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INFLUENCE OF PLANTING DATES AND SOME CHEMICAL SUBSTANCES ON ROOTING OF *PHYTOLACCA DIOICA*

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ABSTRACT: The present study was carried out under plastic house conditions at the nursery of Zohria garden, Hort. Res. Inst., ARC, Cairo, Egypt throughout the two successive seasons of 2015 and 2016 to reveal the effect of planting dates (winter, spring, summer and autumn), some rooting promoters at different concentrations i.e. IBA, NAA, 2,4-D, catechol, cinnamic acid and tryptophan (alone or in combination) and their interactions on rooting of hard-to-root ornamental tree *Phytolacca dioica*. Results revealed that planting in spring increased rooting percentage (%) and root length (cm) in both seasons to the highest values. Treating the cuttings with IBA at 4000 ppm + NAA at 4000 ppm formulation resulted in the highest rooting percentage (%) in both seasons. Although there was no clear trend that could be observed from the obtained results, planting cuttings in either spring or autumn in addition to treating with IBA at 4000 ppm + NAA at 4000 ppm formulation increased rooting percentage (%) to the highest values. In conclusion, to achieve a successful vegetative propagation and to induce rooting on cuttings it is recommended to plant the cuttings in either spring or autumn in addition to treating with IBA at 4000 ppm + NAA at 4000 ppm formulation.

Key words: *Phytolacca dioica*, cuttings, planting date, rooting promoters, auxins.

INTRODUCTION

Phytolacca (Fam: Phytolaccaceae) is a genus of about 25 species of perennials, shrubs, and trees found in open fields or woodland in tropical and subtropical areas of Africa, Asia, and North to South America. They are grown for their attractive autumn foliage color and their decorative fruits (Brickell, 1997). *P. dioica*, Linn., is an evergreen tree, attaining great thickness of trunk and spread of top branchlets. Leaves are slender-petioled, glabrous, elliptic or ovate, mostly broadly acute at apex, the mid-nerve extending at the tip. The inflorescence is racemose, scarcely surpassing the leaves, sub-erect or pendulous; male flowers are with 20-30 stamens, and calyx-parts elliptic and obtuse, white-spotted; whereas the female flowers are with about 10 staminodia, the calyx parts broad, the ovary globose and 7-10-carpelled. Fruits are berry-like, the carpels connate at base and free at top. It is a tree of astonishingly rapid growth, soon making a good shade (Bailey, 1963).

Cuttings are the most important means of propagating of ornamental shrubs-deciduous species as well as the broad- and narrow-leaved types of evergreens (Hartmann *et al.*, 2002). Cuttings taking and planting date are very important factor determining the success of the propagating process, i.e a specific date is more effective than other factors for a specific plant. Celik and Celik (2017) reported that, rooting rates of *Elaeagnus umbellata* Thunb. cuttings

were at the highest when taken form 15 May and 15 July. The best cutting time was 15 May.

Treating cuttings with auxins, which are plant growth regulators, increases the percentage of cuttings that form roots, hastens root initiation, and increases uniformity of rooting. The auxins most reliable in stimulating adventitious root production in cuttings are: indole-3-butyric acid (IBA) and α-naphthaleneacetic acid (NAA), although others can be also used (Hartmann *et al.*, 2002). ZuFei *et al.* (2017) reported that the application of IBA could significantly improve the cuttings rooting ability of *Cinnamomum camphora*. Swamy *et al.* (2002) reported that NAA (500 mg/l) treatment was found to be most effective for inducing rooting in *Robinia pseudoacacia* whereas IBA (250 mg/l) was most effective in *Grewia optiva*. This was in line with the fact that a particular type of auxin is effective in enhancing rooting in a particular species (Singh and Bansal, 1984; Puri and Shamet, 1988).

The application of some non-auxin agents, alone or together with other auxins, has been used to improve the rooting capacity of cuttings in some species. Shaheed *et al.* (2010) revealed that highly significant increase in rooting response of mung bean cuttings aging in o-eoumaric acid, caffeic acid, and p-hydroquinone, ascorbate, cinnamic acid, phenol, o-hydroxyphenol (Catechol) compared to control (d/H_2O). All of these compounds caused off setting or stopping of the oxidative processes that occur during aging as anti-oxidant agents which, acts as free radical scavengers against oxidative processes products and then promoting IAA biosynthesis.

This study, on the other hand, aimed to study the effect of planting date (winter, spring, summer and autumn), some rooting promoters (auxins), i.e. IBA, NAA and 2,4-D, (non-auxins agents) catechol, cinnamic acid and tryptophan (alone or in combination) and their interactions on cuttings rooting of ornamental hard-to-root tree *Phytolacca dioica*.

MATERIALS AND METHODS

The present study was carried out under plastic house conditions at the nursery of Zohria garden, Hort. Res. Inst., ARC, Cairo, Egypt throughout the two successive seasons of 2015 and 2016 to reveal the effect of planting date (winter, spring, summer and autumn), some rooting promoters, i.e. IBA, NAA, 2,4-D, catechol, cinnamic acid and tryptophan (alone or in combination) and their interactions on rooting and following growth on cuttings of an ornamental tree which is hard-to-root, namely *Phytolacca dioica*.

Plant material:

Specific types of stem terminal cuttings (20-25 cm length, 5 mm thickness) were taken from mature, strong and disease-free branches from stock trees of Ombu (*Phytolacca dioica* L.; Fam. Phytolaccaceae) grown at the Zohriya garden, Zamalek Island, in Cairo.

Utilized root promoting:

The six selected chemicals for use in this study were: IBA (Indole-3-butyric acid), NAA (1-Naphthaleneacetic acid), Catechol, Cinnamic acid, 2,4-D (2,4-Dichlorophenoxyacetic acid) and Tryptophan.

Rooting medium:

A mixture of sand + perlite + peat moss at equal parts by volume was prepared, mixed well and sterilized in a furnace at 60-70 ℃ for 3 h. The physical and chemical properties of the sand and peat moss used in the two seasons are shown in Tables (a) and (b), respectively.

Planting date:

The cuttings were taken at four different times; on January, 31st; April, 30th; July, 31st and October, 30th for every season to determine the most suitable date for taking cuttings.

Table a. Physical and chemical properties of the sand used in 2015 and 2016 seasons.

Season	Particle size distribution (%)				S.P.	E.C. (dS/m)	pH	Cations (meq/L)				Anions (meq/L)		
	Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}
2015	89.03	2.05	0.40	8.52	23.10	3.51	7.90	7.50	1.63	33.60	0.50	3.20	22.00	18.03
2016	84.76	6.29	1.50	7.45	21.91	3.72	7.82	19.42	8.33	7.20	0.75	1.60	7.80	26.30

Table b. Some physical and chemical properties of the peatmoss used in both seasons.

Component	Value	Component	Value	Component	Value
Organic matter	90-95%	**Water relation capacity**	60-75%	**K**	1.77%
Ash	5-10%	**Salinity**	300 ppm	**Fe**	421 ppm
Density (vol. dry)	80-90 mg/l	**N**	1.09%	**Mn**	72 ppm
pH value	3.4	**P**	0.23%	**Zn**	41 ppm

Procedure and layout of the experiment:

Immediately after taking the cuttings at the early morning, they were well washed with tap water, then sterilized with a mixture of Topsin (70%) and Rizolex (50%), at the rate of 0.5 g/l for each. Thereafter, they were subjected to a basal quick-dip for 20 seconds in either the hydro aqueous or hydro-alcoholic solutions of the following twelve rooting promotive chemical formulas:

1. Immersing in deionized water free from chemicals for 20 seconds referred to as control.
2. Immersing in IBA hydro-alcoholic solution at 4000 ppm concentration.
3. Immersing in NAA hydro-alcoholic solution at 4000 ppm concentration.
4. Immersing in catechol aqueous solution at 2000 ppm concentration.
5. Immersing in 2000 ppm IBA solution for 20 seconds, then in 2000 ppm NAA one for another 20 seconds.
6. Immersing in 2000 ppm IBA solution for 20 seconds, then in 2000 ppm catechol one for another 20 seconds.
7. Immersing in 2000 ppm NAA solution for 20 seconds, then in 2000 ppm catechol one for another 20 seconds.
8. Immersing in 4000 ppm IBA solution for 20 seconds, then in 4000 ppm NAA one for another 20 seconds.
9. Immersing in cinnamic acid hydro-alcoholic solution at 2000 ppm concentration for 20 seconds, then in 2000 ppm IBA one for another 20 seconds.
10. Immersing in 2,4-D aqueous solution at 200 ppm concentration for 20 seconds, then in 2000 ppm IBA one for another 20 seconds.
11. Immersing in tryptophan aqueous solution at 2000 ppm concentration for 20 seconds, then in 2000 ppm IBA one for another 20 seconds.
12. Immersing in 4000 ppm NAA solution for 20 seconds, then in 2000 ppm IBA one for another 20 seconds, then in 1000 ppm cinnamic acid one for another 20 seconds (as triple treatment).

Immediately after immersing, the treated cuttings and those of the control were inserted 4-5 cm deep into 12-cm-diameter plastic pots (one cutting/pot) filled with about 1.2 kg of the rooting mixture mentioned before and finally put under a tunnel inside plastic house conditions.

The layout of the experiment in the two seasons was of a complete randomized design in a factorial experimental type (Mead *et al.*, 1993), with three replicates. Each replicate contained seven cuttings. Thus, every treatment involved 21 cuttings and the experiment included 48 treatments × 21 cuttings = 1008 cuttings. So, the total number of cuttings used in this study was 2016 cuttings for both seasons.

Data recorded:

Rooting percentage (%), number of roots/cuttings, root length (cm) and root fresh and dry weights (g) were collected at the end of each season.

Statistical analysis:

Data were then tabulated and subjected to analysis of variance according to a program of SAS Institute Inc. (2004), which was followed by Duncan's Multiple Range Test (Steel and Torrie, 1980) for means comparison at 5% level of probability.

RESULTS AND DISCUSSION

1. Rooting percentage (%):

Data registered in Table (1) show that the effect of planting date on rooting percentage was significant. Planting *Phytolacca dioica* cuttings in spring significantly increased rooting percentage to the highest value 37.89% in the first season, while in the second one the superiority was to planting in autumn as has been recorded (35.69%). Here, planting in spring came in the second position without significant differences in the second season as has been recorded (32.92%).

Data presented in Table (1) show that the effect of rooting promoters on rooting percentage was significant. Treating *Phytolacca dioica* cuttings with IBA at 4000 ppm + NAA at 4000 ppm formulation significantly increased rooting percentage to the highest values in both seasons, the results were 61.83 and 49.75% for the first and second seasons, respectively. In addition, treating the cuttings with NAA at 4000 ppm + IBA at 2000 ppm + cinnamic acid at 1000 ppm formulation came in the second position and recorded 60.50 and 46.150 in both seasons, respectively.

Data presented in Table (1) show that the effect of interaction between planting date and rooting promoters on rooting percentage was significant. Planting *Phytolacca dioica* cuttings in spring in addition to treating with IBA at 4000 ppm + NAA at 4000 ppm formulation or NAA at 4000 ppm + IBA at 2000 ppm + cinnamic acid at 1000 ppm formulation produced the highest values in the first season (71.00%, for these two treatments), while in the second one the superiority was to planting in autumn when combined with IBA at 4000 ppm + NAA at 4000 ppm formulation (99.33%).

2. Number of roots/cutting:

From tabulated data in Table (2), it could be observed that the effect of planting date on number of roots/cutting was significant. Planting *Phytolacca dioica* cuttings in autumn significantly increased number of roots/cutting to the highest value in both seasons (6.763 and 12.280 in the first and second seasons, respectively).

As shown in Table (2) the influence of rooting promoters on number of roots/cutting was significant. Treating *Phytolacca dioica* cuttings with IBA at 2000 ppm + NAA at 2000 ppm formulation significantly increased number of roots/cutting to the highest value (8.060) in the first season. This was followed by treating with 2, 4 D at 200 ppm + IBA at 2000 ppm formulation in both seasons (7.688 and 11.560 in the first and second seasons, respectively) without significant differences.

Data registered in Table (2) show that the effect of interaction between planting date and rooting promoters on number of roots/cutting was significant. Planting *Phytolacca dioica* cuttings in autumn in addition to treating with IBA at 2000 ppm + NAA at 2000 ppm formulation produced the highest value in the first season (21.660), while in the second one the mastery was to planting in autumn combined with 2, 4 D at

Table 1. Effect of treating *Phytolacca dioica* cuttings with different growth substances and planting dates on rooting percentage (%) during 2015 and 2016 seasons.

Dates / Treatments	Winter	Spring	Summer	Autumn	Mean
			First season: 2015		
Control	0.000 h	0.000 h	0.000 h	0.000 h	0.000 i
IBA 4000 ppm	42.000 d	14.000 g	28.000 f	28.000 f	28.000 d
NAA 4000 ppm	28.000 f	0.000 h	0.000 h	0.000 h	7.000 g
Cat. 2000 ppm	0.000 h	0.000 h	14.000 g	0.000 h	3.500 h
IBA 2000 ppm + NAA 2000 ppm	42.000 d	57.000 c	42.000 d	42.000 d	45.750 b
IBA 2000 ppm+ Cat. 2000 ppm	0.000 h	57.000 c	14.000 g	28.000 f	24.750 e
NAA 2000 ppm + Cat. 2000 ppm	0.000 h	28.670 f	0.000 h	14.000 g	10.670 f
IBA 4000 ppm + NAA 4000 ppm	57.000 c	71.000 a	63.000 b	56.330 c	61.830 a
Cin. 2000 ppm + IBA 2000 ppm	35.330 e	57.000 c	28.000 f	0.000 h	30.080 cd
2, 4 D 200 ppm + IBA 2000 ppm	14.000 g	57.000 c	14.000 g	28.000 f	28.250 d
Try. 2000 ppm + IBA 2000 ppm	28.000 f	42.000 d	28.000 f	28.000 f	31.500 c
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	57.000 c	71.000 a	57.000 c	57.000 c	60.500 a
Mean	25.280 b	37.890 a	24.000 bc	23.440 c	
			Second season: 2016		
Control	0.000 j	0.000 j	0.000 j	0.000 j	0.000 e
IBA 4000 ppm	41.330 e-g	14.000 i	28.000 h	71.000 b	38.580 b
NAA 4000 ppm	14.000 i	14.000 i	14.000 i	14.000 i	14.000 d
Cat. 2000 ppm	0.000 j	0.000 j	0.000 j	14.000 i	3.500 e
IBA 2000 ppm + NAA 2000 ppm	28.000 h	42.000 ef	28.000 h	42.000 ef	35.000 b
IBA 2000 ppm+ Cat. 2000 ppm	0.000 j	57.000 cd	14.000 i	42.000 ef	28.250 c
NAA 2000 ppm + Cat. 2000 ppm	0.000 j	28.000 h	0.000 j	14.000 i	10.500 d
IBA 4000 ppm + NAA 4000 ppm	14.000 i	57.000 cd	28.670 gh	99.330 a	49.750 a
Cin. 2000 ppm + IBA 2000 ppm	28.000 h	57.000 cd	28.000 h	0.000 j	28.250 c
2, 4 D 200 ppm + IBA 2000 ppm	28.000 h	42.000 ef	14.000 i	28.000 h	28.000 c
Try. 2000 ppm + IBA 2000 ppm	42.000 ef	42.000 ef	29.330 f-h	45.330 de	39.670 b
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	42.000 ef	42.000 ef	42.000 ef	58.600 bc	46.150 a
Mean	19.780 b	32.920 a	18.830 b	35.690 a	

Cat.= Catechol, Cin.= Cinnamic acid, Try.= Tryptophan.
Means having the same letter are not significantly differed at 0.05 level of probability.

Table 2. Effect of treating *Phytolacca dioica* cuttings with different growth substances and planting dates on number of roots/cutting during 2015 and 2016 seasons.

Treatments \ Dates	Winter	Spring	Summer	Autumn	Mean
			First season: 2015		
Control	0.000 j	0.000 j	0.000 j	0.000 j	0.000 f
IBA 4000 ppm	2.330 i	3.000 hi	3.000 hi	2.500 hi	2.707 e
NAA 4000 ppm	2.000 i	0.000 j	0.000 j	0.000 j	0.500 f
Cat. 2000 ppm	0.000 j	0.000 j	3.000 hi	0.000 j	0.750 f
IBA 2000 ppm + NAA 2000 ppm	6.000 ef	2.250 i	2.330 i	21.660 a	8.060 a
IBA 2000 ppm+ Cat. 2000 ppm	0.000 j	4.000 gh	3.000 hi	4.000 gh	2.750 e
NAA 2000 ppm + Cat. 2000 ppm	0.000 j	4.000 gh	0.000 j	4.000 gh	2.000 e
IBA 4000 ppm + NAA 4000 ppm	1.500 ij	2.000 i	5.262 fg	13.250 c	5.503 c
Cin. 2000 ppm + IBA 2000 ppm	6.000 ef	2.750 hi	6.000 ef	0.000 j	3.688 d
2, 4 D 200 ppm + IBA 2000 ppm	5.000 fg	2.250 i	8.000 d	15.500 b	7.688 a
Try. 2000 ppm + IBA 2000 ppm	6.000 ef	7.000 de	6.000 ef	6.000 ef	6.250 bc
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	2.750 hi	3.000 hi	5.500 e-g	14.250 bc	6.375 b
Mean	2.632 c	2.521 c	3.508 b	6.763 a	
			Second season: 2016		
Control	0.000 p	0.000 p	0.000 p	0.000 p	0.000 h
IBA 4000 ppm	2.000 m-o	2.000 m-o	2.333 m-o	3.000 k-n	2.333 fg
NAA 4000 ppm	1.000 op	3.000 k-n	1.000 op	5.000 h-j	2.500 ef
Cat. 2000 ppm	0.000 p	0.000 p	0.000 p	20.000 c	5.000 d
IBA 2000 ppm + NAA 2000 ppm	7.500 ef	1.666 no	1.500 n-p	21.660 b	8.082 b
IBA 2000 ppm+ Cat. 2000 ppm	0.000 p	3.000 k-n	2.000 m-o	20.000 c	6.250 c
NAA 2000 ppm + Cat. 2000 ppm	0.000 p	3.500 j-m	0.000 p	3.000 k-n	1.625 g
IBA 4000 ppm + NAA 4000 ppm	2.000 m-o	1.750 no	4.000 i-l	21.710 b	7.364 b
Cin. 2000 ppm + IBA 2000 ppm	4.500 h-k	2.250 m-o	6.000 f-h	0.000 p	3.188 e
2, 4 D 200 ppm + IBA 2000 ppm	5.000 h-j	1.750 no	7.000 e-g	32.500 a	11.560 a
Try. 2000 ppm + IBA 2000 ppm	8.000 e	7.000 e-g	5.500 g-i	5.333 hi	6.458 c
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	2.000 m-o	1.666 no	2.660 l-n	15.170 d	5.373 d
Mean	2.667 b	2.299 b	2.666 b	12.280 a	

Cat.= Catechol, Cin.= Cinnamic acid, Try.= Tryptophan.
Means having the same letter are not significantly differed at 0.05 level of probability.

200 ppm + IBA at 2000 ppm formulation (32.50). In this regard, the previously mentioned treatment occupied the second position in the first season as it recorded 15.500 roots/cutting.

3. Root length (cm):

From tabulated data in Table (3), it could be indicated that the effect of planting date on root length (cm) was significant. Planting *Phytolacca dioica* cuttings in spring significantly produced the longest roots in both seasons (22.84 and 25.18 cm in the first and second seasons, respectively).

It can be concluded from data in Table (3) that the effect of rooting promoters on root length (cm) was significant. Treating *Phytolacca dioica* cuttings with IBA at 4000 ppm + NAA at 4000 ppm or with NAA at 4000 ppm + IBA at 2000 ppm + cinnamic acid at 1000 ppm formulation significantly increased root length (cm) to the highest values in both seasons, results being 25.100 and 24.56 cm for the first treatment and 25.23 and 20.56 cm for the second one in both seasons, respectively.

Data registered in Table (3) illustrate that the effect of the interaction between planting dates and rooting promoters on root length (cm) was significant. Planting *Phytolacca dioica* cuttings in spring in addition to treating with tryptophan at 2000 ppm + IBA at 2000 ppm or with NAA at 4000 ppm + IBA at 2000 ppm + cinnamic acid at 1000 ppm formulation produced the highest values in the first season without significant differences between them (38.00 and 40.40 cm for the first and second treatments, respectively). While in the second season the superiority was to planting in winter in addition to treating with IBA at 2000 ppm + NAA at 2000 ppm formulation (37.50 cm). This was followed without significant differences by planting in spring in addition to treating with NAA at 4000 ppm + IBA at 2000 ppm + cinnamic acid at 1000 ppm formulation (36.00 cm).

4. Root fresh weight (g):

As shown in Table (4), the influence of planting date on root fresh weight (g) was significant. Planting *Phytolacca dioica* cuttings in autumn significantly increased root fresh weight (g) to the highest value in both seasons (1.828 and 2.014 g in first and second seasons, respectively).

Data registered in Table (4) show that the effect of rooting promoters on root fresh weight (g) was significant. Treating *Phytolacca dioica* cuttings with NAA at 2000 ppm + catechol at 2000 ppm formulation significantly increased root fresh weight (g) to the highest value in the first season (2.057 g), while in the second one the mastery was to treating with NAA at 4000 as it gave 2.088 g.

It can be realized from data in Table (4) that the interaction effect between planting date and rooting promoters on root fresh weight (g) was significant. Planting *Phytolacca dioica* cuttings in autumn in addition to treating with NAA at 2000 ppm + catechol at 2000 ppm formulation produced the highest values in both seasons (6.40 and 5.400 g for the first and second seasons, respectively).

5. Root dry weight (g):

Data in Table (5) demonstrate that the influence of planting date on root dry weight (g) was significant. Planting *Phytolacca dioica* cuttings in autumn significantly produced the highest root dry weight (g) value in both seasons (0.319 and 0.180 g in first and second seasons, respectively).

Data registered in Table (5) show that the effect of rooting promoters on root dry weight (g) was significant. Treating *Phytolacca dioica* cuttings with IBA at 2000 ppm + NAA at 2000 ppm formulation significantly increased root dry weight (g) to the highest value in the first season (0.623 g), while in the second one the highest value was obtained by treating with IBA at 4000 ppm (0.191 g).

Table 3. Effect of treating *Phytolacca dioica* cuttings with different growth substances and planting dates on root length (cm) during 2015 and 2016 seasons.

Dates / Treatments	Winter	Spring	Summer	Autumn	Mean
		First season: 2015			
Control	0.000 m	0.000 m	0.000 m	0.000 m	0.000 g
IBA 4000 ppm	30.000 cd	30.000 cd	14.000 kl	18.000 i-k	23.000 ab
NAA 4000 ppm	23.000 e-i	0.000 m	0.000 m	0.000 m	5.750 f
Cat. 2000 ppm	0.000 m	0.000 m	30.000 cd	0.000 m	7.500 f
IBA 2000 ppm + NAA 2000 ppm	31.000 bc	25.500 d-f	13.330 kl	9.660 l	19.870 c
IBA 2000 ppm+ Cat. 2000 ppm	0.000 m	27.250 c-e	30.000 cd	9.500 l	16.690 d
NAA 2000 ppm + Cat. 2000 ppm	0.000 m	26.000 c-f	0.000 m	17.000 jk	10.750 e
IBA 4000 ppm + NAA 4000 ppm	30.000 cd	36.400 ab	23.000 e-i	11.000 l	25.100 a
Cin. 2000 ppm + IBA 2000 ppm	20.000 g-j	20.750 f-j	23.500 e-h	0.000 m	16.060 d
2, 4 D 200 ppm + IBA 2000 ppm	20.000 g-j	29.750 cd	22.000 e-j	13.850 kl	21.400 bc
Try. 2000 ppm + IBA 2000 ppm	26.000 c-f	38.000 a	17.500 jk	13.500 kl	23.750 ab
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	25.250 d-g	40.400 a	18.500 h-k	16.750 jk	25.230 a
Mean	17.100 b	22.840 a	15.990 b	9.105 c	
		Second season: 2016			
Control	0.000 p	0.000 p	0.000 p	0.000 p	0.000 h
IBA 4000 ppm	29.000 de	35.000 ab	13.00 k-m	8.600 m-o	21.400 b-d
NAA 4000 ppm	20.000 hi	30.000 c-e	26.000 ef	10.000 l-n	21.500 bc
Cat. 2000 ppm	0.000 p	0.000 p	0.000 p	10.000 l-n	2.500 g
IBA 2000 ppm + NAA 2000 ppm	37.500 a	25.330 e-g	5.000 o	8.330 m-o	19.040 d
IBA 2000 ppm+ Cat. 2000 ppm	0.000 p	25.500 e-g	26.000 ef	13.500 kl	16.250 e
NAA 2000 ppm + Cat. 2000 ppm	0.000 p	23.000 f-h	0.000 p	15.000 jk	9.500 f
IBA 4000 ppm + NAA 4000 ppm	30.000 c-e	36.750 a	22.500 f-h	9.000 l-o	24.560 a
Cin. 2000 ppm + IBA 2000 ppm	19.500 h-j	21.130 g-i	22.500 f-h	0.000 p	15.780 e
2, 4 D 200 ppm + IBA 2000 ppm	21.000 g-i	35.500 ab	21.00 g-i	12.75 k-m	22.560 a-c
Try. 2000 ppm + IBA 2000 ppm	31.660 b-d	34.000 a-c	17.500 i-k	9.953 l-n	23.280 ab
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	20.500 hi	36.000 ab	19.330 h-j	6.410 no	20.560 cd
Mean	17.430 b	25.180 a	14.400 c	8.629 d	

Cat.= Catechol, Cin.= Cinnamic acid, Try.= Tryptophan.
Means having the same letter are not significantly differed at 0.05 level of probability.

Table 4. Effect of treating *Phytolacca dioica* cuttings with different growth substances and planting dates on root fresh weight (g) during 2015 and 2016 seasons.

Dates / Treatments	Winter	Spring	Summer	Autumn	Mean
			First season: 2015		
Control	0.000 s	0.000 s	0.000 s	0.000 s	0.000 g
IBA 4000 ppm	0.900 o-r	3.520 c	1.710 h-k	0.740 p-r	1.717 b-e
NAA 4000 ppm	4.200 b	0.000 s	0.000 s	0.000 s	1.050 f
Cat. 2000 ppm	0.000 s	0.000 s	0.800 o-r	0.000 s	0.200 g
IBA 2000 ppm + NAA 2000 ppm	3.130 cd	1.040 m-r	0.470 q-s	2.830 de	1.867 a-d
IBA 2000 ppm+ Cat. 2000 ppm	0.000 s	1.072 l-q	1.300 i-p	3.550 c	1.480 e
NAA 2000 ppm + Cat. 2000 ppm	0.000 s	1.827 g-i	0.000 s	6.400 a	2.057 a
IBA 4000 ppm + NAA 4000 ppm	1.680 h-l	1.090 l-p	1.110 k-p	2.367 e-g	1.562 de
Cin. 2000 ppm + IBA 2000 ppm	1.207 j-p	0.825 o-r	0.960 n-r	0.000 s	0.748 f
2, 4 D 200 ppm + IBA 2000 ppm	1.800 g-j	2.000 f-h	1.600 h-m	2.650 de	2.013 ab
Try. 2000 ppm + IBA 2000 ppm	2.700 de	2.470 ef	0.450 rs	2.000 f-h	1.905 a-c
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	1.720 h-k	1.760 g-j	1.550 h-n	1.400 h-o	1.607 c-e
Mean	1.445 b	1.300 b	0.829 c	1.828 a	
			Second season: 2016		
Control	0.000 u	0.000 u	0.000 u	0.000 u	0.000 f
IBA 4000 ppm	0.820 t	3.720 c	1.160 o-s	1.760 i-l	1.865 b
NAA 4000 ppm	4.500 b	1.050 p-t	0.730 t	2.070 g-i	2.088 a
Cat. 2000 ppm	0.000 u	0.000 u	0.000 u	2.230 fg	0.558 e
IBA 2000 ppm + NAA 2000 ppm	2.480 ef	1.346 n-q	0.030 u	2.443 ef	1.575 c
IBA 2000 ppm+ Cat. 2000 ppm	0.000 u	1.017 q-t	1.250 n-r	2.830 d	1.274 d
NAA 2000 ppm + Cat. 2000 ppm	0.000 u	1.685 j-m	0.000 u	5.400 a	1.771 b
IBA 4000 ppm + NAA 4000 ppm	1.820 i-k	1.035 q-t	1.240 n-r	2.170 f-h	1.566 c
Cin. 2000 ppm + IBA 2000 ppm	0.915 r-t	0.740 t	0.930 r-t	0.000 u	0.646 e
2, 4 D 200 ppm + IBA 2000 ppm	1.380 m-p	1.705 j-m	1.560 j-n	2.580 de	1.806 b
Try. 2000 ppm + IBA 2000 ppm	1.416 m-o	2.756 de	0.880 st	1.167 o-s	1.555 c
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	1.890 h-j	1.456 l-o	1.540 k-n	1.520 k-n	1.602 c
Mean	1.268 c	1.376 b	0.777 d	2.014 a	

Cat.= Catechol, Cin.= Cinnamic acid, Try.= Tryptophan.
Means having the same letter are not significantly differed at 0.05 level of probability.

Table 5. Effect of treating *Phytolacca dioica* cuttings with different growth substances and planting dates on root dry weight (g) during 2015 and 2016 seasons.

Treatments \ Dates	Winter	Spring	Summer	Autumn	Mean
			First season: 2015		
Control	0.000 j	0.000 j	0.000 j	0.000 j	0.000 f
IBA 4000 ppm	0.040 h-j	0.220 d-g	0.110 f-j	0.270 d-f	0.160 cd
NAA 4000 ppm	0.035 ij	0.000 j	0.000 j	0.000 j	0.009 f
Cat. 2000 ppm	0.000 j	0.000 j	0.160 e-j	0.000 j	0.040 ef
IBA 2000 ppm + NAA 2000 ppm	0.080 g-j	0.140 f-j	0.270 d-f	2.000 a	0.623 a
IBA 2000 ppm+ Cat. 2000 ppm	0.000 j	0.103 g-j	0.700 b	0.200 d-h	0.251 b
NAA 2000 ppm + Cat. 2000 ppm	0.000 j	0.157 f-j	0.000 j	0.500 c	0.164 cd
IBA 4000 ppm + NAA 4000 ppm	0.330 d	0.112 f-j	0.120 f-j	0.233 d-g	0.199 bc
Cin. 2000 ppm + IBA 2000 ppm	0.157 f-j	0.340 cd	0.075 g-j	0.000 j	0.143 cd
2, 4 D 200 ppm + IBA 2000 ppm	0.080 g-j	0.187 d-i	0.200 d-h	0.150 f-j	0.154 cd
Try. 2000 ppm + IBA 2000 ppm	0.105 g-j	0.080 g-j	0.055 h-j	0.160 e-j	0.100 de
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	0.053 h-j	0.186 d-i	0.110 f-j	0.320 de	0.167 cd
Mean	0.073 c	0.127 b	0.150 b	0.319 a	
			Second season: 2016		
Control	0.000 h	0.000 h	0.000 h	0.000 h	0.000 f
IBA 4000 ppm	0.046 d-h	0.320 b	0.105 d-h	0.293 bc	0.191 a
NAA 4000 ppm	0.030 f-h	0.080 d-h	0.030 f-h	0.370 ab	0.128 a-c
Cat. 2000 ppm	0.000 h	0.000 h	0.000 h	0.150 d-f	0.038 ef
IBA 2000 ppm + NAA 2000 ppm	0.105 d-h	0.136 d-g	0.006 gh	0.180 cd	0.107 b-d
IBA 2000 ppm+ Cat. 2000 ppm	0.000 h	0.095 d-h	0.080 d-h	0.180 cd	0.089 c-e
NAA 2000 ppm + Cat. 2000 ppm	0.000 h	0.135 d-h	0.000 h	0.480 a	0.154 a-c
IBA 4000 ppm + NAA 4000 ppm	0.110 d-h	0.085 d-h	0.160 c-f	0.170 c-e	0.131 a-c
Cin. 2000 ppm + IBA 2000 ppm	0.010 gh	0.080 d-h	0.070 d-h	0.000 h	0.040 d-f
2, 4 D 200 ppm + IBA 2000 ppm	0.040 e-h	0.147 d-f	0.120 d-h	0.170 c-e	0.119 bc
Try. 2000 ppm + IBA 2000 ppm	0.502 a	0.046 d-h	0.025 f-h	0.057 d-h	0.157 ab
NAA 4000 ppm + IBA 2000 ppm + Cin. 1000 ppm	0.055 d-h	0.123 d-h	0.060 d-h	0.110 d-h	0.087 c-e
Mean	0.075 bc	0.104 b	0.055 c	0.180 a	

Cat.= Catechol, Cin.= Cinnamic acid, Try.= Tryptophan.
Means having the same letter are not significantly differed at 0.05 level of probability.

As exhibited in Table (5) the influence of interaction between planting date and rooting promoters on root dry weight (g) was significant. Planting *Phytolacca dioica* cuttings in autumn in addition to treating with IBA at 2000 ppm + NAA at 2000 ppm formulation resulted in the highest values in the first season (2.00 g), while in the second one the superiority was to planting in autumn in addition to treating with NAA at 2000 ppm + catechol at 2000 ppm formulation (0.480 g).

Such results are in harmony with those obtained by Hussein (2008) who showed that planting *Thunbergia grandiflora* cuttings on 21st March produced significant increases in rooting percentage and number of roots/plant. Hussein (2003) investigated planting *Beaumontia grandiflora* cuttings that ultimately gave the highest rooting percentage in March. Younis (1999) on *Ficus retusa* found that the high rooting percentage was in mid-March and mid-April and high number of roots/cutting in mid-April while high root length in mid-April. Meanwhile, Khali *et al.* (1997) reported that on *Ficus benghalensis* and *Ficus religiosa* best rooting was from March to October cuttings in *F. benghalensis* and from March to July in *F. religiosa.* Thus, superior rooting of cuttings made in spring may be due to that cause and/or effect of growth and mobilization of metabolities as pointed out by Swamy *et al*. (2002).

It's clear from the obtained data that all rooting promoter formulations comprising both IBA and NAA together produced the highest values in most cases with a few exceptions. Such results are in harmony with those obtained by Singh *et al.* (2017) on cuttings of *Bougainvillea peruviana* cv. Thimma; Li *et al.* (2017) on *Camellia azalea* cuttings, Peticila *et al.* (2016) on *Actinidia deliciosa* cuttings, Hashemabadi and Sedaghathoor (2008) on *Camellia japonica* cuttings and Pinto *et al.* (2005) on stem cuttings from *Rollinia rugulosa*. Treating cuttings with auxins, which are plant growth regulators, increases the percentage of cuttings that form roots, hastens root initiation, and increases uniformity of rooting. The auxins most reliable in stimulating adventitious root production in cuttings are: indole-3-butyric acid (IBA) and α-naphthaleneacetic acid (NAA), although others can be still used (Hartmann *et al.,* 2002).

It could be also noticed that regardless planting date, integration of some non-auxin agents (cinnamic acid, catechol and tryptophan) in formulation based on NAA and/or IBA resulted in obvious effect in some cases (tryptophan and cinnamic acid for root length, catechol for root fresh and dry weights and cinnamic acid for rooting percentage). Shaheed *et al.* (2010) revealed that there was a significant increase in rooting response of mung bean cuttings aging in some hydroxyl groups of some phenolic compounds (cinnamic acid catechol). All of these compounds caused offsetting or stopping of the oxidative processes that occur during aging as anti-oxidant agents which, acts as free radical scavengers against oxidative processes products and then promoting IAA biosynthesis.

In conclusion, to achieve a successful vegetative propagation and to induce rooting on cuttings of *Phytolacca dioica* it is recommended to plant the cuttings in either spring or autumn in addition to treating with a formulation of IBA at 4000 ppm + NAA at 4000 ppm.

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تأثير مواعيد الزراعة وبعض المواد الكيماوية على تجذير عقل الفيتولاكا

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تم إجراء هذه التجربة تحت ظروف الصوبة البلاستيكية بمشتل حديقة الزهرية، معهد بحوث البساتين، مركز البحوث الزراعية، مصر خلال موسمين متتالين (٢٠١٥ و ٢٠١٦) لدراسة تأثير مواعيد الزراعة (الشتاء، الربيع، الصيف، الخريف)، منشطات تكوين الجذور (أندول حمض البيوتريك، نفثالين حمض الخليك، ٢،٤- دي، كاتيكول، حمض السيناميك، التربتوفان منفصلين أو بالتداخل فيما بينهم) كذلك التفاعل فيما بين هذين العاملين علي تجذير عقل أشجار الفيتولاكا.

أظهرت النتائج أن الزراعة في الربيع أدت إلى زيادة النسبة المئوية للتجذير (%) وطول الجذور (سم) في كلا الموسمين لأعلى القيم. معاملة العقل بتركيبة من اندول حمض البيوتريك بتركيز ٤٠٠٠ جزء في المليون + نفثالين حمض الخليك بتركيز ٤٠٠٠ جزء في المليون أدت إلى الحصول على أعلى نسبة مئوية للتجذير في كلا الموسمين. بالرغم من أنه لم يكن هناك اتجاه واضح للنتائج التي تم الحصول عليها، فإن زراعة عقل الفيتولاكا في أي من الربيع أو الخريف بالإضافة الى معاملتها بإندول حمض البيوتريك بتركيز ٤٠٠٠ جزء في المليون + نفثالين حمض الخليك بتركيز ٤٠٠٠ جزء في المليون عملت على وصول النسبة المئوية للتجذير لأعلى القيم.

في الخلاصة حتى يتم انجاح عملية الإكثار الخضري بالعقل لأشجار الفيتولاكا صعبة التجذير فإنه يوصى بزراعة العقل في أي من الربيع أو الخريف بالإضافة الى معاملتها بإندول حمض البيوتريك بتركيز ٤٠٠٠ جزء في المليون + نفثالين حمض الخليك بتركيز ٤٠٠٠ جزء في المليون.