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Effect of cutting type and Seradix 3 on rooting percentage and some characteristics of produced Paulownia's sapling *Paulownia tomentosa* L.

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ABSTRACT

This experiment was carried out during the period between February 20th and October 1st, 2016 in the Lath house at Nursery of the college of Agricultural Siences/ University of Sulaimani, Sulaimani city with an altitude of 748 meter above mean sea level, to find out the effect of cutting type (basal, intermediate and apical cuttings) and plant growth regulator (Seradix 3) on the improvement of rooting of cuttings, vegetative and root growth characteristics of *Paulownia tomentosa*, using a factorial experiment in a randomized block design (RCBD) in three replications, the means were compared according to Duncan's multiple range test ($P \leq 0.05$). The data revealed that significant effect of cutting type and growth regulator on most of studied growth characters. The basal cutting has been superior significantly on the intermediate and apical cuttings, giving the highest results for; survival percentage 48.52%, length of sapling 17.05 cm, stem diameter 2.77 mm, fresh weight of shoot system 24.20 g, dry weight of shoot system 11.32 g, number of lateral roots/sapling 10.28, root length 22.01 mm, fresh weight of root system 15.77 g, dry weight of root system 5.11 g. Whereas intermediate cutting gave the significant highest result in the number of branches/sapling 2.00 and number of leaves/sapling 9.50. From the results, use of Seradix 3, significantly gave the highest value of studied characters; survival percentage 42.79%, length of sapling 14.43 cm, number of branches/sapling 2.33, number of leaves/sapling 10.11, fresh weight of shoot system 19.26 g, dry weight of shoot system 8.82 g, number of lateral roots/sapling 8.50, root length 19.33 cm, fresh weight of root system 13.80 g, dry weight of root system 3.68 g. So interaction of basal cuttings with auxin application significantly gave the best result for most of studied characters.

تأثير نوع العقل وسيراديكس3 في نسبة تجذير عقل الباولونيا *Paulownia tomentosa* L وصفات الشتلات المنتجة

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الخلاصـة

اجري هذا البحث خلال الفترة الواقعة بين (2016/2/20) و(2016/10/1) داخل الظلة الخشبية في مشتل التابع لكلية العلوم الزراعية/جامعة السليمانية في بكرجو، والواقع على إرتفاع 748م عن مستوى سطح البحر، بهدف معرفة تأثير نوع العقلة و منظم النمو سيرادكس 3 في تحسين تجذير العقل و صفات النمو الخضري و الجذري لشتلات الباولونيا، بإستخدام ثلاثة أنواع من العقل (الطرفية و الوسطية و القاعدية) و منظم النمو سيرادكس 3 في تجربة عاملية طبقاً لتصميم القطاعات العشوائية الكاملة (RCBD) بثلاث مكررات، قورنت المتوسطات حسب اختبار دنكن متعدد الحدود عند مستوى احتمالية 0.05 . واظهرت النتائج ان العقل القاعدي تفوق معنويا على القلم الوسطي والطرفي ، وأدى الى زيادة معنوية لمعظم الصفات المدروسة ، حيث بلغت نسبة النجاح 48,52% و طول الشتلة 17,05 سم و قطر الساق 2,77ملم والوزن الطري للمجموع الخضري 24,2غم والوزن الجاف للمجموع الخضري 11,3غم وعدد التفرعات الجانبية للجذور 10,28 فرع/شتلة و طول الجذر 22,01سم والوزن

الكلمات المفتاحية :
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الطري للمجموع الجذري 15,77غم و الوزن الجاف للمجموع الجذري 5,11غم. بينما العقل الوسطي تفوق معنويا على العقل القاعدي و الطرفي في صفتي عدد الافرع 2,00 و عدد الاوراق 9,50 . ان استخدام منظم النمو سيراديكس3، أدى الى زيادة معنوية لمعظم الصفات المدروسة حيث بلغت نسبة النجاح 42,79% و طول الشتلة 14,43سم، عدد الافرع الخضرية 2,33 فرع/شتل و عدد الاوراق 10,11 ورقة/ شتل و الوزن الطري للمجموع الخضري 19,26غم و الوزن الجاف للمجموع الخضري 8,82غم و عدد التفرعات الجذرية 8,50 فرع/شتلة و طول الجذور 19,33 سم و الوزن الطري للمجموع الجذري 13,80غم و الوزن الجاف للمجموع الجذري 3,68 غم. بينما اظهرت النتائج ان استخدام الاوكسين لم يؤثر معنويا على صفة قطر الساق 2,38 ملم. بالنسبة للتداخل بين عاملين نوع العقل و استخدام الاوكسين اظهرت النتائج بأن العقل القاعدية المعاملة بمنظم النمو تفوق معنويا في معظم الصفات المدروسة.

Introduction:

Paulwonia tomentosa (Empress tree), is a deciduous, fast growing, hard wood tree, belongs to the family Paulwoniaceae which includes nine species of fast growing trees. The genus *Paulwonia* is indigenous to China and East Asia. The tree is ornamental, widely distributed throughout China, Korea and Japan (Duncan, 1988; Freeman *et al.*, 2012). *Paulwonia* species are growing naturally and under cultivated conditions in several parts of the world including China, Japan, Southeast Asia, Australia, North and central America. It extremely adaptive to wide variation in edaphic and climatic factors (Zhu *et al.*, 1986). *Paulwonia*'s timber is popular in the world market used for furniture, musical instruments, decorative moldings, laminated structural beams shipping containers and plywood (Showk and Showk, 2003). *Paulwonia*'s leaves and fruits have been used in traditional Chinese herbal medicine for the treatment of tonsillitis, bronchitis, asthmatic attack and bacterial infections (Jiang *et al*., 2004 ; Šmejkal *et al*., 2007). Extracts of *Paulwonia* contains many bioactive compounds such as flavonoids and particularly Apigenin (Loizzo *et al*., 2007). It has received and increased attention due to it's marketable value for wood and biofuel production, its rapid growth, high biomass production, and high stress tolerance (Liu *et al*., 2007; Doumett *et al*., 2010). The tree is propagated through seed, stem and root cuttings. Propagating by seeds are unreliable because of disease, pest problem, and slow growth than cuttings (Bergmann and Moon, 1997). The best type of cuttings can be used successfully for reproduction depending on the species, genotype and season of collection (Abdullah and Amjed, 2008). Ibronic (2013) pointed out that using hardwood cuttings of *Duranta repens* rooted better, gave the highest roots length and number of leaves than soft wood cuttings. Rout *et al*. (1996) showed that lateral cutting of *Casuarina equisetifolia* L. were more responsive to rooting than the terminal cuttings. Result of a study carried out by Ochea *et al*, (2003) on the effect of stem position, apical and basal of *Nerium oleander* L. showed that the basal cuttings produced larger root growth than apical cuttings.

Application of auxin, particularly indole-3-butyric acid (IBA) is one of the most common and effective means to enhance rooting of cuttings (Dirr and Heuser, 2006; Hartmann *et al*., 2011). On the other hand, Wang *et al*. (2011) showed that IBA treatment increased rooting percentage of *Robinia psudoacacia* hardwood cuttings. Also, Carlos *et al*. (2014) found that IBA application on *Paulwonia fortunei* cuttings not affected on rooting, while, Puri and Thompson (2003) pointed out that IBA application on *Populus* spp. cuttings significantly increased fresh and dry weight of root system. Accordingly, this study was conducted to investigate the effect of three types of cuttings (basal, intermediate and apical) and auxin (seradix 3) application on survival and growth of *Paulwonia tomentosa* L. in Bakrajo.

Materials and methods

The experiment was conducted during the period from February 20th to October 1st, 2016, under field condition at Nursery of the college of Agricultural Sciences, University of Sulaimani, located on 2.5 kilometers south western of Sulaimani city. One year old shoots of *Pawlounia tomentosa* tree were collected from the upper one third of the crown of dominated healthy vigor young tree grown in Sulaimani on February 19th, three types of cuttings were prepared each cutting were (10-20cm) in length . The experiment included two factors:

1- Type of stem cuttings (C): three types were used
   C1= Basal cuttings.
   C2= Intermediate cuttings.
   C3= Apical cuttings.
2- Auxin application (H) Seradix 3.(0.3% IBA).
   H1= control, cuttings without treating by Seradix 3.
   H2= cuttings treating by Seradix3 (0.3% IBA).

The study was designed as a factorial experiment according to the randomized complete block design (RCBD) in three replications, the data were analyzed using the XLSTAT analysis system (XLSTAS, 2005), the means were compared according to Duncan's multiple rang test ($P \leq 0.05$) using 6 treatments, each treatment replicated three times with 12 cuttings, 6 of each type of them planted in plastic bags without treating by Seradix 3 and treated the base of 6 others cutting by Seradix 3 (0.3% IBA) in powder shape then planted in plastic bags in February 20th, 2016.

At the end of the experiment period on October 1st, 2016, saplings of each replicate were taken for further following measurements:

1- Survival percentage (%)
2- Length of saplings (cm).
3- Stem diameters (mm).
4- Number of branches/sapling.
5- Number of leaves/sapling.
6- Fresh weight of shoot system (gm)
7- Dry weight of shoot system (gm)
8- Number of lateral roots/sapling.
9- Root length average.
10- Fresh weight of root system (gm).
11- Dry weight of root system (gm).

Table 1. Some of physical and chemical characteristics of the soil.*

field soil characteristics	Value
Sand %	3.52
Silt %	44.95
Clay %	51.53
Type of texture	Silty clay
E. C. (ds.m)	0.32
pH	7.43
O. M. %	2.14
CaCO3 %	32.42
Total N (ppm)	1.98
K+ (ppm)	2.39
Ca++ (Meq/l)	2.83
Mg++ (Meq/l)	1.88
Cl^- (Meq/l)	2.63

***The physical and chemical properties of soil media were estimated in the Laboratory of the Department of Soil and Water Science at college of Agriculture Science.

Results and discussion

1- ***Type of cuttings***:

The result of the study revealed that basal cuttings of empress tree gave a higher survival percentage compared to intermediate and apical cuttings which was 48.52% (Table2), while the lowest survival percentage 31.19% was found with apical cuttings. This may be due to that the basal cuttings contain more amounts of ccumulated endogenous auxin than intermediate and apical cuttings, which is responsible for creating initiate primary root (Mark, 1996). Throughout the rooting process, providing better physical conditions, mainly providing energy necessary for the adventitious root formation process, so that the carbohydrates produced are important for cutting survival (Roland *et al*., 2006). Softwood cuttings with less mature plant growth stage are easy to loss water, dry out and die (Day and Loves, 1998). These results are in agreement with Ibronke, (2013) who reported that hardwood cutting of *Duranta repens* rooted better than apical cuttings.

The results in (Table 2) showed that basal cuttings significantly affected on the length of saplings and stem diameter of the saplings and increased it significantly which was (17.05) cm and (2.77 mm), respectively, while the lowest height of length of sapling and stem diameter (9.77 cm and 1.30 mm, respectively) were given by apical cuttings. This result might be as a consequence of that basal cutting which contains more storage nutrient substrate than intermediate and apical cuttings which contribute for cell division and conjunction of stem diameter (Lebrun *et al*., 1998). These results are in agreement with Ayan *et al*. (2006) indicated that basal cutting of *Alnus glutinosa* gave the highest sapling length growth compared with tip cutting.

The data showed that intermediate cuttings gave the best results of number of branches/sapling and number of leaves/sapling (Table 2) which were 2.83 and 13.83. While the lowest value of number of branches/sapling and number of leaves/sapling 1.17 and 5.33 were found with apical cuttings. These results are in agreement with (Husen and Pal, 2006) who pointed that intermediate cuttings of *Tectona grandis* Linn gave the highest number of leaves more than basal and apical cuttings.

Table (2) indicated that there was a significant difference between basal, intermediate and apical cuttings on fresh and dry weights of shoot system, the highest value of fresh and dry weights of shoot system were 24.20 g and 11.32 g, respectively observed with basal cuttings, while the lowest value of fresh and dry weights of shoot system were 11.62 g and 3.13 g, was observed with apical cuttings. This result may be due to the increase of the length of saplings and stem diameter which obtained by this type of cutting. These results are in agreement with Mahmood, (2012) who showed that hardwood cutting of *Platanus orientalis* L. gave the highest values of fresh and dry weight of shoot system compared to semihardwood and softwood cuttings.

Table 2. Effect of cuttings type on some of shoot system characters.*

Characters / Cutting Type	Survival %	Length of sapling (cm)	Stem diameter (mm)	Number of branches /sapling	Number of leaves /sapling	Fresh weight of shoot system (g)	Dry weight of shoot system (g)
C_1	48.52 a	17.05 a	2.77 a	2.00 b	9.50 b	24.20 a	11.32 a
C_2	35.75 b	12.65 b	2.06 ab	2.83 a	13.83 a	16.34 b	8.63 b
C_3	31.19 c	9.77 c	1.30 b	1.17c	5.33 c	11.62 c	3.13 c

* Means within a column followed with different letters are significantly differ from each other according to Duncan's Multiple range test at 0.05 level.

The results presented in table (3) indicated that the basal cuttings differed significantly from the intermediate and apical cuttings on their effect on root length and number of lateral roots/sapling which gave the highest values (22.01 cm and 10.28) respectively. The lowest values of root length 14.16 cm recorded with apical cuttings which is not differ to intermediate cuttings 15.45cm and number of lateral roots/sapling 5.55 recorded with apical cuttings. This result may be explained that natural accumulation of endogenous auxin, favorable to the development of root in

the basal part of cutting (Wilson, 1993), or may be due to that carbohydrates have a physiological effect as a source of energy for new metabolic products, which caused to divisions and elongation of cells, so this led to roots had ability to enter inside the soil (Shukor and Liew, 1994). These results agree with a study carried out by Ochoa *et al*., (2003) on the effect of stem position (apical and basal) cuttings of native *Oleander*, the results showed that basal cuttings of *Nerium oleander* L. produced larger root growth than apical cuttings.

Fresh and dry weights of root system increased significantly by basal cuttings compared with intermediate and apical cuttings which attained (15.77 g and 5.11g) respectively (Table 3). While the lowest values of fresh and dry weight of root system (8.14 g and 1.26 gm) were found with apical cuttings. This increasing could be attributed to the improvement of the number of lateral roots and the root length (Al Bebewat, 2011). These results are in agreement with Zalensy *et al.*, (2003) in that basal cuttings of five types of *Populus* gave the highest values of number of lateral roots, fresh and dry weights of root system compared to intermediate and apical cuttings.

Table 3. Effect of cuttings type on some of root system characters.*

Characters / Type of cuttings	Root length (cm)	Number of lateral roots / sapling	Fresh weight of root system (gm)	Dry weight of root system (gm)
C_1	22.01 a	10.28 a	15.77 a	5.11 a
C_2	15.45 b	7.53 b	13.27 b	3.63 b
C_3	14.16 b	5.55 c	8.14 c	1.26 c

* Means within a column followed with different letters are significantly differ from each other according to Duncan Multiple range test at 0.05 level.

*2- **Auxin (Seradix 3) application**:*

Analysis of variance (Table 4) concerning the effect of auxin application, indicated that using Seradix 3 had a significant effect on survival percentage value (42.79%). Whereas the lowest value of this trait was found with no auxin application (36.85%). This may be due to that auxin played an active role on the first division on cuttings, which was responsible for creating initiated primary root (Salman, 1988). These results are in agreement with those of (Swamy *et al.*, 1993) when they propagated mature *Grewia optiva* and *Robinia psudoacacia* by hardwood cuttings, they pointed that 250 mg/L IBA and 500 mg.L^{-1} NAA application caused increased survival percentage.

Table (3) shows that Seradix 3 dominant to the control factor, the sapling length 14.43 cm, number of branches/sapling 2.33 and number of leaves/sapling 10.11 were given by sapling produced from cutting treated with Seradix 3. And the lowest value of sapling length 11.88cm, number of branches/sapling 1,67 and number of leaves/sapling were 9.00, were found with saplings not treated with Seradix 3. This might be due to that plant growth regulator accumulates assistant compounds for root formation due to the fact that auxin application caused cell division and elongation, there by promoting root length which was resulting better overall growth of cutting (Abdin and Baker, 1984). These results agree with those of Mahmood, (2012) who found out that using Seradix 2 increased the sapling length, number of branches and leaves of saplings produced from *Platanus orientalis* L. stem cuttings.

Results shown in table (3) indicated that there was a highly significant difference on the stem diameter due to treating and non treating by Seradix 3, the highest value of stem diameter (2.38 mm) was found with no auxin application, whereas Seradix 3 application gave the lowest value of stem diameter 1.71 mm. Auxin application sometimes was effected and sometimes failed to show the effectiveness (Grolli *et al.*, 2005; Dirr and Husen, 2006).

The effect of Seradix 3 application on fresh and dry weights of shoot system per sapling was statistically significant at $P \leq 0.05$ level (Table 3). The highest values of fresh and dry weights of shoot system were (19.26 g and 8.82 gm) respectively were recorded by Seradix 3 application,

while the lowest weight values of fresh and dry weights of shoot system were (15.51 g and 6.57 gm) respectively recorded with no Seradix 3 application. This increasing of fresh and dry weights of shoot system could be attributed to the improvement of the number of branches and leaves due to increasing the fresh and dry weights. These results are in agreement with Al-Ma'athid *et al.,* (2009) in that Seradix application on *Pelaryonium zonale* stem cuttings caused in increasing the fresh and dry weights of leaves.

Table 4. Effect of Auxin application (Seradix3) on some of shoot system characters*.

Characters / Seradix3	Survival %	Sapling length (cm)	Stem diameter (mm)	Number of branches /sapling	Number of leaves /sapling	Fresh weight of shoot system (g)	Dry weight of shoot system (g)
H_1	36.85 b	11.88 b	2.38 a	1.67 b	9.00 b	15.51 b	6.57 b
H_2	42.79 a	14.43 a	1.71 b	2.33 a	10.11 a	19.26 a	8.82 a

* Means within a column followed with different letters are significantly differ from each other according to Duncan Multiple range test at 0.05 level.

Concerning the effect of Seradix 3 on root length and number of lateral roots (Table 5) obviously showed that auxin application was superior significantly making the root system extended vertically reaching 19.33 cm root length and 8.50 number of lateral roots/sapling compared with the shortest roots 15.09 cm and less number of lateral roots/sapling 7.07 which occurred with no auxin application. This might be due to that auxin application caused the cell division and elongation which is promoting root length (Abdin and Bakr, 1984), or may be due to that plant growth regulator promotes the hydrolysis and mobilization of nutrients and sugars to the base of cuttings (Das *et al.*, 1997). These results in agreement with (Gehlot *et al.*, 2014) in that 250 $mg.L^{-1}$ treatment significantly gave best results of number of lateral roots and root length when they propagated *Azadirachta indica* by cuttings. Also it is noticed in the same Table (5) that using Seradix 3 gave the highest values of fresh and dry weights of root system (13.80 g and 3.68 gm) respectively, while the lowest weight of fresh and dry root system (10.98 g and 2.99 gm) were recorded with no Seradix3 application. This increasing of fresh and dry weights of root system could be attributed to the improvement of the number of lateral roots and root length of sapling occurred, which permit increase in dry and fresh weights of root system. These results in agreement with Gehlot *et al.*, (2014) who found out that the use of IBA at 1000 mg/L increased the root biomass of *Azadirachta indica*.

Table 5. Effect of Seradix3application on some of root system characters.*

characters / Seradix3	Root length (cm)	Number of lateral roots / sapling	Fresh weight of root system (g)	Dry weight of root system(g)
H_1	15.09 b	7.07 b	10.98 b	2.99 b
H_2	19.33 a	8.50 a	13.80 a	3.68 a

* Means within a column followed with different letters are significantly differ from each other according to Duncan Multiple range test at 0.05 level.

3-***The interaction between the type of cuttings and auxin application****:*

Comparing the average, table (6) showed that interaction of basal cuttings with auxin application gave the maximum survival percentage 53.38%, while the minimum survival percentage 31.05% was appeared with interaction of apical cuttings with Seradix 3 application c3h2.

Also same table showed that interaction of cuttings with Seradix 3 application c1h2 caused a significant difference in sapling height growth 18.87 cm as compared with other interactions, while the lowest value 9.43 cm was given by the interaction of apical cutting without treating by

auxin c3h1 which was not significantly differ from interaction of apical cutting with Seradix 3 application c3h2 and interaction of intermediate cutting without treating by plant growth regulator c2h1.

In table 6, there were significant differences between interaction of cutting type and Seradix 3 application on plant diameter, so the interaction of basal cuttings without treating by auxin c1h1 gave the thickest diameter of plant which was 3.34 mm, whereas the less thickness of the plant diameter 1.06 mm was found with interaction of apical cutting with plant growth regulator application c3h2 with no significant difference from the interaction of apical cuttings without treating by Seradix 3 c3h1 and interaction of intermediate cuttings without treating by auxin c2h2.

It is clear from the table (6) that the interaction between cutting type and plant growth application (Seradix 3) was significant on the number of branches per plant, so interaction of intermediate cuttings with Seradix 3 aplication c2h2 gave the highest number of branches per plant which was 3.00 with no significant difference from the interaction of intermediate cuttings without plat growth regulator application c2h1 and interaction of basal cuttings with auxin application c1h2, while the lowest number 1.00 was observed from the interaction of apical cuttings without application of auxin c3h1 with no significant difference from interaction of apical cutting with Seradix 3 application c3h2.

Table (6) showed that the interaction between cutting type and plant growth application (Seradix 3) was significant on the number of leaves per plant, so interaction of intermediate cuttings with auxin application c2h2 gave the highest number of leaves per plant which was 14.00 with no significant difference from interaction of intermediate cuttings without Seradix 3 application c2h1, while the lowest number 4.67 was observed from the interaction of apical cuttings without application of auxin c3h1 with no significant difference from interaction of apical cutting with Seradix 3 application c3h2.

Regarding to the fresh weight of shoot system characters the result shows that the interaction of intermediate cuttings with auxin application c1h2 gave the highest fresh weight of shoot system 27.02 g, comparing to the lowest fresh weight of shoot system 10.80 g which was observed from the interaction of apical cuttings without Seradix 3 application c3h1.

It is clear from the table (6) that the interaction between cutting type and plant growth application (Seradix 3) was significant on dry weight of shoot system, so interaction of basal cuttings with auxin application c1h2 gave the highest value 12.38 g with no significant difference from interaction of apical cutting without treating by Seradix 3 application c1h1 and interaction of intermediate cuttings with Seradix 3 application c2h2, while the lowest value of dry weight of shoot system 2.80 g was observed from the interaction of apical cuttings without auxin application c3h1.

Table 6. Effect of the interaction between the type of cuttings and auxin application on some characters of shoot system.*

Characters / treatments	Survival %	Length of sapling (cm)	Stem diameter (mm)	Number of branches/ sapling	Number of leaves/ sapling	Fresh weight of shoot system (g)	Dry weight of shoot system (g)
C_1H_1	43.65 b	15.23 b	3.34 a	1.33 b	8.67 b	21.37 b	10.26 b
C_1H_2	53.38 a	18.87 a	2.21 ab	2.67 a	10.33 b	27.02 a	12.38 a
C_2H_1	35.58 c	10.97 c	2.25 ab	2.67 a	13.67 a	14.35 c	6.65 b
C_2H_2	43.93 b	14.33 b	1.83 b	3.00 a	14.00 a	18.32 b	10.60 a
C_3H_1	31.33 c	9.43 c	1.54 b	1.00 b	4.67 c	10.80 d	2.80 c
C_3H_2	31.05 c	10.10 c	1.06 b	1.33 b	6.00 b	12.43 cd	3.46 bc

* Means within a column followed with different letters are significantly differ from each other according to Duncan Multiple range test at 0.05 level.

Variance analysis results (Table 7) showed that there were high significant influence in the formation of the longest roots and number of lateral roots of the sapling due to interaction between cutting type and Seradix 3 application. The interaction of basal cutting with auxin application c1h2 gave the tallest root 25.94 cm and higher number of lateral roots 11.38, while the interaction of apical cuttings without auxin application c3h1 gave the shortest root 13.39 cm and lowest number of lateral roots 5.16. However the interaction of basal cuttings with auxin application c1h2 showed that it was increased the values significantly which gave the highest fresh and dry weights of root system (17.42 g and 5.56 gm) respectively. While the lowest value of fresh and dry weights of root system were (7.15 g and 0.98 gm) respectively recorded with interaction of apical cuttings without auxin application c3h1, with no significant difference of dry weight of root system from interaction of apical cutting without treating by Seradix 3 c3h1 and interaction of apical cuttings with auxin application c3h2.

Table 7. Effect of the interaction between the type of cuttings and Seradix 3 application on some of root system characters.*

Characters / treatments	Root length (cm)	Number of lateral roots/ sapling	Fresh weight of root system (g)	Dry weight of root system (g)
C_1H_1	18.08 b	9.20 b	14.11 b	4.36 b
C_1H_2	25.94 a	11.38 a	17.42 a	5.56 a
C_2H_1	13.78 d	6.86 cd	11.68 c	3.06 c
C_2H_2	17.12bc	8.20 bc	14.86 b	4.21 b
C_3H_1	13.39 d	5.16 e	7.15 e	1.55 d
C_3H_2	14.94 cd	5.94 de	9.13 d	0.98 d

* Means within a column followed with different letters are significantly differ from each other according to Duncan Multiple range test at 0.05 level.

Conclusion:

From the result of the experiment we can conclude that:

1- The basal cuttings are considered the best types for vegetative reproducing method of *Paulwonia tomentosa* which provided to gain reasonable surviving with good growth characters.
2- The auxin application (Seradix 3) may be used for *Paulwonia tomentosa* saplings reproductive by stem cuttings to improve the most growth characters.

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