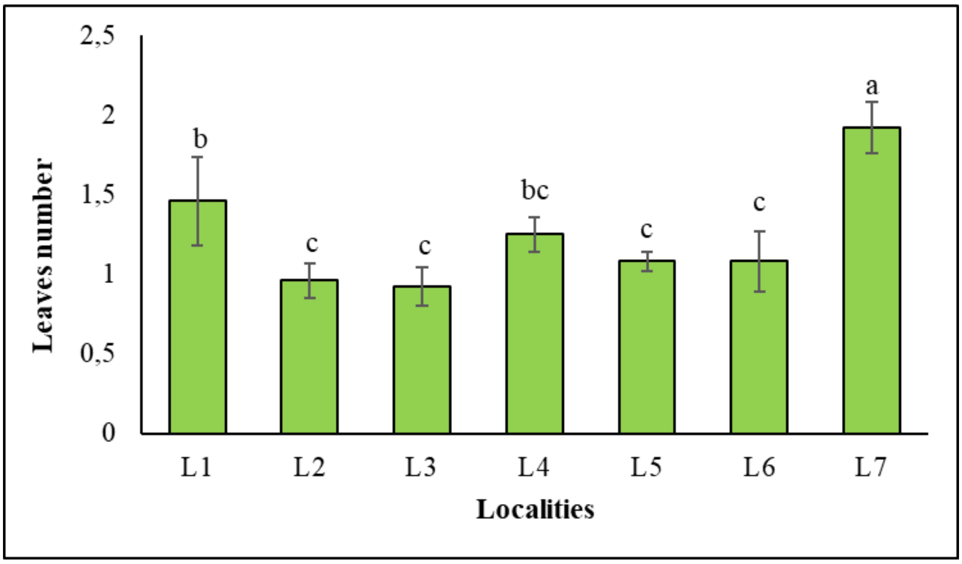


**Fig. 4.** Effect of locality on the number of leaves in *Rosa damascena* cuttings after 45 days of transplanting. Values are mean ± SE and histograms with the same letters are not significantly different (p <0.05) according to Tukey's test

### 3.2. Combined effects of locality and auxin treatment on the cuttings of *Rosa damascena* from M'gouna-Dades.

In the present study, the effect of IBA doses (0, 2000 and 4000 ppm) on survival rate, rooting rate, shoots and leaves number on *Rosa damascena* cuttings has been studied. The obtained results are presented in **Table 2 and Figs. 6-10.**

**Table 2.** Tukey's test of Combined effects of locality and IBA concentration (0; 2000 and 4000 ppm) on the survival rate (%), rooting rate (%), shoot number and leaves number of *Rosa damascena* cuttings after 45 days of transplanting. T0: 0 ppm IBA, T1: 2000 ppm IBA and T2: 4000 ppm IBA. Values are mean ± SE and values with the same letters are not significantly different (p <0.05) according to Tukey's test

| Locality | Treatment (IBA ppm) | Survival rate (%) | Rooting rate (%) | Shoots number | Leaves number |
|---|---|---|---|---|---|
| L1 | 0 | $92 \pm 28^{a}$ | $00 \pm 00^{f}$ | $3.54 \pm 0.44^{fg}$ | $1.46 \pm 0.28^{fg}$ |
| | 2000 | $13 \pm 70^{ef}$ | $00 \pm 00^{f}$ | $5.21 \pm 0.17^{bcd}$ | $1.83 \pm 0.13^{ef}$ |
| | 4000 | $13 \pm 70^{ef}$ | $13 \pm 70^{def}$ | $5.79 \pm 0.21^{ba}$ | $2.33 \pm 0.18^{cde}$ |
| L2 | 0 | $71 \pm 18^{ab}$ | $00 \pm 00^{f}$ | $4.13 \pm 0.18^{ef}$ | $0.96 \pm 0.11^{g}$ |
| | 2000 | $17 \pm 80^{def}$ | $04 \pm 40^{ef}$ | $5.54 \pm 0.16^{bcd}$ | $2.54 \pm 0.29^{bcd}$ |
| | 4000 | $13 \pm 70^{ef}$ | $00 \pm 00^{f}$ | $3.63 \pm 0.23^{fg}$ | $1.08 \pm 0.17^{g}$ |
| L3 | 0 | $71 \pm 90^{ab}$ | $71 \pm 90^{a}$ | $5.00 \pm 0.21^{bcd}$ | $0.92 \pm 0.12^{g}$ |
| | 2000 | $71 \pm 90^{ab}$ | $67 \pm 10^{a}$ | $5.54 \pm 0.13^{bcd}$ | $3.29 \pm 0.13^{a}$ |
| | 4000 | $75 \pm 90^{ab}$ | $71 \pm 90^{a}$ | $4.00 \pm 0.17^{f}$ | $2.33 \pm 0.25^{cde}$ |
| L4 | 0 | $71 \pm 90^{ab}$ | $58 \pm 10^{ab}$ | $3.92 \pm 0.48^{f}$ | $1.25 \pm 0.11^{g}$ |
| | 2000 | $71 \pm 90^{ab}$ | $67 \pm 10^{a}$ | $4.96 \pm 0.19^{cd}$ | $2.04 \pm 0.07^{de}$ |
| | 4000 | $71 \pm 90^{ab}$ | $67 \pm 10^{a}$ | $2.88 \pm 0.34^{gh}$ | $2.22 \pm 0.29^{cde}$ |
| L5 | 0 | $46 \pm 10^{bcde}$ | $29 \pm 60^{cd}$ | $3.38 \pm 0.20^{fg}$ | $1.08 \pm 0.06^{g}$ |
| | 2000 | $08 \pm 80^{aef}$ | $06 \pm 40^{ef}$ | $2.25 \pm 0.39^{h}$ | $0.38 \pm 0.12^{h}$ |
| | 4000 | $01 \pm 10^{cdef}$ | $04 \pm 40^{ef}$ | $2.13 \pm 0.07^{h}$ | $1.29 \pm 0.09^{g}$ |
| L6 | 0 | $63 \pm 10^{abc}$ | $63 \pm 10^{ab}$ | $3.71 \pm 0.14^{f}$ | $1.08 \pm 0.19^{g}$ |
| | 2000 | $42 \pm 10^{bcde}$ | $42 \pm 10^{c}$ | $4.83 \pm 0.20^{de}$ | $3.04 \pm 0.20^{ab}$ |
| | 4000 | $21 \pm 80^{def}$ | $21 \pm 80^{cdef}$ | $4.96 \pm 0.32^{cd}$ | $2.67 \pm 0.13^{bc}$ |
| L7 | 0 | $05 \pm 10^{bcd}$ | $26 \pm 90^{cde}$ | $5.83 \pm 0.32^{ab}$ | $1.92 \pm 0.16^{ef}$ |
| | 2000 | $13 \pm 70^{ef}$ | $13 \pm 70^{def}$ | $6.46 \pm 0.21^{a}$ | $3.08 \pm 0.23^{ab}$ |
| | 4000 | $00 \pm 00^{f}$ | $00 \pm 00^{f}$ | $5.29 \pm 0.28^{bcd}$ | $2.67 \pm 0.21^{bc}$ |

As shown in **Fig. 6**, the L1, L2, L3, L4 and L6 localities express the highest survival rates in the absence of auxin treatment with percentages that exceed 60%. The application of auxin reduced significantly (P <0,01) the survival rate of cuttings from L1, L2, L5, L6 and L7 localities with a reduction rate ranging from 33% (L6 cuttings treated with 2000 ppm IBA) to

100% (L7 cuttings treated with 4000 ppm IBA). However, no significant effect was observed in cuttings from localities L3 and L4 regardless of the applied treatment with survival rates exceeding 70% **(Fig. 6)**.

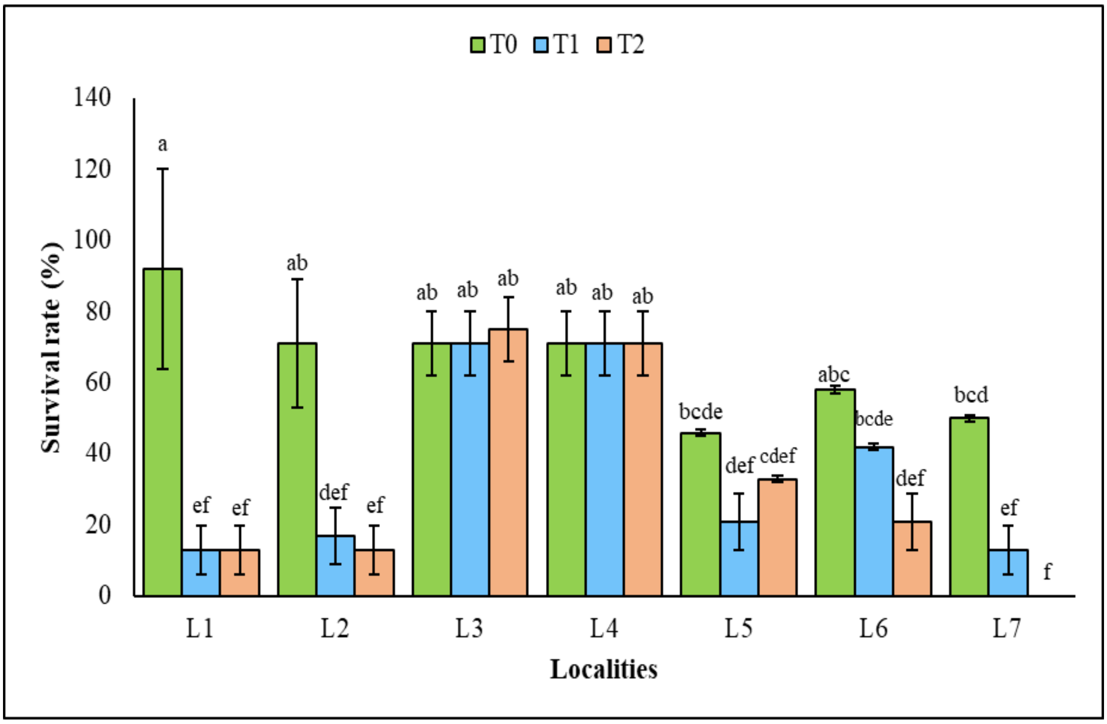


**Fig. 5.** Combined effects of locality and IBA concentration on the survival rate of *Rosa damascena* cuttings after 45 days of transplanting. T0: 0 ppm IBA, T1: 2000 ppm IBA and T2: 4000 ppm IBA. Values are mean ± SE and histograms with the same letters are not significantly different ($p < 0.05$) according to Tukey's test

For the rooting rate, in the absence of auxin treatment, only the L3, L4 and L6 localities have a rooting rate that exceeds 60% **(Fig. 7)**. However, no root was observed in the absence of auxin for cuttings from the localities L1 and L2. The application of auxin induced a slight increase in the rooting rate after treatment with 4000 ppm of IBA (13%) on cuttings from locality L1 and after treatment with 2000 ppm of IBA (4%) on cuttings from locality L2. While no significant effect was observed in cuttings from locality L3 regardless of the applied treatment with a rooting rate exceeding 60%. For cuttings from the L4 locality, a significant increase of 15% was observed with both treatments. Regarding localities L5, L6 and L7, the application of auxin reduced significantly the rooting rate of cuttings regardless of the used concentration **(Fig. 7).**

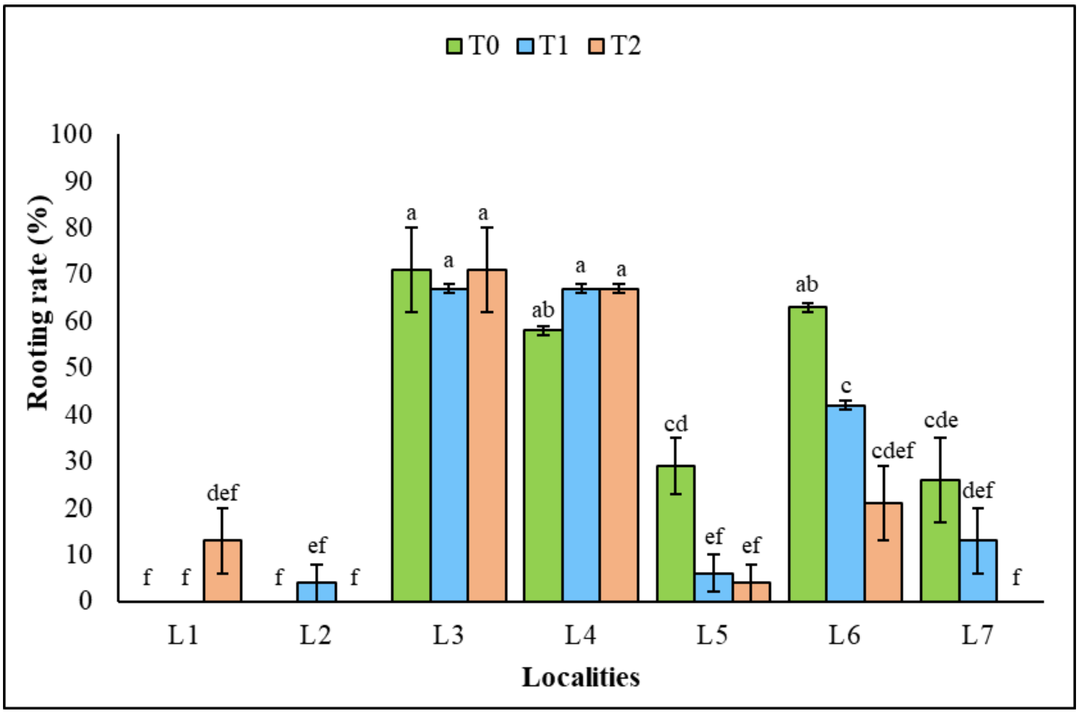


**Fig. 6.** Combined effects of locality and IBA concentration on the rooting rate of *Rosa damascena* cuttings after 45 days of transplanting. T0: 0 ppm IBA, T1: 2000 ppm IBA and T2: 4000 ppm IBA. Values are mean ± SE and histograms with the same letters are not significantly different ($p < 0.05$) according to Tukey's test

Regarding the shoots number per cutting, a significant increase (ranging from 10% to 47% compared to the control) was observed after treatment with IBA (2000 ppm) at the level of all localities except for locality L5 where a decrease (33%) in the number of shoots was observed (2.2 shoots/cutting) (**Fig. 8)**.

Whereas, the application of 4000 ppm of IBA induced an increase in the number of shoots which varied from 33% to 63% at the level of the cuttings coming from the localities L1 (5.8 shoots/cuttings) and L6 (5 shoots/cuttings). While, at the level of the other localities, a decrease in the number of shoots was observed (which varied from 9% to 37%) (**Fig. 8**).

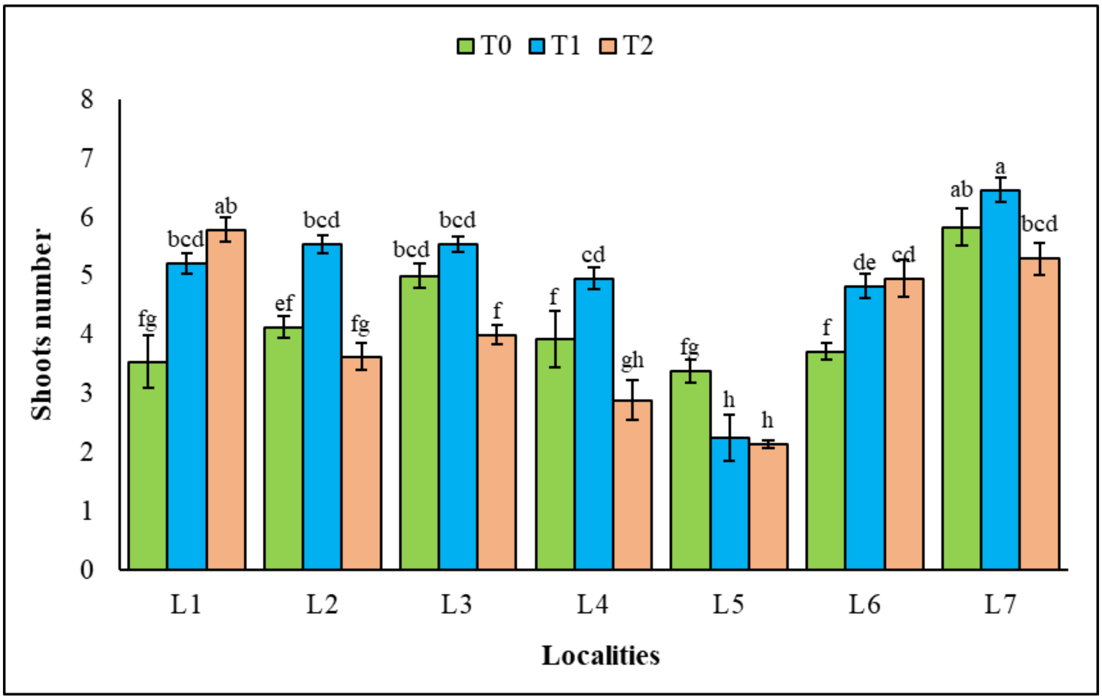


**Fig. 7.** Combined effects of locality and IBA concentration on the number of shoots from *Rosa damascena* cuttings after 45 days of transplanting. T0: 0 ppm IBA, T1: 2000 ppm IBA and T2: 4000 ppm IBA. Values are mean ± SE and histograms with the same letters are not significantly different ($p < 0.05$) according to Tukey's test

For the average number of newly formed leaves, the obtained results follow the same distribution as the number of shoots with a maximum of 3.3 leaves at the level of cuttings from locality L3 treated with 2000 ppm IBA (**Fig. 9**). In all localities (exception of locality L5), an increase in the number of newly formed leaves was observed after treatment with IBA (2000 ppm and 4000 ppm). It generally varies from 1.8 leaves on cuttings from locality L1 treated with 2000 ppm IBA to 3.3 leaves on cuttings from L3 locality treated with 2000 ppm. Whereas, for cuttings from locality L5, the application of 2000 ppm of IBA reduced the number of newly formed leaves (0.38 leaves) compared to control (1.1 leaves). While application of 4000 ppm IBA resulted in a slight increase in the number of leaves (1.3 leaves) (**Fig. 9**).

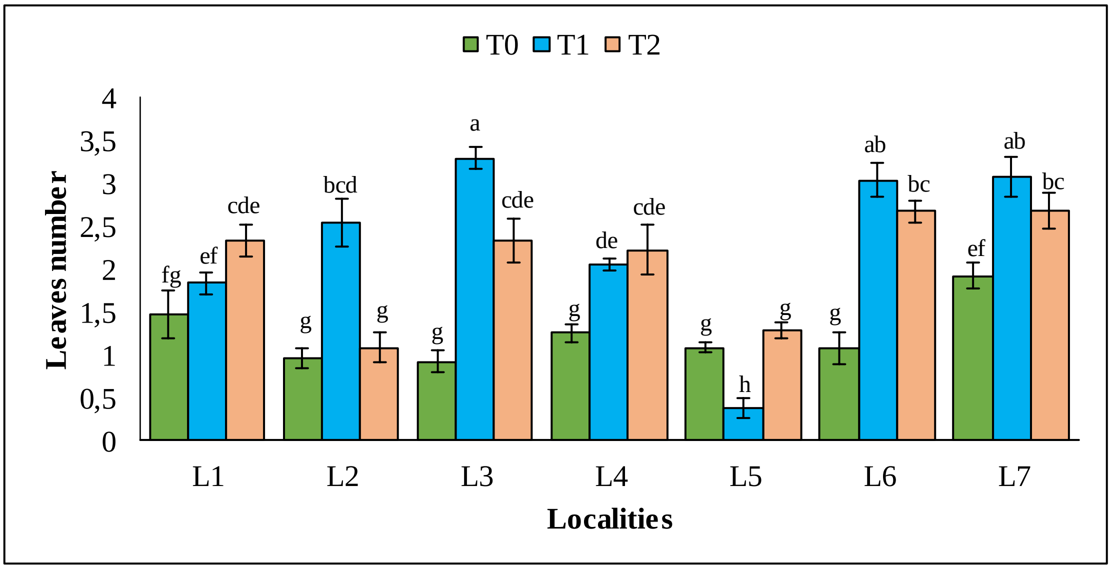


**Fig. 8.** Combined effects of locality and IBA concentration on the number of leaves of *Rosa damascena* cuttings after 45 days of transplanting. T0: 0 ppm IBA, T1: 2000 ppm IBA and T2: 4000 ppm IBA. Values are mean ± SE and histograms with the same letters are not significantly different ($p < 0.05$) according to Tukey's test

The limiting factor for successful cuttings is rooting. Considering the total number of cuttings, the success rate of cutting is 30%. However, this rate varies also according to the origins of the cuttings from 69% in cuttings of L3 and L5 localities to 1% in cuttings from L2 locality. The application of auxin had no significant effect on rooting during this experiment. However, the cuttings treated with IBA have a more developed root system characterized by a large size and high root number as can be seen in **Figs 10 and 11**.


**Fig. 9.** Morphological appearance of *Rosa damascena* cuttings roots after 45 days of cultivation. **a**: cutting without IBA treatment, **b**: cutting treated with IBA (2000ppm).

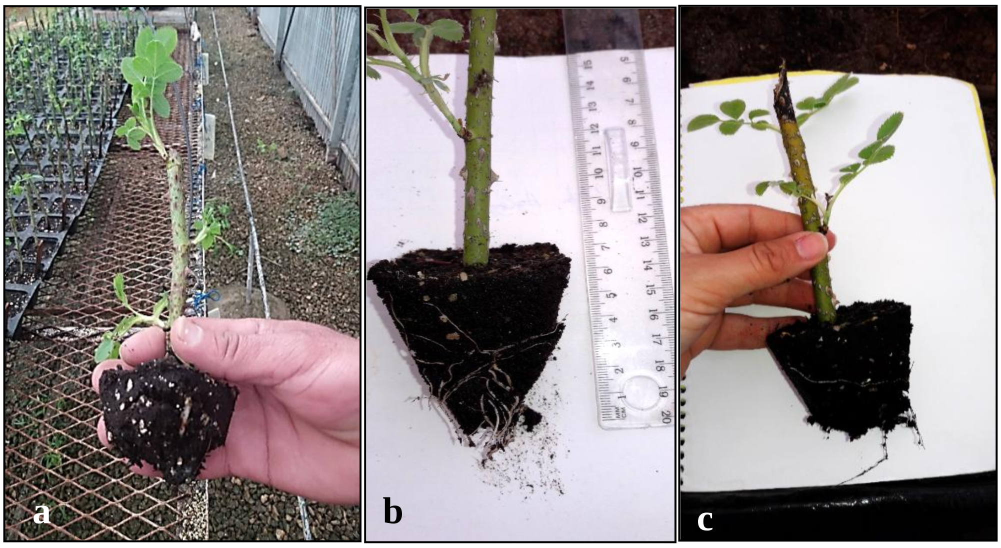


**Fig. 10.** Morphological appearance of *Rosa damascena* cuttings. **a**: non-treated cuttings; **b:** cuttings treated with 2000 ppm IBA; **c**: cuttings treated with 4000 ppm IBA.

## 4. Discussion

The multiplication of *Rosa damascena* in the M'gouna-Dades area constitutes a handicap for the crop, since propagation by root rejection delays flowering as well as flower bud yield until the third year after cultivation.

In this study, the data relating to the different parameters (survival rate, rooting rate, shoots and newly formed leaves number) were collected after 45 days of culture, during the first transplantation of healthy cuttings. This choice was based on the results of preliminary studies, where it was found that the process of rooting begins after 25 days of culture (data not shown). This is in agreement with other studies describing the cutting conditions of *Rosa damascena* (Hartmann and Kester 1975, Hartmann et al. 2002; Nikbakht et al. 2005). However, other authors have evaluated this parameter from the third month of culture. Although, it has been noted that in other studies this period is extended to four months (Khosh-khui and Tafazoli 1979; Sohail Khan et al. 2006; Nasri et al. 2015).

In this study, cuttings from seven localities were cultivated. The obtained results show a total average survival rate of 66%. However, in the absence of auxin treatment, this parameter varies between 46% (minimum) for cuttings from locality L5 and 92% (maximum) for cuttings from locality L1. These values are similar to those obtained by Laribi et al. (2013) in

their study on the effect of the type of cuttings and of the auxin treatment on the cuttings of a Tunisian ecotype of *Rosa canina*, neighboring species and a probable ancestor of *Rosa damascena* (Mill) (Iwata et al. 2000). In this study, a semi-woody cutting (between 1 and 1.5 cm in diameter) was used to facilitate cell dedifferentiation. The differences observed between the cuttings could be linked mainly to intrinsic factors (Hassanein 2013; Villa et al. 2018).

The rooting remains the limiting factor for the success of the cuttings and the vegetative propagation in general (Tsaktsira et al. 2021). Indeed, it is the development of the root system that allows the growth and supply of nutrients and thus the development of the plant (Hartmann et al. 2002). However, the rooting capacity and the percentage of cuttings successful generally depend on many factors, such as; genotype, season, origin, age of the mother plant, the part of the plants used as well as the soil and climatic conditions of the region (Kumaresan et al. 2019; Tsaktsira et al. 2021). In this study, the observed differences, in the absence of auxin treatment, are due mainly to the origin of the cuttings, as well as to intrinsic and/or genetic factors. Despite the spatial spacing between localities, plants with common morphological characteristics react in the same way towards cuttings as is the case of cuttings from localities L5, L6 and L7 which have similar survival and rooting rates.

The average rooting rate obtained in this study, in the absence of auxin treatment, is 35%. However, a significant difference between localities was noted since this rate varies between 0% obtained in cuttings from localities L1 and L2 and 71% in cuttings from locality L3. These results show that the capacity and rooting rate of *Rosa damascena* cuttings from the M'gouna-Dades area differs considerably from one locality to another. This effect is also highlighted by Ghazghali-Albouchi (2012) in a study on two indigenous rose species (*Rosa canina* and *Rosa sempervirens*) at three stations in Tunisia. This author reported significant differences between the cuttings of different origins in terms of length and the number of emitted roots, as well as the survival rate of the cuttings. Nasri et al. (2015), working on *12 Rosa damascena* genotypes from Kurdistan, found that the rooting rate varied between 0% and 79%, thus demonstrating the effect of the genotype on cuttings. In other studies, on *Rosa damascena* (Hajian and Khoshkhoy 2000; Pourkhaloee and Khosh-Khui 2013; Erol and Altun 2017), the authors have shown that the rooting rate generally varies between 3.3% and 97%, which is in agreement with the results obtained in this work.

Regarding the emergence of shoots and leaves, a significant difference was noted between the different localities. The maximum number of shoots (5.8) was observed at the level of cuttings from locality L7 and the minimum (3.5) was observed at the level of localities L1, L4, L5 and L6. While for the leaves, the maximum number (2) was observed at the level of the cuttings of locality L7 and the minimum (1) at the level of the cuttings of localities L2, L3, L5 and L6. The differences between cuttings in the emergence of shoots and new leaves could be due to the variation in their growth rate, which is usually controlled by genetic factors (Nasri et al. 2015; Tsaktsira et al. 2021). However, the emission of shoots and leaves is mainly linked to the handling of cuttings during transplanting and also to the humidity level. It can also be due to the nutritive reserves of the cutting therefore to the locality effect. But it is a rather negative sign because a cutting that gives quickly shoots consumes its reserves quickly which can induce its senescence. This explains the low survival rates in cuttings whose average number of shoots exceeds 4 shoots/cuttings; as is the case with cuttings from localities L1, L2, L5 and L7 that express low survival and rooting rates. Mature leaves help to root by initiating the process of photosynthesis, while new shoots are parasites since they require reserves.

Plant growth regulators also play an important role in root formation and the growth of cuttings. The effect of these regulators varies according to the concentration of applied hormone as well as the treated species (Kumaresan et al. 2019). Auxins are the most used hormones to improve the rooting of different types of cuttings. Among these auxins, IBA is the most widely used to promote root initiation and the production of adventitious roots in cuttings (Pop et al. 2011; Da Costa et al. 2013).

Nasri et al. (2015) highlighted the role of auxin on cutting and found that the response to auxin treatment varies significantly between genotypes. These results are consistent with those of the present study. Indeed, the optimization of rooting by rapid soaking (less than a minute), long soaking (a few minutes) or by using powdered auxin, has been approved by several authors. However, the 2000 ppm dose gave the best results for the *Rosa damascena* species (Hajian and Khoshkhoy, 2000; Rushi and Debergh, 2001; Pati et al. 2004; Erol and Altun 2017). Ghosh et al. (2017), have studied the rooting of *Rosa damascena* cuttings and have obtained the best results with a concentration of 1000 ppm of IBA. Although, these authors obtained the best results for the survival rate of the cuttings and the duration of formation of the shoots with an application of 500 ppm of IBA.

In this study, this effect was not observed. Although, it was noted (during the second transplant after two months of cultivation) that the diameter and the number of roots are visibly important in the presence of IBA. We can say the effect of IBA is linked to the plant origin, its physiological state and in particular its sugar reserves since the indirect effect of IBA on rhizogenesis is reflected by the translocation of carbohydrates that stimulate the division and differentiation of cells at the base of the cuttings to initiate roots (Marcelis-van Acker 1995). The auxin treatment induced a slight increase of 14% in the rooting rate in the cuttings from localities L1, L2, L3 and L4. While a reduction in this rate was observed in the cuttings from the other localities. The low rooting rate of cuttings (L1, L2, L3 and L4) and the negative effect of auxin treatment observed in cuttings from L5, L6 and L7 localities could be explained (in addition to the intrinsic (genetic) effect), by the high concentration of IBA used in this study. Indeed, it has been shown that a low dose of IBA (500 ppm) had a beneficial effect on the rooting parameters while the high dose of IBA (1500 ppm) affect negatively the rooting (Erol and Altun 2017).

## 5. Conclusion

The results of this study showed that the propagation of *Rosa damascena* (Mill), from M'goun-Dade valleys, by cutting can promote this culture. However, the optimization of this method is linked to the choice of plants origin of the cuttings. The individuals belonging to the same morphotype act in the same way with regard to cuttings. In fact, the samples from localities L1 and L2 belonging to the same morphotype express the lowest rooting rates. However, samples from L3 and L6 express the optimal rooting rates. This further supports the hypothesis of the cohabitation of several genotypes of *Rosa damascena* in the M'goun-Dades valleys, reported in a previous agro-morphological study (Ait Hida et al. 2019) .

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