

A Study on Vegetative Propagation of Juvenile and Mature *Chrysophyllum oliviforme* Trees

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ABSTRACT

The present work was conducted during 2015 and 2016 seasons at the Tropical Farm, Aswan Botanical Garden, Agric. Res. Inst. to study the possibility of propagated *Chrysophyllum oliviforme* L. vegetatively. Semi-hardwood cuttings from juvenile (3 years old) and mature (30 years old) *C. oliviforme* trees were used to test their prospect to form the adventitious roots. The growth media consisted of 2:1 peat: perlite (v: v) ratio and the base of cuttings were soaked for 24 h. in different IBA concentrations (0, 1000, 2000, 4000 and 5000 ppm). The obtained results showed significant differences in the root and shoot development of cuttings with a higher rooting parameters for the young than mature trees. Using the high hormone concentrations (4000- 5000 ppm) increased the rooting percentage and growth parameters compared to the low concentrations (1000- 3000 ppm). However, the anatomy of cuttings postulate that sectors of mature trees had a thicker stripe of xylem vessels and additional cell layers of sclerenchyma than sectors from juvenile trees. Also, cambium was more differentiated with high activity in young trees than in the mature one. You can say that the presence of a continuous sclerenchyma layer can work as a physiological partition to the emerging root and increase with the aging of the tree.

Keywords: Cutting propagation, IBA, *Chrysophyllum oliviforme*, juvenile, stem anatomy.

INTRODUCTION

Chrysophyllum oliviforme L. (stainleaf) belongs to family Sapotaceae, the species is cultivated in many of tropical countries as ornamental tree and it lives wild in a region of Hawaii and French Polynesia (Pacific Island Ecosystems at Risk, 2002). Its wood is hard, heavy, strong and has a specific gravity of 0.9. The tree is used for construction in Cuba (Little and Wadsworth, 1964). It has been extensively used as an ornamental in Florida, Hawaii, and elsewhere. The tree makes a beautiful addition to the natural landscaping, a good basically plant, and an attractive garden, street, and parking lot tree. It may be necessary to maintain a single stem and removal of drooping branches by pruning (Gilman and Watson, 1993). Also they pointed out that *C. oliviforme* was propagated vegetatively by using misted hardwood cuttings and air layers, both treated with 0.3percent IBA (indole-butyric-acid). They added that tree production is by the seed and softwood cuttings under mist (Gilman and Watson, 1993). Propagation by seed is a confirmed method for establishing large plantations of *Chrysophyllum oliviforme* trees in Aswan, Egypt. On the other hand, vegetative propagation from superior specimens of this species resulted in selection and genetic improvement. Also, using vegetative propagation has the advantage of mass production, uniformity of vigor trees in a shorter time, propagating the exact replica of the parent species, the cloning of trees with important characteristics (Beardsell, 1985) and maintaining the genetic purity (Hartmann *et al.*, 1990). Uniformity character can be produced with cuttings from one selected clone at a given age, having the same diameter and height. These trees are much sought after, especially for wood properties and production. In addition, vegetative propagation leads to the opportunity for close matching of a selected clone to the special characteristics of a particular locality and is of great importance from a silvicultural point of view (Eldridge *et al.*, 1994).

In the tree improvement programs, rooting of cuttings is one of the most preferred methods (Libby

and Rauter, 1984). There are many factors play an important role on the success of rooting of cuttings as early selection of desired characters, age and the environmental interactions (Ali and El-Tigani, 2007). Rooting of cuttings from the wooden trees pointed out that the lignifications degree in the primary phloem affects the rooting succeed of cuttings from trees by hindering the root primordial tissue to the root initials development (Ali, 1986). In this respect, Ali and El-Tigani (2007) studied the vegetative propagation of *Acacia nilotica* by using stem cuttings from nursery seedlings and trees concluded that IBA at 10, 20, 50 and 100 mg/l improved the rooting ability in young and mature cuttings. Also, Carpenter *et al.* (1984) used IBA at 8000 ppm to root "new green stem" cuttings taken from juvenile red alder trees (4-to 5-year-old). They obtained enough rooted cuttings for their experiment. Radwan *et al.* (1989) show that red alder propagated by using semi- hardwood cuttings from shoots of young trees and epicormic sprouts of older trees, especially when IBA is applied. Using epicormic sprouts obtained from mature trees of proven performance will allow cutting propagation of presumably superior trees. Catherine *et al.* (2010) revealed that *Khaya senegalensis* saplings are amenable to clone propagation, allowing screening from multiplication and seedling populations of eventual resistant genotypes by semi-hardwood cuttings. Also, it can be summarized that seedlings and saplings have comparable growth patterns. Moreover, juvenile cuttings of *Tabebuia heterophylla* trees possess the ability to produce more roots compared with that of older cuttings as well as produces a larger root ball; these cuttings have a higher ability to survive (Awang *et al.*, 2011).

The weakness of the ability to rooting of plant species has been attributed to the presence of growth inhibitors (Ooyama, 1962), little or hormonal imbalance or rooting cofactors and the presence of natural barriers (Edwards and Thomas, 1980). There is numerous anatomical studies show that a relationship between the difficulty in rooting and the presence of a pericyclic

sclerenchyma layer (Beakbane, 1969). Edwards and Thomas (1980) suggest that the presence of a continuous sclerenchyma layer functions as a physiological constraint to adventitious root initiation or as a mechanical barrier to root emergence. Hicks and Gladstone (1971) pointed out that the density and occurrence of sclerenchyma cells in the cortex of cuttings for *Populus tremuloides* Michx. was found to increase with tree age. They added that when subject to favorable rooting conditions, cuttings from mature trees failed to form root primordia, while those from juvenile root suckers succeeded. Hackett (1985) pointed that nutritional status, environmental and genetic factors affect the length of the juvenile periods. Trees reach to the stage of maturity goes hand in hand with a decline in the growth rate during the post embryonic juvenile vegetative phase to the adult reproductive phase, increased plagiotropism, and changes in reproductive competence, branching characteristics and foliar morphology. On the other side, there are many physiological, biochemical and anatomical changes with the move to the adult phases (Greenwood and Hutchinson, 1993; Husen and Pal, 2006). Husen and Pal (2006) on the anatomical characteristics of shoot for *Tectona grandis* shows that there are significant differences between them and found that variations in the anatomy of shoot can be used as an indicator of juvenility/maturity in teak. Accordingly, the purpose of this research was designed to study the effect of age of the tree and the IBA concentrations on adventitious root formation in semi hardwood cuttings of *Chrysophyllum oliviforme*. Also, the anatomical features of sapling and mature tree shoots were studied to determining if these could be used as markers of maturity in these trees.

MATERIALS AND METHODS

The experiment was carried out during February of 2015 and 2016 seasons at Kom- Omba Tropical Farm, Aswan Botanical Garden, Aswan Governorate, Egypt to study the impact of age of trees and IBA concentrations on the rooting capability of cuttings for *Chrysophyllum oliviforme* L.

Procedures:

Cuttings were prepared from mature (30 years old) and saplings (3 years old) *Chrysophyllum oliviforme* L.; these trees were located in the tropical farm and they were selected on the basis of excellence in important traits such as growth faster and straightening the tree trunk. Semi-hardwood cuttings were taken from lateral branches; cuttings were 12-15cm length, 0.5- 1.0 cm diameter, with 4 to 5 nodes; leaves of cuttings were cut in order to reduce evaporation. Cuttings were hormone treated and planted immediately after treatment.

However, pure IBA was placed in 250 ml of alcohol and diluted with distilled water to get the concentrations required for each treatment (1000, 2000, 4000 and 5000 ppm), then the cuttings were treated by IBA by soaking cutting base in aqueous solution or distilled water (as control) for 24 hours; they were then

placed on the growth medium, which previously prepared before the cuttings had been cut. The substrate consisted of 2:1 peat: perlite medium (v: v) proportion and then placed inside 24 x 24 cm black polyethylene bags, filling only 75%. The cuttings were individually set in the growth media at approximately 8- 10 cm deep, irrigation has been using a very fine sprayer and put bags on shelves in a Ceram house. The cuttings were covered by plastic and test the moisture of growth medium every few days and have irrigation when necessary.

Experimental design and observations:

The experiment was sit in a completely randomized design, with 5 IBA concentrations (0, 1000, 2000, 4000 and 5000 ppm) and two cuttings type (mature and sapling trees) with three replicates of 8 cuttings per experimental unit, for a total of 240 cuttings by the end of the experiment. Measurements were taken on, number of rooted cuttings, adventitious root number, root length, root dry weight; leaf number and leaf dry weight at 3 months after treatments. Root length was measured along with the three longest roots measured on the cutting. Also, the roots and leaves dry weights produced by the cuttings were recorded after drying the plant parts for 72 h at 70°C.

Chemical analysis:

Chemical analysis of dried samples (at 3 months after treatments) of the basal 2 cm of cuttings was conducted to determine the total carbohydrates and nitrogen contents. Total carbohydrate content (% of dry matter) was calorimetrically determined with the anthrone sulphuric acid according to the method described by Fales (1951). Total nitrogen (% of dry matter) was also measured using the Kjeldahl method as Hambrick *et al.* (1991). Then, carbon/nitrogen ratio (C/N ratio) was calculated.

Anatomical study:

To study the anatomy of the cutting, it was taken 5 cuttings of each age (sapling and mature *Chrysophyllum oliviforme* trees) were collected and processed for sectioning. It was soaked fresh cutting of stems at least 48 hours in formalin acetic acid alcohol solution and preserved in 70% alcohol, then dehydrated in ethyl alcohol series. It was taken sectors by using a rotary microtome and stained in safranin and fast green and then mounted in canada balsam (Johansen, 1940). Sectors were examined using a light microscope to view the slides and adjusted to finest resolution. The capture photos using a Nikkon digital camera installed on the microscope eyepiece.

Statistical analysis:

Data were tabulated and statistically analyzed according to the method by Snedecor (1956), and L.S.D mentioned by Little and Hills (1978).

RESULTS

The results of indolebutyric acid (IBA) treatments after 3 months on rooting percentage, main root number and length of roots/ cutting among mature and sapling *Chrysophyllum oliviforme* trees are given in

Table (1). Cutting from sapling trees demonstrated higher rooting percentage, main root number and main root length than from mature one during the two seasons. On the other hand, IBA treatments were found very effective and the differences between concentrations were significant for root formation in *C. oliviforme* cuttings either for sapling or mature trees. A

maximum rooting percentage (78.01%) and root number (6.51) was achieved in cuttings from sapling trees with the application of 5000 ppm IBA treatment, while cuttings from sapling trees with 4000 ppm IBA produce maximum of main root length/ cutting (5.31 cm) as mean of the two seasons.

Table 1. Rooting percentage and number and length of roots per cutting coming from mature or sapling of *Chrysophyllum oliviforme*, submitted to different concentrations of indolebutyric acid (IBA) during 2015 and 2016 seasons.

IBA conc.ppm(A)	2015			2016		
	Origin of cutting(B)		Averages	Origin of cutting(B)		Averages
	Mature trees	Sapling trees		Mature trees	Sapling trees	
	Rooting percentage					
0	1.39	23.61	12.50	1.39	23.61	12.50
1000	11.11	33.33	22.22	16.67	40.28	28.48
2000	21.39	40.28	30.84	33.33	45.28	39.31
4000	33.33	53.11	43.22	45.83	62.50	54.17
5000	45.83	77.78	61.81	51.39	78.24	64.82
Averages	22.61	45.62	29.72	49.98		
LSD 5% A: 0.86	B: 1.77	AxB:2.50		A:2.96	B:1.35	AxB:1.91
	Average number of roots/ cutting					
0	1.00	3.01	2.01	1.00	3.12	2.06
1000	2.63	3.76	2.20	3.12	4.27	3.70
2000	3.75	4.48	4.12	4.56	5.48	5.02
4000	4.39	5.39	4.89	5.28	6.30	5.79
5000	5.55	6.33	5.94	6.35	6.69	6.52
Averages	3.46	4.59	4.06	5.17		
LSD 5% A: 0.32	B: 0.27	AxB:0.38		A:0.11	B:0.21	AxB:0.29
	Average length of root/cutting (cm)					
0	1.02	2.27	1.65	0.99	2.61	1.80
1000	3.30	4.58	3.94	3.30	4.56	3.93
2000	4.52	5.04	4.78	4.45	4.90	4.68
4000	4.79	5.19	4.99	4.86	5.44	5.15
5000	4.51	5.10	4.81	4.34	5.11	4.73
Averages	3.63	4.44	3.59	4.52		
LSD 5% A: 0.31	B: 0.13	AxB:0.18		A:0.05	B:0.14	AxB:0.20

The results of number of leaves and leaves and roots dry weight per cutting coming from mature or sapling of *C. oliviforme* trees, submitted to different concentrations of IBA during are tabulated in Table (2). There were a significant differences in all the attributes measured for different treatments. The concentration of 4000 ppm gave the highest leaves number (4.83) and roots dry weight (33.50 mg), while the highest value (1.48 gm) of dry leaves was recorded with IBA at 5000

ppm as mean of seasons. Concerning the interaction between the tree age and IBA concentrations and their effects on the number of leaves and leaves and roots dry weight per cutting, the highest value of leaves number and root dry weight was noticed with cutting from sapling trees that applied with IBA at 4000 ppm. On the other hand, IBA at 5000 ppm for cuttings from sapling trees produced the best result for the leaves dry weight in the two seasons.

Table 2. Number of leaves and leaves and roots dry weight per cutting coming from mature or sapling of *Chrysophyllum oliviforme*, submitted to different concentrations of indolebutyric acid (IBA) during 2015 and 2016 seasons.

IBA conc.ppm(A)	2015			2016		
	Origin of cutting(B)		Averages	Origin of cutting(B)		Averages
	Mature trees	Sapling trees		Mature trees	Sapling trees	
	Number of leaves					
0	0.36	1.96	1.16	0.43	2.89	1.66
1000	2.38	3.75	3.07	3.00	4.01	3.51
2000	3.52	4.42	3.97	3.86	4.94	4.39
4000	4.74	5.15	4.95	4.43	5.01	4.72
5000	3.86	4.81	4.34	3.94	4.74	4.34
Averages	2.97	4.02	3.13	4.32		
LSD 5% A: 0.04	B: 0.26	AxB:0.37		A:0.11	B:0.18	AxB:0.25
	Leaves dry weight (gm)					
0	0.45	0.95	0.70	0.30	0.90	0.60
1000	0.99	1.24	1.12	1.08	1.30	1.19
2000	1.24	1.35	1.30	1.21	1.36	1.29
4000	1.33	1.43	1.38	1.43	1.47	1.45
5000	1.41	1.51	1.46	1.48	1.51	1.50
Averages	1.08	1.30	1.10	1.31		
LSD 5% A: 0.18	B: 0.08	AxB:0.11		A:0.21	B:0.05	AxB:0.08
	Roots dry weight (mg)					
0	7.00	12.00	9.50	10.00	16.00	13.00
1000	15.00	18.00	16.50	28.33	30.00	31.67
2000	19.00	29.67	24.34	32.33	35.00	33.67
4000	27.33	34.33	30.83	34.67	37.67	36.17
5000	23.67	31.33	29.00	30.67	35.67	33.17
Averages	18.40	25.07	27.20	30.87		
LSD 5% A: 2.91	B: 1.69	AxB:2.39		A:2.01	B:2.61	AxB:3.69

The result from the study indicated that there were significant differences between treatments for nitrogen content, total carbohydrate % and C/N ratio in the cutting base of *C. oliviforme* during the two seasons as shown in Table (3). Also these characters vary with the type of cutting (tree age) and the concentration of IBA treatments. The cutting from sapling trees had higher nitrogen content, total carbohydrate % and C/N

ratio however, at 5000 ppm; the highest total carbohydrates % was recorded for the cutting base of sapling trees. The same trends was observed for the average C/N ratio, while at 5000 ppm the average nitrogen contents at the cutting base were the lowest for all the stem cutting types. The average nitrogen content was higher in the cutting base without IBA treatment (control) for all the stem cutting types.

Table 3. Nitrogen content, total carbohydrates and C/N ratio of the cutting base coming from mature or sapling of *Chrysophyllum oliviforme*, submitted to different concentrations of indolebutyric acid (IBA) during 2015 and 2016 seasons.

IBA conc.ppm(A)	2015			2016		
	Origin of cutting(B)		Averages	Origin of cutting(B)		Averages
	Mature trees	Sapling trees		Mature trees	Sapling trees	
	Nitrogen content (%)					
0	2.31	2.60	2.46	2.47	2.63	2.55
1000	2.11	2.43	2.37	2.43	2.46	2.45
2000	2.01	2.26	2.14	2.30	2.35	2.33
4000	2.10	2.21	2.16	2.19	2.30	2.25
5000	2.04	2.11	2.08	2.10	2.17	2.14
Averages	2.11	2.32		2.30	2.38	
LSD 5% A: 0.07	B: 0.08	AxB:0.12		A:0.05	B:0.09	AxB:0.12
	Total carbohydrates (%)					
0	13.69	16.33	15.01	14.08	16.02	15.05
1000	14.93	18.65	16.79	16.01	17.92	16.97
2000	16.00	21.44	18.72	17.82	20.06	18.94
4000	18.68	22.78	20.73	20.67	23.64	22.16
5000	20.33	23.88	22.11	22.15	24.23	23.19
Averages	16.73	20.62		18.15	20.37	
LSD 5% A: 0.81	B: 0.87	AxB:1.23		A:2.37	B:0.75	AxB:1.06
	C/N ratio					
0	5.93	6.29	6.11	5.72	6.11	5.92
1000	7.07	7.69	7.38	6.60	7.28	6.94
2000	7.98	9.36	8.67	7.74	8.55	8.15
4000	8.90	10.33	9.62	9.42	10.28	9.85
5000	9.97	11.32	10.65	10.57	11.17	10.87
Averages	7.97	9.00		8.01	8.68	
LSD 5% A: 0.48	B: 0.59	AxB:0.83		A:0.73	B:0.31	AxB:0.44

Semi- hardwood cutting from juvenile and mature trees of *Chrysophyllum oliviforme* showed similar basic anatomical structures (Figs. 1&2). The stems had a region of central pith, vascular tissue with internal phloem, xylem, cambium and external phloem; this was surrounded by cortical tissue. Moreover, central pith shape is more regular in the sections of cuttings from mature trees. Sections from mature trees had a thicker band of xylem vessels and more cell layers

of sclerenchyma than sections from juvenile trees. Silica is often present in elements, but it was higher in the mature trees than the juvenile one. Also, cambium is more differentiated with high activity in young trees than in the mature one. Cortex tissue in young trees is thicker and ended by a semi- continuous strip of pericycle fibers, while it is less in thickness and ended by batches of pericycle fibers in the mature trees.

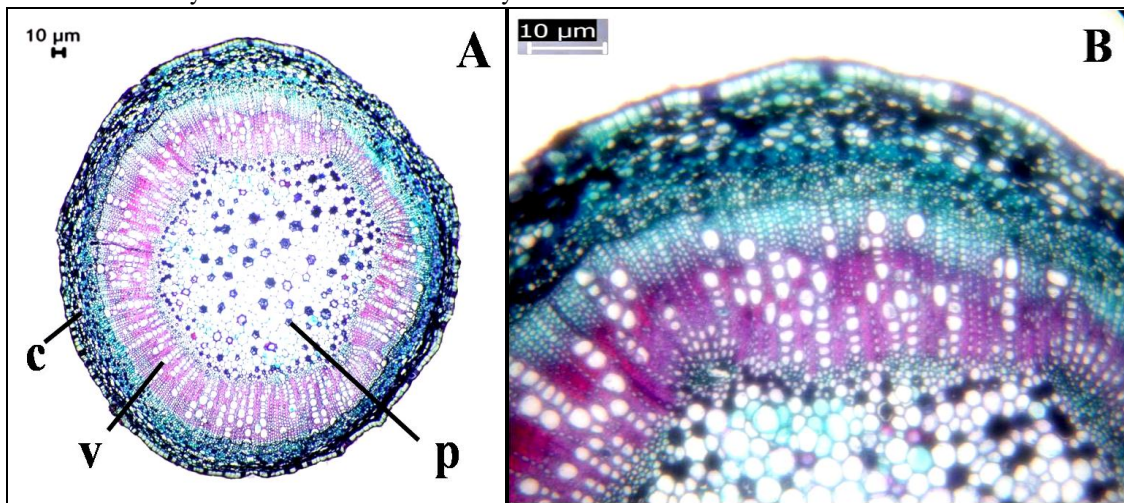


Figure 1. Transverse sections of the semi- hardwood cuttings of young *Chrysophyllum oliviforme* stock plants (3 years old), (A) the general view of the sector; magnification x= 10 and (B) an enlarged part showing the internal composition of the sector; magnification x= 40 from the same species, c = cortex; v = vascular tissue; p = pith. Scale bars = 10 µm.

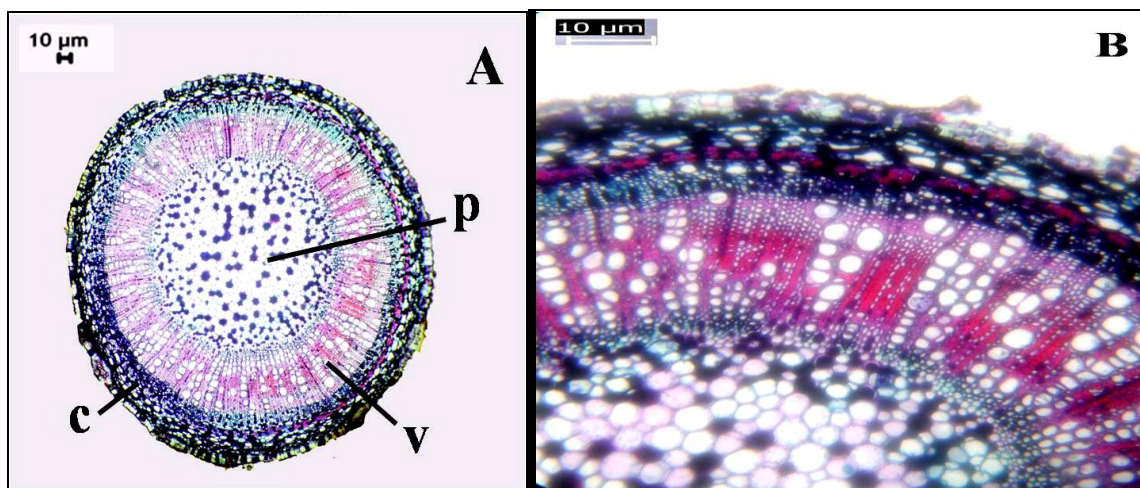


Figure 2. Transverse sections of the semi- hardwood cuttings of mature *Chrysophyllum oliviforme* stock plants (30 years old), (A) the general view of the sector; magnification x= 10 and (B) an enlarged part showing the internal composition of the sector; magnification x= 40 from the same species, c = cortex; v = vascular tissue; p = pith. Scale bars = 10 µm.

DISCUSSION

Cutting from sapling trees of *Chrysophyllum oliviforme* demonstrated higher rooting percentage, main root number and main root length than from mature one during the two seasons. Also, cutting from sapling trees demonstrated higher leaves number and dry root and leaves compared to the mature one. The same trends were observed for the nitrogen content, total carbohydrate % and average C/N ratio. Generally, seedlings of woody plants pass through a juvenile stage before they become matured. These two stages are different in many ways. In some species, they can be easily recognized by morphological differences. Apart from their differences in morphological properties, most woody species are usually capable of exponential increase in size. However, the age of the tree from which cuttings are taken is often one of the most important factors affecting rooting response and early growth. For instance, when cuttings are obtained from trees 10 years of age or less, rooting is usually good; after 10 years it diminishes rapidly, and later more slowly. Rarely is it possible to obtain useful rooting of cuttings from trees older than 80 years (Ruden, 1972). Rooting percentage, root length and number, survival, and growth in and after the year of rooting, all decrease with increasing age of the parent tree (Girouard, 1970b and 1971). The percentage of rooting in the species *Karwinskia humboldtiana* was higher than that in *Karwinskia parvifolia* and this was dependent on the age of the plants, the type of stimulator, cutting, substrate, and conditions of cultivation (Henselova *et al.*, 2002). In *Eucalyptus grandis*, a juvenile characteristic can be preserved at the base of the plant in juvenile tissue and used in the vegetative propagation of difficult to root mature plants (Huang, 1993; Eldridge *et al.*, 1994). Rooting of cuttings from fir (*Abies nordmanniana*) trees was greatly reduced with age, while cuttings from the branches decreased less

dramatically (Nielsen *et al.*, 2009). However, the success of rooting in the stem cuttings depends upon the physiological condition of the mother plant, its nutritional status and general conditions of growth; type of cutting, pre- treatments and environmental conditions, including the growing season. The emergence of adventitious roots in cutting is basically a phenomenon of differentiation and growth at cellular level. The process of root regeneration is associated with the genetic properties of tree species and status and activities of interior plant hormones (Dhillon *et al.*, 2014).

The higher concentration of IBA (5000 and 4000 ppm) resulted maximum rooting characteristics of *C. oliviforme*, number of leaves and leaves and roots dry weight per cutting as well as the total carbohydrates and C/N ratio in cutting base, whereas the lowest value of nitrogen content in cutting base was recorded with the highest IBA concentrations. Improving of adventitious root formation in stem cuttings with plant hormones and commercial rooting media is well known in many plant species those are difficult-to-root (Purohit, 2002). In this respect, Nandi *et al.* (1997) on *Taxus baccata* and Nandi *et al.* (2002) on *Cedrus deodara* obtained that using IBA was more effective in inducing rooting in stem cutting. In these studies, the rooting percentage was increased as a result of increasing the concentration of plant hormones. Use of rooting hormone is conducive to improve the percentage of rooting and root quality of many of the tree species (Hartman and Kester, 1983). Use rooting hormone can indirectly affect the rooting by improving the speed of transition and movement of sugar to the base of cuttings and consequently stimulate rooting (Haissig, 1974). Also, application of 500µM IBA increased the number of roots on each rooted cuttings as compared with another concentrations applied; this may have an advantage by enhancing good anchorage when planted in the field. Monaco *et al.* (1980) on their studies of *Alnus rubra* revealed that cuttings from saplings were rooted well after using 4000 and 8000 ppm IBA treatment. Also, results of Radwan

et al. (1989) show that red alder can be vegetatively propagated by using softwood cuttings from shoots of young trees and sprouts of older individuals, especially when IBA is employed. Moreover, Salami and Hesami (2016) confirm that taking date and cutting ages affect of *Ficus religiosa* rooting. Bryant and Trueman (2015) postulated that auxin-treated eucalypt cuttings can produce roots at multiple positions around the vascular tissue. Auxins can be a successful material for increasing rooting ability in cuttings.

The rooting parameters of *Chrysophyllum oliviforme* cuttings were related to their stem anatomy. The cuttings of mature trees, which have a less ratio and vigor of rooting was more lignified and had a denser ring of sclerenchyma than that of sapling trees for the same species. Pohio *et al.* (2005) and Hartmann *et al.* (2011) found that a continuous rings of sclerenchyma are often formed exterior to the region of adventitious root formation as the stem develops; rooting capacity is sometimes negatively associated with the continuity or number of cell layers of the ring (Amisshah *et al.*, 2008). It could be argued that there is no direct causal relationship between sclerification and reduced rooting capacity, as adventitious roots can emerge through breaks in the sclerenchyma that form during root or stem growth, and cuttings of species that difficult to rooting often fail to form root primordia irrespective of their sclerenchyma development (Hartmann *et al.*, 2011). Also, Pijut *et al.* (2011) and Wendling *et al.* (2014) pointed out that rooting potential may be related to stem anatomy, as soft cuttings often provide higher rooting than semi-firm or lignified cuttings. Cuttings from older stock plants can be more lignified and possess a continuous ring of sclerenchyma that could act as a mechanical barrier to root formation (Maynard and Bassuk, 1996). Therefore, our study pointed out that auxin-treated *C. oliviforme* cutting can produce roots around the vascular tissue especially that from saplings and so propagation methods can aim to produce more roots and leaves.

CONCLUSION

The study shows that there are differences in the roots and shoot development of the stem cuttings. The age of the trees has a significant effect on the response of rooting of stem cuttings in *Chrysophyllum oliviforme*. Cuttings from juvenile trees root easily, while the rooting percentage is lower in mature trees. Using of IBA caused a significant effect on the rooting and growth of *C. oliviforme* during the two studied seasons. The most effective concentration of IBA was 5000 ppm; all growth parameters were increased up to the highest concentration (5000 ppm) of IBA. It is also necessary to use the anatomical features of wood like the cortex and vessel tissue as indicator of juvenility and maturity in *C. oliviforme*. However, more experimental studies are needed to develop specific indicators of maturity and juvenility in these valuable trees.

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دراسة عن التكاثر الخضري لأشجار الكريزوفيلم الشابة والناضجة

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قسم بحوث الأشجار الخشبية- معهد بحوث البساتين- مركز البحوث الزراعية- مصر

أجريت هذه الدراسة خلال موسم الربيع من عامي ٢٠١٥، ٢٠١٦ بالمزرعة الاستوائية بكم أمبو - الحديقة النباتية بأسوان التابعة لمعهد بحوث البساتين - مركز البحوث الزراعية - مصر للوقوف على مدى إمكانية أكثر أشجار الكريزوفيلم خضريا، بالرغم من أنه يمكن زراعتها بالبذرة داخل المشتل، حتى يتسنى لنا الاستفادة من مميزات التكاثر الخضري لمثل هذه الأشجار عالية القيمة. وفي هذا البحث نلقي الضوء على أهمية مرحلة الحدأة وتأثير النقع للجزء القاعدي للعقلة لمدة ٢٤ ساعة في بعض التركيزات من أندول حمض البيوتريك على مدى استجابة العقل لخروج الجذور وانتاج شتلات خضريا. وقد تم مقارنة تأثير عمريين من الأشجار (أشجار شابة عمر ٣ سنوات، وأشجار ناضجة عمر ٣٠ سنة) وخمس تركيزات من الهرمون (٠، ١٠٠٠، ٢٠٠٠، ٤٠٠٠، ٥٠٠٠ جزء في المليون) على نجاح العقل نصف الخشبية، والمنزوعة في بيئة نمو مكونة من البيتموس: البيرليت بنسبة ٢: ١ حجما. وتم أيضا دراسة التركيب التشريحي للعقل سواء الشابة أو الناضجة وتأثيره على نجاح العقل وكان أهم النتائج ما يلي: - أظهرت العقل المأخوذة من الأشجار الشابة أفضل النتائج الخاصة بالتجذير والنمو، عنه في حالة الأشجار الناضجة في كلا الموسمين. - كانت الاستجابة للهرمون واضحة للعقل المأخوذة من كلا العمرين، وان كانت أعلى في حالة الأشجار الشابة، وفي حالة التركيزات العالية ٥٠٠٠، ٤٠٠٠ جزء في المليون. - أدى استخدام التركيز ٤٠٠٠ جزء في المليون إلى الحصول على أعلى القيم الخاصة بعدد الأوراق والوزن الجاف للجذور الناتجة. - اختلف محتوى الجزء القاعدي للعقل معنويا من حيث النيتروجين والكربوهيدرات الكلية ونسبة الكربون إلى النيتروجين، ونتج عن المعاملة ب ٤٠٠٠ جزء في المليون أعلى القيم الخاصة بمحتوى الكربوهيدرات الكلية ونسبة الكربون إلى النيتروجين، بينما نتج أقل القيم الخاصة بمحتوى النيتروجين بعد المعاملة ب ٥٠٠٠ جزء في المليون. - أظهرت العقل المأخوذة من كلا العمرين تراكيب تشريحية أساسية متشابهة، من حيث منطقة النخاع المركزية والمحاطة بالأنسجة الوعائية من لحاء خارجي، خشب، كميوم، ولحاء داخلي، وان كانت هذه العناصر مكونة من طبقات أكثر سماكة في حالة الأشجار الناضجة عنه في حالة الأشجار الشابة. توصى الدراسة بإمكانية أكثر أشجار الكريزوفيلم خضريا باستخدام العقل نصف الخشبية والمأخوذة من أشجار شابة، مع التوصية بنقع الجزء القاعدي للعقل لمدة ٢٤ ساعة في محلول أندول حمض البيوتريك بتركيز ٤٠٠٠ أو ٥٠٠٠ جزء في المليون للحصول على شتلات قوية مشابهة للأصل. ونوصى بالتوسع في زراعة هذه الأشجار في برامج التشجير بمصر لما لها من قيمة تنسيقية وجمالية عالية، وأيضا للحصول على أخشاب ثقيلة، متينة، وذات مواصفات جيدة.

