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(Original Article)

Impact of Indole-3-Butyric Acid, Chitosan and *Aloe vera* Gel on Root Growth Promotion of *Conocarpus erectus* L. Air-layers

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Abstract

The current study was carried out to evaluate the impact of indole-3-butyric acid (IBA) at 0 and 400 ppm, chitosan (40 ppm), *Aloe vera* gel and their combinations on rooting percentage, number of days for root appearance and root parameters of *Conocarpus erectus* L. air-layers. Results showed that treating *C. erectus* air-layers with IBA at 400 ppm, chitosan at 40 ppm and *Aloe vera* gel (100%) increased root percentage, decreased the number of days to root appearance and improved root characteristics (root number, root length, root fresh and dry weights) as well as content of total phenols, total carbohydrates percentage and C/N ratio comparing with the control. *Aloe vera* gel either alone or combined with IBA at 400 ppm were more effective than those treated with chitosan alone or combined with IBA. The best results were obtained by application of IBA (400 ppm) combined with chitosan (40 ppm) and *Aloe vera* gel. Therefore, it is advisable to apply any of these treatments when propagating *Conocarpus erectus* by air-layering for commercial production.

Keywords: *Air-layering, Aloe vera gel, Chitosan, Conocarpus erectus, IBA,*

Introduction

Conocarpus erectus, L. belonging to Combretaceae family is an evergreen shrub or tree growing on shores of tropical and subtropical regions around the world (Bailey, 1976; Dhaarani *et al*., 2017). It has two varieties, i.e. silver with pubescent leaves and the other green having glabrous leaves (Rehman *et al*., 2019). *Conocarpus* tree is an ideal plant for desert and barren lands cultivation. It can tolerate diseases, insects, elevated temperatures, light frosts, air pollution, salt, drought and poor drainage (Little,1983; Gilman and Watson, 1993).

Additionally, it can be used to fix dunes against migration, protect soil during storms and grow as a hedge (Gilman and Watson, 1993).

Traditional propagation of *C. erectus* is performed through stem cuttings, although it is feasible to use seeds (Mohamed *et al*., 2014; Abdel-Rahman, 2020). However, although seed production may be high, many of them do not germinate and the estimated

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viability of seeds is just 12%, especially during the dry season (Tomlinson, 1986; Hernandez and Espino; 1999; Kass *et al*., 2007). Layeringulture techniques could be used as an alternate method to propagate *C*. *erectus* plant, but air layering has many advantages over other methods since the produced plants are taller and healthier in short period when compared with other propagation methods.

The main step for successful pant propagation by air layering is impacted by a number of endogenous and exogenous factors (Hartmann *et al*., 2014; Abdel-Rahman *et al*., 2019). Exogenous application of auxins is one of the most widely used methods to stimulate root formation on air-layer (Mousa *et al*., 2019; Giriprasath *et al*., 2025). Indole butyric acid (IBA) is the most commonly utilized among auxin compounds that promote root since it is safe to plants over a wide concentration range, low mobility, high chemical stability and effective for a wide range of plant species (Wiessman-Ben and Tchoundejeu, 2000; Abdel-Rahman *et al*., 2019). The beneficial effect of IBA on rooting and survival of air-layers was confirmed by Abdul-Hafeez (2020) on *C. erectus*, Ibrahim (2020) on *Dracaena marginata*, Mousa *et al*. (2019) on *Ficus elastica var. decora* and Tomar and Singh (2011) on *Ficus krishna*e and *F. auriculata*. Additionally, exogenous auxins are commonly used either alone or in combination with other substances to promote adventitious root formation on air-layers (Abdul-Hafeez, 2020; Zhang *et al*., 2022; Giriprasath *et al*., 2025).

Replacement of synthetic plant growth regulators (PGRs) with natural substances or biostimulants are becoming popular due to their high cost and potential for toxicity in humans, animals and plants from overdoses (Cutler and Schneide, 1990). *Aloe vera* is an important medicinal plant which belongs to the family Liliaceae. It is a shrubby succulent herb that thrives in various places (Pandey and Singh, 2016). *Aloe vera* gel is one of the natural substitutes that might be used to promote adventitious root formation on air-layer (Karunarathna and Kumuthini, 2016; Mirihagalla and Fernando, 2020; Rajan and Singh 2021). Since *Aloe vera* gel contains auxins, gibberellin and salicylic acid (Surjushe *et al*., 2008). So, it could be used as a source of natural hormone instead of synthetic growth regulators to promote root formation on air-layers of plants (Mirihagalla and Fernando, 2020).

On the other hand, chitosan is a natural source, with low toxicity and low-cost compound that is biodegradable and environmentally friendly with various uses in agriculture. It is such a product which is produced from the waste accumulated in the shellfish processing industry (Hien, 2004). Chitosan affects the growth and development of plants, regulates physiological and metabolic processes. Additionally, it activates the plant's defense mechanisms, promotes root growth and induces certain enzymes including glucanases, pectinases and chitinases (Hien, 2004, Ohta *et al*., 2004; Malerba and Cerana, 2016).

There are few available researches in the literature on propagation of *Conocarpus erectus* L. through air-layering (Abdul-Hafeez, 2020). Therefore, the present investigation was carried out to study the influence of IBA, chitosan, *Aloe vera* gel applications and their possible combinations on rooting percentage and root characteristics of *Conocarpus erectus* L. propagated by air layering.

Materials and Method

The present study was carried out during the two successive seasons of 2023 and 2024 at the Floriculture Farm, Faculty of Agriculture, Assiut University, Egypt. The main objective was to investigate the impact of indole-3-butyric acid (IBA) and natural substances (chitosan, *Aloe vera* gel and chitosan +*Aloe vera* gel) and their combinations on rooting percentage and root characteristics of *Conocarpus erectus* L. propagated by air layering.

Treatments

a-IBA: Indole-3-butyric acid (IBA) was obtained as commercial chemical substance from El-Gomhorya Company, Egypt. Two IBA concentrations (control "distilled water" and 400 ppm) were mixed with rooting substrate at 75 ml/ 450 cm^3 of rooting substrate.

b-Chitosan: The used chitosan is produced by Techno Pharmchem Company, India. Solution of chitosan was prepared at the concentration of 40 ppm by dissolving 20 g citric acid in 1 liter distilled water then adding 0.04 g chitosan stirring until completely dissolved and then was injected into rooting substrate at 15 ml/air-layer (Hien, 2004).

c-*Aloe vera* gel: (100%) *Aloe vera* leaves were cut from mother plants grown at the Floriculture Farm, Faculty of Agriculture, Assiut University, Egypt. Then the gel extracted from the leaves by peeling and cut off small pieces with a sharp knife and was used at 100% for treating air-layers by painting girdled zone (10 ml/air-layer).

d-Control: air-layer was treated with water.

The combined treatments were applied by painting the girdling zone with Aloe vera gel then inject chitosan at 40 ppm into the rooting substrate which drenched with 400 ppm IBA.

Air layering process

On March 15th during both seasons, one-year-old of *Conocarpus erectus* L. mature shoots with 120 cm (±5 cm) length and about 2 cm diameter were selected from healthy uniform mother plants. The selected shoots were girdled by removing 2.0 cm length ring of bark.

Following the previously described treatment of air-layers, the girdling zone was promptly covered with a rooting medium consisting of perlite and peat moss “1:1 v/v” then covered with transparent polyethylene plastic film. Both ends were secured firmly with gunny thread and then covered with aluminum foil.

Experimental design

The experimental treatments were arranged in a spilt-plot design, with four replicates. Both IBA concentrations (0 and 400 ppm) represented the main plots, while natural substances (water, chitosan, *Aloe vera* gel and chitosan + *Aloe vera* gel) represented the sub-plots. Each experimental unit consisted of ten air-layers.

Data recorded

After ten weeks from layering date, all succeeded air-layers (roots can be seen through the poly ethylene plastic cover) were detached from mother plants and the following data were recorded:

1-Rooting percentage: Percentage of rooted air-layers which produced visible roots was recorded.

2-Root characteristics: Four samples were taken from each experimental unit, and the rooted area was dipped in water to eliminate any adhering rooting substrate then the following data were recorded:

-Number of days for root appearance.

-Number of main roots/layer.

-Root length (cm).

-Root fresh and dry weights (g)/rooted air-layer.

3-Chemical analysis: At the time of separating the air-layers from mother plants, the basal 2.0-2.5 cm portion of rooting region was subjected for chemical analysis. Samples were oven-dried at 70ºC for 48 h and ground into homogenous fine powder to determine total carbohydrates %, nitrogen %, C/N ratio and total phenols content.

-Total carbohydrates percentage in rooting zone of air-layers was determined colorimetrically by anthrone sulphuric acid method at 630 nm wave length according to Hansen and Moller (1975).

-Nitrogen % in air-layer bases were estimated by semi-micro Kjeldahl method as described by Black *et al*. (1982).

-Carbohydrate/nitrogen (C/N ratio) was calculated (as an indication of rooting capacity).

-Total soluble phenols content (mg GAE/g d.w.) was measured by using a modified Folin method as described by Vasco *et al*. (2008).

Statistical analysis

Data obtained during both seasons were subjected to statistical analysis using Statistix 8.1 analytical software. Means were compared

by using the least significant differences (L.S.D.) test at 5% level of probability according to Gomez and Gomez (1984).

Results and Discussion

1-Rooting percentage

Data presented in Table (1) clearly show that rooting percentage of *C. erectus* air-layers was considerably increased by using IBA at 400 ppm compared with untreated air-layers during the two seasons. Rooting percentage reached 75.95% for IBA treatment compared to control (40.05%) as an average of the two seasons. These findings are in parallel with those published by Mousa *et al*. (2019), Ibrahim (2020); Abdul-Hafeez (2020); Tomar (2023). The positive impact of IBA in raising rooting percentage could be attributed to the important roles of auxin including accumulation of metabolites at

the auxin application site, enhanced hydrolysis of carbohydrates, stimulation of cell division, cell elongation, root formation, synthesis of RNA, enzymes, new protein and cell-wall components (Lwin *et al*., 2012; Kasem and Abd El-Baset, 2014).

Results also highlight the importance of natural substances treatments to enhance rooting percentage. Treating air-layers with *Aloe vera* gel and/or chitosan significantly increased rooting percentage in comparison with untreated ones. The highest rooting percentage (75%) was recorded with air-layers treated with *Aloe vera* gel plus chitosan, followed by single treatment of *Aloe vera* gel (62.5%) and chitosan (53.15%) as average mean of the two seasons. Meanwhile, the lowest value (41.25%) was recorded with untreated air-layers. These results coincided with the findings obtained by Mirihagalla and Fernando (2020); Eddris (2021) and Sunil *et al.* (2021), who stated that treatment of air-layers with natural substances such as *Aloe vera* gel and chitosan considerably improved adventitious root formation. The promotive effect of *Aloe vera* gel in enhancing rooting percentage may be attributed to *Aloe vera* gel containing auxins, gibberellin, salicylic acid, vitamins, amino acids, minerals, sugar, saponins and lignins (Surjushe *et al*., 2008). Besides, it promotes cell preservation and proliferation (Dagne *et al*., 2000). On the other hand, the stimulating effect of chitosan may attribute to its effectively stimulate and enhance plant growth by affecting plant physiological processes, such as nutrient uptake, cell division and elongation as well as stress resistance (Choudhary *et al*., 2017; Chakraborty *et al*., 2020; Wang *et al*., 2020; Li *et al*., 2021). In addition, it can also trigger the defensive mechanisms in plants, stimulate root growth and induce certain enzymes such as chitinases, pectinases and glucanase (Hien, 2004).

Regarding the interaction effect between IBA and natural substances, it is obvious that exogenous application of IBA increased the effectiveness of *Aloe vera* gel and chitosan in promoting adventitious root formation on air-layers in comparison with the single treatments. The combined treatment of IBA at 400 ppm + chitosan + *Aloe vera* gel produced the highest rooting percentage (96.3%), followed by IBA + *Aloe vera* gel (78.75%) and IBA + chitosan (68.8%) as average of both seasons. Thus, the natural auxin produced as a result of the natural substances application may be enhanced by the exogenous supply of IBA **(Liu *et al*., 2002).**

Table 1. Percentage of rooted layer (%) of *Conocarpus erectus* L. as affected by IBA, chitosan and *Aloe vera* gel during 2023 and 2024 seasons.

Natural substances (NS)	First season (2023)			Second season (2024)		
	IBA concentrations (ppm)					
	0	400	Mean	0	400	Mean
Cont. (water)	22.5	62.5	42.5	22.5	57.5	40.0
Ch.	37.5	70.0	53.8	37.5	67.5	52.5
A.V.G	42.5	77.5	60.0	50.0	80.0	65.0
Ch. + A.V.G	52.5	97.5	75.0	55.0	95.0	75.0
Mean	**38.8**	**76.9**	**---**	**41.3**	**75.0**	**---**
L.S.D. at 0.05						
IBA		6.0			5.1	
NS		9.0			9.2	

Interaction	12.8	13.0

Cont.: Control, Ch.: Chitosan and A.V.G.: *Aloe vera* gel

Root characteristics

As shown in Table 2, it is obvious that treating air-layers of *C. erectus* with IBA significantly encouraged the early appearance of roots and enhanced root characteristics compared to the control during the two seasons. Generally, IBA application decreased the number of days needed for root appearance (24.2 days) and produced the highest root number (40.5) and root length (31.6 cm) as well as the heaviest root fresh weight (15.1 g) and root dry weight (1.6 g) per rooted layer as average of both seasons. On the other hand, untreated air-layers gave the highest number of days required for root appearance (40.0 days) and the lowest values of root number, root length, root fresh and dry weights (24.0, 19.7 cm, 9.2 g and 0.8 g, respectively) per rooted layer. The present findings are similar to that of Reddy *et al*. (2014); Mousa *et al*. (2019); Abdul-Hafeez (2020); Eddris (2021), who revealed that exogenous application of IBA speeds up root appearance and improve root parameters of air-layers when compared to the control. The enhancing effects of IBA on the root traits of *C. erectus* rooted air-layers could be attributed to its property of slow movement and its relatively slow destruction by auxin degrading enzyme system (Dharshan, 2008; Kumar, 2011). This could be possible because early root initiation may have given adequate time for a higher rate of cell proliferation and elongation, which in turn may have encouraged longer roots. The number of roots per rooted layer was positively correlated with cumulative root length. Thus, IBA either increases the number of roots per rooted layer or increases the expansion and division of cells at each root to change the length of the roots. Nanda (1975) attributed the promotive effect of IBA to the hardwood's cutting to the improved utilization of stored carbohydrates with the application of exogenous auxin by turning starch into simple sugars, which are necessary for the production of new cells and for increased respiratory activity in regenerating tissues at the time of root initiation. Additionally, IBA can accelerate root formation, improve rootability and the quality of air-layers by promoting the initiation of root primordia, vascular cambial cells and enhance the transfer of carbohydrates and rooting co-factors to the rooting zone (Yeboah *et al*., 2014; Hartmann *et al*., 2014). The increase in root fresh and dry weights could be a result of exogenous application of auxin which improve the transport of endogenous auxin and other materials downward from the leaves and shoot tips and accumulate at the girdling zone led to the development of roots (Baghel *et al*., 2016).

As for the impact of natural substances, it is noticed that treating air-layer with *Aloe vera* gel and/or chitosan caused early root emergence and improved root measurements in comparison to the control, hence *Aloe vera* gel was more effective than chitosan. The combined treatment of *Aloe vera* gel plus chitosan resulted in the minimum number of days required for root appearance (25.2 days) and the best root traits of root number (39.5), root length (31.8 cm), root fresh weight (15.4 g) and root dry weight (1.5 g) per rooted layer as average of both seasons. Meanwhile, the highest number of days required for root appearance (41.9 days) and the lowest values of root number, root length, root fresh weight and root dry weight (25.0, 19.9 cm, 8.8 g and 0.9

g, respectively) per rooted layer were obtained from untreated air-layer. These results are compatible with those obtained by Sheikha and AL-Malki (2011); Shidiki *et al.* (2019); Eddris (2021); Khalid and Ahmed (2022), who reported that treating air-layers with *Aloe vera* gel or chitosan improved root measurements compared to the control.

Table 2. Number of days for root appearance and root characteristics of *Conocarpus erectus* L. air-layer as affected by IBA, chitosan and *Aloe vera* gel as an average of two seasons.

Natural substances (NS)	No. of days for root appearance			No. of roots/air-layer			Root length (cm)			Root fresh weight (g)			Root dry weight (g)		
	IBA concentrations (ppm)			IBA concentrations (ppm)			IBA concentrations (ppm)			IBA concentrations (ppm)			IBA concentrations (ppm)		
	0	400	Mean	0	400	Mean	0	400	Mean	0	400	Mean	0	400	Mean
Cont. (water)	53.4	30.3	41.9	16.7	33.3	25.0	14.3	25.4	19.9	5.5	12.5	8.8	0.5	1.3	0.9
Ch.	38.9	25.6	32.3	22.2	37.4	29.8	19.1	28.5	23.8	8.5	14.4	11.5	0.7	1.5	1.1
A.V.G	34.9	23.3	29.1	26.4	43.0	34.7	21.2	33.2	27.2	10.3	15.9	13.1	0.9	1.7	1.3
Ch. + A.V.G	32.9	17.5	25.2	30.6	48.4	39.5	24.4	39.3	31.8	12.0	18.2	15.4	1.1	2.0	1.5
Mean	**40.0**	**24.2**	**----**	**24.0**	**40.5**	**---**	**19.7**	**31.6**	**---**	**9.2**	**15.1**	**---**	**0.8**	**1.6**	**---**
L.S.D. at 0.05															
IBA		3.0			1.7			1.2			0.4			0.1	
NS		2.3			1.2			0.9			0.8			0.1	
Interaction		3.2			1.6			1.3			1.1			0.1	

Cont.: Control, Ch.: Chitosan and A.V.G.: *Aloe vera* gel

The interaction effect between IBA and natural substances on number of days needed for root emergence, number of roots, root length, root fresh and dry weights per rooted layer was significant during the two seasons. The best combination of IBA (400 ppm) + chitosan + *Aloe vera* gel resulted in the lowest number of days needed for root emergence and gave the best root characteristics, followed by IBA + *Aloe vera* gel and IBA + chitosan, respectively. Conversely, the lowest values recorded with untreated air-layer. Previous studies have been shown that the combination of IBA with natural growth substances had a stronger influence on accelerating and enhancing root formation than the individual treatments of IBA or natural substances in number of plant species (Gamlath *et al.*, 2010; Eddris, 2021; Sunil *et al.*, 2021). They attributed this effect to the synergistic effect between IBA and natural substances since IBA is known to encourage the root formation when combined with natural substances. The increase in root traits may be linked to the balance between endogenous hormone levels and nutrients contained in plant tissues (Wróblewska, 2015).

Chemical analysis

It is clear from data presented in Table (3) that total carbohydrates percentage, carbohydrate/nitrogen (C/N ratio) and total phenolics content in tissues of rooted air-layer of *C. erectus* were considerably increased by IBA application at 400 ppm in comparison to untreated air-layers (control) in both seasons. Treating air-layer with 400 ppm IBA gave 26.3 and 28.3% of total carbohydrates percentage, 37.96 and 42.60 of C/N ratio as well as 45.2 and 47.1 mg GAE/g dry weight of total phenols content in 1st and 2nd seasons, respectively. Conversely, untreated air-layers recorded the lowest values of total carbohydrates percentage (19.2 and 20.1 %), C/N ratio (23.25 and 23.59 %), total phenols content (30.6 and 32.1 mg GAE/g dry weight) and greater nitrogen percentage (0.83 and 0.86%) in 1st and 2nd seasons, respectively. These results are in harmony with those obtained by Amissah *et al*. (2013); Abdel-Rahman *et al*. (2019); Ibrahim (2020); Abdul-Hafeez (2020). They stated that treating air-layers with IBA remarkably increased content of total phenolics, total carbohydrates percentage and C/N ratio compared to control. They added that higher contents of total carbohydrates, C/N ratio and total phenols in plant tissues may enhance root formation and promote root growth.

IBA (indole-3-butyric acid) plays a dual role in plant growth. First, it binds to sugar molecules and transports them to the base of the shoot, providing energy for root development (Das *et al.,* 1997; Woodward and Bartel, 2005). Second, IBA also binds to phenol molecules, transferring them to the girdled zone to prevent root infection and protect itself against oxidation by IAA-oxidase (Pandey and Pathak, 1981; Hartmann *et al*., 2014).

Regarding natural growth substances effect, it is obvious that all natural growth substances treatments markedly increased content of total phenols, total carbohydrates percentage and C/N ratio in rooted air-layers tissues of *C. erectus* plant. Generally, treating air-layers with chitosan + *Aloe vera* gel produced the maximum values of total carbohydrates percentage (26.4 and 27.8%), C/N ratio (38.38 and 41.18 %), total phenols content (43.5 and 45.4 mg GAE/g dry weight) during both seasons, respectively. Conversely, untreated air-layers recorded the minimum values of total carbohydrates

percentage (18.0 and 19.0%), C/N ratio (23.03 and 23.92 %), total phenols content (31.6 and 33.3 mg GAE/g dry weight) and maximum N% (0.81 and 0.83) during both seasons, respectively.

Moreover, the statistical analysis showed that application of IBA with natural substances was more effective on increasing total carbohydrates, C/N% and phenols content than the individual treatments. Generally, the highest values of total carbohydrates percentage, C/N ratio and total phenolics content were obtained when air-layer was treated with IBA + *Aloe vera* gel + chitosan, followed by IBA + *Aloe vera* gel. Similar results were obtained by Eddris (2021); Sunil *et al.* (2021). Chawla (2012); Abdel-Rahman *et al*. (2020) who suggested that carbohydrates play an important role in regulating root formation.

These positive effects of IBA and natural substances may be due to specific evidences that the presence of IBA with Aloe vera gel and chitosan strongly affects the rootability of air-layer by the effective role of carbohydrates and phenols. The exogenous application of auxins caused the utilization of the stored nutritional materials to promote faster root formation (Arslonov, 1979). It is thought that some compounds such as auxins and carbohydrates are produced in leaves and moved to the rooting zone to promote the adventitious root formation (Raviv and Reuveni, 1984). It is possible for carbohydrates to serve only as a source of metabolic fuel, which is required to supply the energy required for root development. Additionally, carbohydrates may affect auxin levels, which in turn may affect adventitious root growth.

The carbohydrate/nitrogen ratio was found to be slightly higher in air-layer treated with IBA in comparison with the control (Anandhanambi *et al*., 2016). Higher C/N ratio has been thought to increase rooting co-factors activity and improve root formation (Telang, 1981). Regarding nitrogen, it plays a role in the synthesis of proteins and RNA, which through cell arrangement signals adventitious root development.

As for phenols, it has been demonstrated that phenolic compounds interact with proteins to change metabolism of root formation (Kefeli and Kutacek, 1976). The increase in polyphenolic compounds resulted from IBA or natural substances application directly contribute to a reduction in auxin oxidation, which enhances rootability as well as root and vegetative characteristics (Mitchell *et al*., 1986; Scagel and Linderman, 1998). According to Abdel-Rahman *et al*. (2020), the adventitious root formation may be attributed to impact of auxins with rooting co-factors or auxins synergists of carbohydrates and phenols ompounds.

Finally, it could be recommended to propagate *Conocarpus erectus* L. by air-layering using the combination of IBA at 400 ppm, chitosan at 40 ppm and *Aloe vera* gel to produce long, strong and healthy plant for commercial proposes

Table 3. Total carbohydrates (%), nitrogen (%), C/N ratio and total phenols content (mg GAE/g d.w.) in stem tissue of *Conocarpus erectus* L. air-layer as affected by IBA concentrations and natural substances during the 2023 and 2024 seasons.

Natural substances (NS)	Total carbohydrates (%)			Nitrogen (%)			C/N ratio			Total phenols content (mg GAE/g d.w.)		
	2023 Season											
	IBA concentrations (ppm)			IBA concentrations (ppm)			IBA concentrations (ppm)			IBA concentrations (ppm)		
	0	400	Mean	0	400	Mean	0	400	Mean	0	400	Mean
Cont.	12.7	23.6	18.0	0.90	0.73	0.81	14.23	31.83	23.03	24.6	38.5	31.6
Ch.	19.4	25.8	22.6	0.82	0.73	0.78	23.59	34.37	28.98	30.9	44.1	37.5
A.V.G	21.0	27.1	24.0	0.84	0.70	0.77	24.91	39.14	32.02	30.9	47.1	39.0
Ch. + A.V.G	23.3	29.1	26.4	0.78	0.63	0.70	30.28	46.49	38.38	36.0	51.1	43.5
Mean	**19.2**	**26.3**	---	**0.83**	**0.70**	---	**23.25**	**37.96**	---	**30.6**	**45.2**	---
L.S.D. at 0.05												
IBA		1.1			0.03			1.83			2.0	
NS		0.8			0.03			1.09			1.6	
Interaction		1.1			0.04			1.54			2.2	
									2024 Season			
Cont.	13.3	24.6	19.0	0.91	0.74	0.83	14.69	33.16	23.92	26.1	40.6	33.3
Ch.	21.0	27.5	24.2	0.87	0.71	0.79	24.14	38.90	31.52	32.0	45.8	39.0
A.V.G	22.0	29.6	25.8	0.86	0.65	0.75	25.48	46.04	35.76	32.2	49.5	40.8
Ch. + A.V.G	24.2	31.5	27.8	0.81	0.60	0.70	30.04	52.32	41.18	38.2	52.6	45.4
Mean	**20.1**	**28.3**	---	**0.86**	**0.67**	---	**23.59**	**42.60**	---	**32.1**	**47.1**	---
L.S.D. at 0.05												
IBA		1.0			0.01			2.06			1.8	
NS		1.0			0.02			1.36			1.7	
Interaction		1.4			0.04			1.93			2.4	

Cont.: Control, Ch.: Chitosan and A.V.G.: *Aloe vera* gel

Conclusion

Based on the results obtained from this study, it was found that the vegetative propagation of *Conocarpus* plants using air-layering treated with indole butyric acid (IBA) + chitosan + *Aloe vera* gel was the most effective treatment in improving rooting percentage, survival rate, and rooting speed. This treatment also resulted in the highest content of photosynthetic pigments, total carbohydrates, carbohydrate to nitrogen ratio and total phenols. The treatment with IBA + *Aloe vera* gel was the next most effective.

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تأثير إندول حمض البيوتيريك والشيتوزان وجيل الصبار البلدي على تعزيز نمو جذور التراقيد الهوائية لنبات الكونوكاربس

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الملخص

أجريت هذه الدراسة بمزرعة الزينة بكلية الزراعة، جامعة أسيوط، مصر، خلال موسمي 2023 ،2024 وذلك بهدف تقييم تأثيرات إندول حمض البيوتيريك (صفر، 400 جزء في المليون) والشيتوزان (40 جزء في المليون) وجل الصبار البلدي والتأثيرات المشتركة بينهم على نسبة التجذير وعدد الأيام اللازمة لبزوغ الجذور والصفات الجذرية للتراقيد الهوائية، نسبة الكربوهيدرات الكلية، نسبة الكربون إلى النيتروجين ومحتوى الفينولات الكلية لنبات الكونوكاربس.

اظهرت النتائج المتحصل عليها أن معاملة التراقيد الهوائية لنبات الكونوكاربس بإندول حمض البيوتيريك بتركيز 400 جزء في المليون والشيتوزان بتركيز 40 جزء في المليون وجل الصبار البلدي (100%) أدى إلى زيادة نسبة التجذير ونقص عدد الأيام اللازمة لبزوغ الجذور، كما أدى ذلك إلى تحسين الصفات الجذرية (العدد والطول والوزن الطازج والجاف للجذور)، بالإضافة إلى زيادة نسبة الكربوهيدرات الكلية ونسبة الكربون إلى النيتروجين ومحتوى الفينولات الكلية مقارنة بالتراقيد الهوائية غير المعاملة.

كما أوضحت النتائج أن المعاملة الفردية بجيل الصبار البلدي أو بالاشتراك مع إندول حمض البيوتيريك كان أكثر تأثيراً من المعاملة الفردية للشيتوزان أو مشتركاً مع إندول حمض البيوتيريك.

أفضل النتائج تم الحصول عليها بالمعاملة المشتركة بين كل من إندول حمض البيوتيريك بتركيز 400 جزء في المليون مع الشيتوزان بتركيز 40 جزء في المليون وجل الصبار البلدي.

وبناءا على ذلك، فإنه ينصح بتطبيق هذه المعاملات عند استخدام الترقيد الهوائى لإكثار نبات الكونوكاربس بغرض إنتاج عدد كبير من النباتات الطويلة قوية النمو والصالحة للإنتاج التجارى في أسرع وقت ممكن.

الكلمات المفتاحية: *الشيتوزان، إندول حمض البيوتيريك، ترقيد هوائي، جيل الصبار البلدي، كونوكاربس.*