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(Original Article)

Growth Biostimulants as Synthetic Hormone Replacements for Rooting, Vegetative Growth and Chemical Constituents Promotion in Rose Cuttings Under Different Growing Media

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Abstract

The objective of the current study to evaluate rooting media, growth biostimulants and their interactions on rooting, vegetative growth and chemical constituents of rose cuttings. This investigation was laid out in a factorial experiment, the main factor (rooting media) consists of three treatments sand, palm peat and sand + palm peat (1:1 v:v), while the secondary factor consists of seven treatments control (tap water), *Aloe vera* gel extract (AVE) at 2 and 4%, moringa leaf extract (MLE) at 2 and 4% and seaweed extract (SWE) at 2 and 4%, as soaking-cuttings treatments. The obtained data showed that rooting media of sand + palm peat (1:1 v:v) caused a significant increase in all traits of rose, which includes rooting percentage, root length, root number, root fresh weight and root dry weight, plant height, branch number, stem diameter, leaf number, shoot fresh weight and shoot dry weight, total chlorophyll content and total carbohydrates %. As for soaking-cuttings treatments with growth biostimulants found that most concentrations significantly increased these traits under study, as compared to control. Clearly, the highest values were obtained by soaking rose cuttings in moringa leaf extract (MLE) at 4% over control. Regarding to the combined between two examined factors, the best results in rooting and growth rose cuttings were obtained using the mixture of rooting media sand + palm peat (1:1 v:v) with moringa leaf extract at 4% or moringa leaf extract at 2%, in most cases, during the two experimental seasons.

Keywords: *Rosa hybrida, Rooting cuttings, Propagation media, Growth biostimulants.*

Introduction

The commercial production of ornamental plants is a global industry. Their economic worth has expanded dramatically over the last two decades, and there is great potential for further flower production in the future, either in local or worldwide markets (Sardoei and Rahbarian, 2014). The rose ranks first in the international flower market. It is one of the beautiful creations of nature and is

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known by everyone as the "Queen of Flowers". The genus *Rosa* belongs to the family Rosaceae with chromosome number 2n = 4x = 28. The first modern rose was the hybrid tea rose, created from hybrids of a hybrid eternal rose and a tea rose (Marriott, 2003).

Asexual propagation is the best way to perpetuate certain species, especially an individual that best represents that species. Clones are groups of plants that are identical to their single parent plant and can only be propagated asexually. The main methods of asexual propagation are cuttings, layering, division and grafting. Cutting involves rooting a cut portion of the parent plant; layering involves rooting a part of the parent and then cutting it off and budding and splicing two parts of plants of different varieties (Relf and Ball, 2009).

Appropriate growth media is the best way for plant survival. Several soilless substrates are being utilized to grow seedlings, propagate plants, and generate ornamental plants (Ahmad, 1989 and Fozia *et al*., 2010). Growth media should be able to provide great water retention capacity, adequate drainage, and sufficient cation exchange capacity (Hamidpour *et al*., 2013). A good growth media, it should be ideal in terms physical and biological properties, it should be available, comparatively inexpensive, good enough to make working with it simpler and cost-effective transportation (Higaki and imanmura 1985). Recently, it became urgently needed to be recycling agricultural waste due to economic problems, palm waste can be optimal alternative to peat moss in well-known culture media. Mixing other waste, such as bark, compost, and a range of inorganic components, such as perlite, vermiculite, sand, and rock wool with palm peat can be combining porosity and water retention capacity, which improves its nutritional status (Khalighi and Padasht, 2000 and Rahbarian and Salehi, 2014). Palm trash contains compounds that are similar with cocopeat and fiber palm tree. Annually, large amounts of waste produces or it is burned or utilized at low proportions in the paper industry (Borji *et al*., 2010).

Extraction of medicinal plants is a process of separating active plant materials or secondary metabolites such as alkaloids, flavonoids, terpenes, saponins, steroids, and glycosides using an appropriate solvent such as water or organic solvents. Natural plant extracts are a cost-effective and environmentally friendly alternative to plant growth. Synthetic growth regulators are still difficult to acquire in ordinary life and are somewhat expensive, thus other solutions must be sought (El Sherif, 2017 and Sumantra and Widnyana, 2011). Examples of alternative hormones used are *Moringa oleifera* (family: Moringaceae) is one of the world's most remarkable and important trees, native to Asia and Africa. Moringa is one of the most beneficial and medicinal species. It is well-known and used for a variety of applications all over the world (Steinitz *et al*., 2009). *Moringa oleifera* leaf extract is rich in amino acids, ascorbate, zeatin, minerals, and many other compounds known for their growth stimulant potential. Also, it is rich in cytokinins, which are a natural plant hormones where it is important regulators of plant growth and development, such as cell division, leaf senescence, apical dominance, stress tolerance, lateral root formation and

nutritional signaling (Argueso *et al.*, 2009, Sakakibara 2006 and Nouman *et al*., 2012).

Aloe vera is fundamental medicinal plant of African origin from the Liliaceae family. It is a succulent plant that grows in a variety of countries (Pandey and Singh, 2016). *Aloe vera* gel utilized in promote root development in a lot of ornamental cuttings. This is apparently because *Aloe vera* gel includes plant growth regulators, specifically auxin, amino acids, vitamins and minerals, which might promote adventitious root formation of cuttings (Sundahri, 1994).

Seaweed extract consisting of growth biotimulants are classified into three groups: gibberellins, auxins and cytokinins. It is rich in potassium salts and amino acids by up to 10%. Also, it is improving macro and microelement absorption and translocation within plants, boosts respiration and root development and participates in photosynthesis and other metabolic activities. It is improving plant resilience to stress and improve flowering (Bai *et al*., 2007).

Therefore, the aim goal of this investigation was to study the influence of growing media (sand, palm peat and sand + palm peat (1:1 v:v), some biostimulants (moringa leaf extract "MLE", Aloe vera gel "ALE" and seaweeds extract "SWE") and their interactions on root, growth parameters and active ingredients of rose (Rosa *hybrida*) to determine the most appropriate treatment to improve these characteristics.

Materials and Methods

Rooting cuttings experiment was carried out in the Nursery of the Agricultural Research Center, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt, during two consecutive seasons (10^{th} January) 2021 and 2022 in order to study the influence of rooting media and biostimulants, as well as their interactions on rooting, growth and chemical constituents of rose (*Rosa hybrid*), which is known in Egypt as the fiery rose hybrid.

Materials and treatments listed below were used

Three hundred and fifteen cuttings were chosen to be almost uniform in length and diameter. The cuttings were taken via sharp scissors from mother-stock orchard 3 years old from middle and basal cuttings depending on its position in the plant branches and a length of 15 cm with removing the entire leaves. Treatments were laid out as a 3 × 7 factorial arranged in a split-plot design with three replicates. Each experimental unit contained 5 cuttings (one cutting/plastic bag). The factors included the following treatments:

Rooting media were assigned in the main plot as follows

1- Sand.

2- Palm peat.

3- Sand + palm peat (1:1 v/v).

Palm peat media was obtained from Zahrat Al-Nil Company for Gardens and Landscapes, Cairo, Egypt.

The chemical analysis of the rooting media is shown in Table (1).

Table 1. Chemical analysis of the rooting media as the average of the two growing seasons.

Rooting media	pH	EC (dSm^{-1})	Total N ($g\ kg^{-1}$)	Total P ($g\ kg^{-1}$)	Total K ($g\ kg^{-1}$)
Sand	6.99	0.48	0.33	0.19	0.26
Palm peat	6.82	0.24	0.89	0.45	0.87
Sand + Palm peat (1:1 v/v)	6.88	0.33	0.75	0.38	0.71

Biostimulants were allocated in sub-plots as follows

1- control (tap water).

2- Moringa leaf extract t (MLE) at 2 %.

3- Moringa leaf extract (MLE) at 4 %.

4- Aloe vera gel extract (AVE) at 2 %.

5- Aloe vera gel extract (AVE) at 4 %.

6- Seaweed extract (SWE) at 2 %.

7- Seaweed extract (SWE) at 4%.

Biostimulant extracts were prepared as follows:

Moringa leaf extract (MLE) was prepared from fresh *Moringa oliefera* leaves, that air-dried under shade, and ground into a fine form, after that was macerated in 70% ethanol (1:5 w/v), then filtered through the filter paper type 12 Whatman twice, 24 hours apart, between the first and the second times. After filtration the alcohol was allowed to evaporate using water bath at 74° C and the remaining extract prepared according to the concentrations employed in this study (Vongsak *et al*., 2013).

Fresh and mature *Aloe vera* leaves were used. These leaves were cleaned and sliced transversely to separate the epidermal layer from the pulp. The resultant mucilaginous gel was homogenized using an electric blender to be a liquid form then prepare the concentrations employed in this investigation (Hanafy *et al*., 2012).

Super oligo product includes seaweeds extract in granules form was obtained from Sinochem Agro Co., Ltd., Shanghai. Chemical analyses of moringa leaf extract, aloe leaf gel extract and seaweed extract were shown in Tables (2, 3 and 4) respectively.

Treatment cuttings with biostimulants

The lower parts of cuttings were initially dipped in fungicide (carbendazim at 0.2%) for 10 minutes then it was taken out and allowed in the air to dry. The cuttings after drying were soaked in biostimulants for 30 minutes then also left to air dry (Massoud *et al*., 2017). All cuttings have been grown in the aforementioned propagated media and packed in polyethylene bags (15 × 20 cm) under a small greenhouse (plastic house), each bag contained one cutting with

leaving a distance of 2 cm at the top of the bag to allow for irrigation process. Finally, the bags were irrigated abundantly and then the greenhouse (plastic house) was tightly closed.

Table 2. Chemical analysis of moringa leaf extract according to Ali *et al*., 2018.

Components	Value (mg/g-1 DW)
Total phenols	1.635
Total chlorophyll	4.378
Ascorbic acid (mg/g-1 FW)	8.47
Total carotenoids	1.72
Amino acids	387.72
Proline	33.65
Nutrient profile	
Potassium	13.78
Phosphorus	3.82
Nitrogen	12.36
Calcium	15.92
Magnesium	3.96
Zinc	0.051
Iron	0.379
Manganese	0.081
Copper	0.038
Phytohormonal profile (µg/g-1 FW)	
Gibberellins	0.65
Cytokinins	0.63
Indole acetic acid	0.72
Abscisic acid	0.13
Salicylic acid	1.87

Table 3. Chemical analysis of *Aloe vera* extract (according to Rawe (1966) and Nandi *et al.*, 1990).

Mineral	mg/100 ml f.w	Phytohormones	Result	Unit
Nitrogen	81	**GA_3**	16	mg/100gm f. w
Phosphorus	7	**IAA**	0.6	mg/100gm f. w
Potassium	61	**ABA**	3.1	mg/100gm f. w
Iron	0.3	**Total carbohydrates**	10	(%)
Zinc	0.02	**Glucose**	3	g/100g
Manganese	0.03	**Protein**	1.0	mg/g
Calcium	40	**Cholesterol**	19	mg/g
Copper	0.004			
Magnesium	14			
Sodium	51			

Table 4. Chemical composition of the used seaweed extract.

Components	Value	components	value
Organic (N)	3.07 %	**Total amino acid**	5 %
P_2O_5	2.44 %	**Carbohydrates**	29 %
K_2O	10 %	**Alginic acid**	10 %
S	2.43 %	**IAA**	0.04 %
Ca	0.22 %	**Cytokinins**	0.03 %
Mg	0.53 %		
Fe	145 ppm		
Zn	60 ppm		
Mn	11 ppm		
Cu	14 ppm		

The recorded data

Different characteristics of rooted rose cuttings were assessed 90 days after planted in rooting media. The characteristics were rooting percentage and root characteristics (root length per cutting, root number per cutting, root fresh weight and root dry weight per cutting. Vegetative growth characteristics; plant height (cm), stem diameter (mm), shoot number per cutting, leaf number per cutting, fresh and dry weight of shoots per cutting. Chemical traits; total chlorophyll content in plant leaves was measured as SPAD units using Minolta chlorophyll meter (model SPAD 502) according to Markwell *et al*. (1995). Total carbohydrates % was estimated by hydrolyzing for 2 g of dry leaves with 20 ml Sulphoric acid (2 N) for 4 hours on water-bath at 70˚ C then after cooling, the solution was filtered, the acidity was neutralized by barium carbonate and filtered. The filtrate was quantitatively transferred into 100 ml volumetric flask and completed with distilled water. After that, two ml of the filtrate was taken in a test tube and 1 ml of 5% phenol was taken then added then a gentle shaking, 5 ml of concentrated sulphoric acid were directly added. The tube was cooled under the tap for 15 minutes till the orange colour developed. Immediately, it was measured spectrophotometerically at 490 nm then the percentage of carbohydrates was calculated through the following equation as described by Smith *et al*. (1956).

$$\text{Total carbohydrate \%} = \frac{A \times 100 \times 100}{1000 \times 1000 \times B}$$

Where, A: Concentration and B: Weight of sample.

All root, vegetative growth and chemical traits were statistically analyzed by CoStat soft-ware was used to analyze all of the data. Firstly, a two-way analysis of variance (ANOVA) was performed on the data. Then LSD test was set at the 0.05 confidence level to separate treatment means according to (Steel and Torrie, 1986).

Results

Root parameters

The obtained data in Table (5) revealed that rooting percentage, root length, root number, root fresh weight (g/plant) and root dry weight (g/plant) of rose were positively affected by the using of different growing media, during the two experimental seasons. Plainly, the best rooting media was those that consists of a mixture sand + palm peat (1:1 v:v), in both seasons. The highest values of these traits were given by a mixture of sand + palm peat (1:1 v:v) which increased it by 24.14 and 23.63, 20.33 and 21.41, 18.46 and 15.25, 31.71 and 29.43 and 31.73 and 29. 20% compared to sand media, in the first and the second seasons, respectively.

As for growth biostimulants effect, data in Table (5) showed that rooting percentage, root length, root number, root fresh weight (g/plant) and root dry weight (g/plant) of rose were positively responded to the use of the examined growth biostimulants, during the two experimental seasons. Apparently, soaking rose cuttings in all used materials and by all concentrations led to a significant augment in all of the aforementioned attributes, in both seasons, comparing to only soaked in water. The highest values were detected when rose cuttings soaked in moringa leaf extract at the high concentration (4%), which increased it by 28.73 and 32.13, 36.52 and 29.83, 39.64 and 49.15, 64.37 and 58.74, 64.42 and 56.30 % over control, respectively during the two consecutive seasons.

In respect to the interaction between rooting media and growth biostimulants on root parameters, it was statistically significant impact on rooting percentage, root length, root number, root fresh weight (g/plant) and root dry weight (g/plant) of rose, in the two seasons. According to the results, the highest values occurred in rose cuttings grown in sand + palm peat media (1:1 v:v) with moringa leaf extract (MLE) at 4% or moringa leaf extract (MLE) at 2%, as soaking treatment in most cases, during both seasons, respectively. On the other hand, the lowest values of these traits were found in rose cuttings grown in sand + control (biostimulants), in the two experimental seasons, as clearly seen in Table (5).

Vegetative growth parameters

The findings in Table (5) showed that the use of various propagation media had a favorable effect on vegetative growth parameters, such as plant height (cm), branch number, stem diameter (mm), leaf number, shoot fresh weight (g/plant) and shoot dry weight (g/plant) of rose in the two experimental seasons. In both seasons, the optimal growth substrate consisted of (1:1 v:v) combination of sand and palm peat, in the first and second seasons. The greatest values of these parameters were detected by a mixture of sand + palm peat (1:1 v:v), which increased it by 19.9 and 20.4, 30.00 and 33.33, 38.20 and 33.51, 30.23 and 27.66, 16.61 and 13.15 and 16.41 and 13.11% over sand media.

Table 5. Effect of rooting media and growth biostimulants extracts on root parameters of (*Rosa hybrid*) during the seasons of 2021 and 2022.

Phytostimulant extracts (B)	Rooting media (A)							
	Rooting percentage							
	First season				Second season			
	Sand	Palm peat	Sand+Palm peat	Mean (B)	Sand	Palm peat	Sand+Palm peat	Mean (B)
Control	47.27	54.91	61.23	**54.47**	49.34	56.74	61.92	**56.00**
AVE at 2%	55.67	62.89	70.20	**62.92**	57.20	65.80	71.53	**64.84**
AVE at 4%	57.23	65.26	73.00	**65.16**	61.35	68.34	74.87	**68.19**
MLE at 2%	61.28	65.28	73.56	**66.70**	63.45	67.74	75.73	**68.97**
MLE at 4%	63.73	68.61	78.01	**70.12**	65.34	73.99	82.63	**73.99**
SWE at 2%	59.89	63.25	73.70	**65.91**	61.69	65.29	76.80	**67.93**
SWE at 4%	61.17	65.98	74.60	**66.95**	64.02	69.33	78.72	**70.69**
Mean (A)	**58.03**	**63.74**	**72.04**		**60.34**	**66.75**	**74.60**	
LSD 0.05%	**A=3.39**	**B=5.18**	**AB=8.97**		**A=4.58**	**B=7.00**	**AB=12.13**	
	Root length (cm)							
Control	12.14	13.16	14.30	**13.20**	13.27	14.19	15.90	**14.45**
AVE at 2%	14.19	15.06	15.37	**14.87**	14.93	15.41	17.10	**15.81**
AVE at 4%	14.70	15.89	15.90	**15.50**	15.46	16.50	17.43	**16.46**
MLE at 2%	15.11	17.04	19.30	**17.15**	15.73	16.56	21.77	**18.02**
MLE at 4%	15.63	18.20	20.23	**18.02**	16.16	17.96	22.17	**18.76**
SWE at 2%	14.30	15.50	16.18	**15.33**	15.56	15.90	17.50	**16.32**
SWE at 4%	14.47	16.34	19.68	**16.83**	16.12	16.57	18.33	**17.01**
Mean (A)	**14.36**	**15.88**	**17.28**		**15.32**	**16.15**	**18.60**	
LSD 0.05%	**A=0.64**	**B=0.98**	**AB=2.90**		**A=0.69**	**B=1.06**	**AB=3.12**	
	Root number							
Control	2.78	3.40	3.82	**3.33**	3.02	3.71	3.88	**3.54**
AVE at 2%	3.10	3.76	3.93	**3.60**	3.24	4.29	4.07	**3.87**
AVE at 4%	3.51	4.18	4.12	**3.94**	4.09	4.41	4.50	**4.33**
MLE at 2%	4.06	4.32	4.94	**4.44**	4.58	4.97	5.10	**4.88**
MLE at 4%	4.11	4.70	5.13	**4.65**	5.09	5.18	5.58	**5.28**
SWE at 2%	3.76	4.04	3.97	**3.92**	3.60	3.71	4.44	**3.92**
SWE at 4%	4.09	4.36	4.21	**4.22**	4.40	4.52	4.75	**4.55**
Mean (A)	**3.63**	**4.11**	**4.30**		**4.00**	**4.40**	**4.61**	
LSD 0.05%	**A=0.05**	**B=0.07**	**AB=0.21**		**A=0.04**	**B=0.06**	**AB=0.17**	
	Root fresh weight (g/cutting)							
Control	2.40	2.63	2.79	**2.61**	2.52	2.70	2.86	**2.69**
AVE at 2%	2.56	2.81	3.05	**2.81**	2.61	2.94	3.16	**2.90**
AVE at 4%	2.63	2.95	3.13	**2.90**	2.72	3.08	3.27	**3.03**
MLE at 2%	2.77	3.93	4.81	**3.84**	3.12	4.01	4.96	**4.03**
MLE at 4%	3.86	4.04	4.96	**4.29**	3.63	4.14	5.03	**4.27**
SWE at 2%	2.71	2.99	3.78	**3.16**	3.02	3.15	3.84	**3.34**
SWE at 4%	3.18	3.56	3.93	**3.55**	3.30	3.62	4.00	**3.64**
Mean (A)	**2.87**	**3.27**	**3.78**		**2.99**	**3.38**	**3.87**	
LSD 0.05%	**A=0.05**	**B=0.08**	**AB=0.23**		**A=0.04**	**B=0.06**	**AB=0.18**	
	Root dry weight (g/cutting)							
Control	1.162	1.272	1.351	**1.262**	1.230	1.306	1.385	**1.307**
AVE at 2%	1.238	1.360	1.477	**1.358**	1.273	1.423	1.528	**1.408**
AVE at 4%	1.273	1.426	1.516	**1.405**	1.319	1.492	1.584	**1.465**
MLE at 2%	1.343	1.903	2.343	**1.863**	1.517	1.942	2.400	**1.953**
MLE at 4%	1.866	1.957	2.400	**2.075**	1.763	2.011	2.434	**2.069**
SWE at 2%	1.314	1.459	1.831	**1.535**	1.464	1.525	1.861	**1.617**
SWE at 4%	1.533	1.722	1.902	**1.719**	1.596	1.754	1.938	**1.763**
Mean (A)	**1.390**	**1.586**	**1.831**		**1.452**	**1.636**	**1.876**	
LSD 0.05%	**A=0.025**	**B=0.039**	**AB=0.115**		**A=0.022**	**B=0.033**	**AB=0.079**	

AVE= Aloe vera gel extract, MLE= moringa leaf extract and SWE= seaweed extract

Table 6. Effect of rooting media and growth biostimulants extracts on vegetative growth parameters of (*Rosa hybrid*) during the seasons of 2021 and 2022.

Phytostimulant extracts (B)	Growing media (A)							
	Plant height (cm)							
	First season				Second season			
	Sand	Palm peat	Sand+Palm peat	Mean (B)	Sand	Palm peat	Sand+Palm peat	Mean (B)
Control	14.8	16.1	17.1	**16.0**	15.6	17.4	17.5	**16.8**
AVE at 2%	15.2	16.9	18.4	**16.8**	16.7	18.5	19.3	**18.2**
AVE at 4%	17.4	17.6	19.8	**18.3**	18.7	19.1	22.6	**20.1**
MLE at 2%	17.3	19.4	23.6	**20.1**	17.6	20.7	24.8	**21.0**
MLE at 4%	19.7	20.1	23.9	**21.2**	20.9	22.0	25.0	**22.6**
SWE at 2%	16.8	18.9	19.9	**18.6**	17.4	19.7	20.8	**19.3**
SWE at 4%	18.3	19.6	21.1	**19.7**	19.5	21.4	22.4	**21.1**
Mean (A)	**17.1**	**18.4**	**20.5**		**18.1**	**19.8**	**21.8**	
LSD 0.05%	**A=1.4**	**B=2.1**	**AB=3.6**		**A=1.6**	**B=2.5**	**AB=4.3**	
	Branch number							
Control	2.21	2.39	2.85	**2.48**	2.30	2.42	2.93	**2.55**
AVE at 2%	2.71	2.89	3.18	**2.93**	2.78	3.06	3.24	**3.03**
AVE at 4%	2.79	3.29	3.49	**3.19**	2.85	3.33	3.67	**3.28**
MLE at 2%	2.76	3.56	3.81	**3.37**	2.81	3.73	4.09	**3.54**
MLE at 4%	2.86	3.81	4.10	**3.59**	2.92	3.84	4.39	**3.72**
SWE at 2%	2.72	2.95	3.44	**3.04**	2.79	3.13	3.62	**3.18**
SWE at 4%	2.82	3.21	3.72	**3.25**	2.86	3.40	3.83	**3.36**
Mean (A)	**2.70**	**3.16**	**3.51**		**2.76**	**3.27**	**3.68**	
LSD 0.05%	**A=0.02**	**B=0.09**	**AB=0.29**		**A=0.03**	**B=0.10**	**AB=0.31**	
	Stem diameter (mm)							
Control	1.51	1.81	1.98	**1.77**	1.56	1.88	2.08	**1.84**
AVE at 2%	1.57	2.07	2.45	**2.03**	1.66	2.25	2.51	**2.14**
AVE at 4%	1.69	2.26	2.47	**2.14**	1.89	2.40	2.54	**2.28**
MLE at 2%	1.83	2.65	2.59	**2.35**	2.07	2.77	2.73	**2.52**
MLE at 4%	2.35	2.71	2.68	**2.58**	2.37	2.82	2.86	**2.68**
SWE at 2%	1.75	2.16	2.51	**2.14**	1.80	2.27	2.53	**2.20**
SWE at 4%	1.78	2.24	2.56	**2.19**	2.04	2.42	2.62	**2.36**
Mean (A)	**1.78**	**2.27**	**2.46**		**1.91**	**2.40**	**2.55**	
LSD 0.05%	**A=0.03**	**B=0.04**	**AB=0.12**		**A=0.05**	**B=0.04**	**AB=0.11**	
	Leaf number							
Control	17.2	20.9	22.5	**20.2**	18.6	22.2	24.9	**21.9**
AVE at 2%	20.6	23.6	25.1	**23.1**	21.8	25.9	26.9	**24.9**
AVE at 4%	22.2	25.8	27.4	**25.2**	23.0	27.2	29.6	**26.6**
MLE at 2%	22.5	27.2	28.4	**26.0**	25.4	29.3	32.4	**29.0**
MLE at 4%	24.6	31.4	32.4	**29.5**	27.5	33.3	34.7	**31.8**
SWE at 2%	20.9	24.1	27.9	**24.3**	23.8	26.2	28.5	**26.2**
SWE at 4%	22.4	27.7	32.1	**27.4**	24.5	28.4	33.3	**28.7**
Mean (A)	**21.5**	**25.8**	**28.0**		**23.5**	**27.5**	**30.0**	
LSD 0.05%	**A=0.8**	**B=1.2**	**AB=3.4**		**A=0.8**	**B=1.3**	**AB=3.6**	
Shoot fresh weight (g/cutting)								
Control	4.77	5.26	5.37	**5.13**	4.84	5.33	5.43	**5.20**
AVE at 2%	5.37	5.57	5.74	**5.56**	5.51	5.66	5.77	**5.65**
AVE at 4%	5.43	5.65	5.79	**5.62**	5.56	5.74	5.86	**5.72**
MLE at 2%	5.92	6.00	7.52	**6.48**	6.07	6.53	7.74	**6.78**
MLE at 4%	6.37	6.64	7.68	**6.90**	6.58	6.85	7.77	**7.07**
SWE at 2%	5.42	5.97	6.43	**5.94**	5.94	6.06	6.48	**6.16**
SWE at 4%	5.48	6.30	6.69	**6.15**	5.95	6.49	6.72	**6.38**
Mean (A)	**5.54**	**5.91**	**6.46**		**5.78**	**6.09**	**6.54**	
LSD 0.05%	**A=0.07**	**B=0.11**	**AB=0.31**		**A=0.02**	**B=0.04**	**AB=0.11**	

Table 6. continue

Shoot dry weight (g/cutting)								
Control	2.20	2.43	2.48	**2.37**	2.24	2.46	2.51	**2.40**
AVE at 2%	2.48	2.57	2.65	**2.57**	2.55	2.62	2.67	**2.61**
AVE at 4%	2.51	2.61	2.67	**2.60**	2.57	2.65	2.71	**2.64**
MLE at 2%	2.73	2.77	3.47	**2.99**	2.80	3.02	3.58	**3.13**
MLE at 4%	2.94	3.07	3.54	**3.18**	3.04	3.17	3.59	**3.27**
SWE at 2%	2.50	2.76	2.97	**2.74**	2.73	2.80	2.99	**2.84**
SWE at 4%	2.53	2.91	3.09	**2.84**	2.75	2.99	3.10	**2.95**
Mean (A)	**2.56**	**2.73**	**2.98**		**2.67**	**2.82**	**3.02**	
LSD 0.05%	**A=0.02**	**B=0.03**	**AB=0.10**		**A=0.01**	**B=0.02**	**AB=0.06**	

AVE= *Aloe vera* gel extract, MLE= moringa leaf extract and SWE= seaweed extract

In regard to growth biostimulants effect, the listed data in Table (6) indicated that these examined biostimulants significantly affected plant height (cm), branch number, stem diameter (mm), leaf number, shoot fresh weight (g/plant) and shoot dry weight (g/plant) of rose, in the two experimental seasons, except for Aloe vera gel at 2%, as for plant height parameter, in first and second seasons. It is clear that soaking rose cuttings in all doses of the three biostimulants resulted in a significant increase in these traits, during the two growing seasons, as compared to cuttings soaked in water only. The best results in these parameters were apparently provided by moringa leaf extract (MLE) at the high concentration (4%), which increased it by 32.5 and 34.5, 44.76 and 45.88, 43.50 and 55.43, 46.0 and 45.2, 34.50 and 35.96 and 34.18 and 36.25 % over control, during the two seasons, respectively.

Table (6) pointed out that plant height (cm), branch number, stem diameter (mm), leaf number, shoot fresh weight (g/plant) and shoot dry weight (g/plant) of rose were positively responded to the interaction treatments, in the two seasons. Clearly, the best results happened when the rose cuttings grown in sand + peat palm media (1:1 v:v) with soaking in moringa leaf extract (MLE) at 4% or moringa leaf extract (MLE) at 2%, in most cases during the two consecutive seasons, respectively. Contrary, the lowest results of these parameters were seen in rose cuttings grown in sand + control (biostimulants), in both seasons.

Chemical parameters

The given results in (Table 7) showed that rooting media greatly affected total chlorophyll content and total carbohydrates % in rose leaves, during both seasons. Clearly, the best results of rose cuttings were those cultivated in a mixture sand + palm peat (1:1 v:v), in both seasons. The greatest values of these traits were given by a mixture of sand + palm peat (1:1 v:v), which varied between 4.5 and 4.9 and 7.36 and 7.63 %, as compared to sand media, in the first and the second seasons, respectively.

In terms of growth biostimulant treatments, the results in Table (7) demonstrated that the usage of the tested biostimulants significant increased chlorophyll and carbohydrates percentage of rose leaves, during the two experimental seasons, except for Aloe vera gel extract at 2%, regarding chlorophyll content, in both seasons. Obviously, Soaking rose cuttings in most biostimulants and concentrations resulted in a significant increase in these

parameters, in both seasons, as compared to just soaked in water only, during the two successive seasons. The greatest values were obtained by soaking rose cuttings in moringa leaf extract at a high concentration (4%), which enhanced it by 14.5 and 14.8 and 13.26 and 13.81%, as compared untreated cuttings, respectively.

Table 7. Effect of rooting media and growth biostimulants on chemical constituent parameters of (*Rosa hybrid*) during the seasons of 2021 and 2022.

Phytostimulant extracts (B)	Rooting media (A)							
	Total chlorophyll content (SPAD)							
	First season				Second season			
	Sand	Palm peat	Sand+Palm peat	Mean (B)	Sand	Palm peat	Sand+Palm peat	Mean (B)
Control	42.9	44.2	45.1	**44.1**	44.5	46.3	47.0	**45.9**
AVE at 2%	46.2	45.7	48.3	**46.7**	47.2	48.4	50.9	**48.8**
AVE at 4%	46.5	48.5	49.2	**48.0**	47.7	51.1	51.5	**50.1**
MLE at 2%	48.3	49.6	49.8	**49.3**	50.8	52.2	51.8	**51.6**
MLE at 4%	49.1	51.0	51.3	**50.5**	52.0	52.8	53.4	**52.7**
SWE at 2%	46.4	47.4	49.2	**47.7**	47.5	49.0	50.3	**49.0**
SWE at 4%	48.9	48.4	50.1	**49.1**	50.1	50.3	51.2	**50.5**
Mean (A)	**46.9**	**47.8**	**49.0**		**48.5**	**50.0**	**50.9**	
LSD 0.05%	**A=1.6**	**B=2.5**	**AB=4.3**		**A=1.8**	**B=2.7**	**AB=4.7**	
	Total carbohydrates %							
Control	26.06	27.52	28.09	**27.22**	26.66	27.88	28.66	**27.73**
AVE at 2%	28.24	28.31	28.62	**28.39**	28.45	29.60	29.35	**29.13**
AVE at 4%	28.58	30.06	30.65	**29.76**	29.35	30.26	31.21	**30.27**
MLE at 2%	28.66	30.35	31.60	**30.20**	29.39	30.73	31.88	**30.67**
MLE at 4%	29.40	31.16	31.94	**30.83**	30.03	31.77	32.88	**31.56**
SWE at 2%	27.02	30.05	29.68	**28.92**	27.58	30.31	31.08	**29.65**
SWE at 4%	28.80	30.28	30.70	**29.93**	29.59	30.70	31.30	**30.53**
Mean (A)	**28.11**	**29.67**	**30.18**		**28.72**	**30.18**	**30.91**	
LSD 0.05%	**A=0.99**	**B=1.51**	**AB=2.62**		**A=1.03**	**B=1.57**	**AB=2.72**	

AVE= *Aloe vera* gel extract, MLE= moringa leaf extract and SWE= seaweed extract

chlorophyll content and total carbohydrates percentage in rose leaves responded effectively to the interaction treatments, in both seasons, according to data in Table (7). Clearly, in most cases, the best values occurred when the rose cuttings were cultivated in sand + peat palm media (1:1 v:v) with soaking in moringa leaf extract (MLE) at 4% or moringa leaf extract (MLE) at 2%, respectively, for two consecutive seasons. On the other side, rose cuttings grown in propagation substrate sand + control (biostimulants) had the lowest outcomes for these parameters.

Discussion

The purpose of this study was to investigate the effects of rooting media and growth biostimulants, such as Aloe vera gel extract (AVE), moringa leaf extract (MLE) and seaweed extract (SWE), as well as their interactions on root parameters, vegetative growth parameters and chemical parameters of rose cuttings. The following is physiological implications of the findings:

Effect of rooting media

The effect of propagation media on the quality of ornamental plants is widely recognized. It influences germination rate as well as other physiological factors such as plant height, leaf number, florets per spike and spike length (Vendrame *et al*., 2005). Rajkumar *et al*. (2017) and Kumar *et al*. (2019) stated that propagation media is the most important component that plays vital role on rooting and development of cuttings in many plants. Manila *et al*., (2017) and Dawa *et al*. (2018) showed that suitable propagation media has an important role in adequate support for the plant, providing nutrients and hold plant available water, as well as enable oxygen passage to the roots and gaseous exchange between the roots and the surrounding environment.

In comparison to alternative rooting media, the combination of peat moss with sand is ideal for rooting and cuttings growth in a lot of plants (Exadaktylou *et al*., 2009 and Jaleta and Sulaiman, 2019). Rahbarian and Salehi (2014) used some rooting media (100% peat moss, 100% peat palm, 100% cocopeat, 100% cococheps, 50% peat moss + 25% sand + 25% perlite, 50% peat palm + 25% sand + 25% perlite, 50% cocopeat + 25% sand + 25% perlite and50% cococheps + 25% sand + 25% perlite), as rooting media for Ficus benjamina cuttings and showed that, the highest lateral shoot were resulted in palm peat substrate at 100 %. While, the highest number of branches were resulted in 50% peat moss + 25% sand + 25% perlite. As for stem diameter, the best values were resulted in 50% palm peat + 25% sand + 25% perlite. Abd El Gayed and Attia (2018) studied the effect of growing media on Celosia argentea and cleared that, total chlorophyll (SPAD) and total carbohydrates % were significantly affected by using different propagated media, in both seasons. Apparently, Celosia argentea plants grown in peat + sand (2:1) medium recorded the highest values of total chlorophyll and total carbohydrate, in the two experimental seasons. Also, Tiwari *et al*. (2020) studied the effect of growing media on survival percentage, root length and root number of patchouli. The results indicated that these traits were significantly influenced by different growing media.

Effect of growth biostimulants

Alternative hormones are natural materials that possess the ability to stimulate the rooting of cuttings. Moringa extract contains a high level of cytokinins, which may play a vital role in stimulating the growth of roots and shoots (Leakey, 2004 and Yong *et al*., 2013). Mashamaite *et al*. (2022) pointed out that the extract derived from moringa (Moringa oleifera Lam.) leaves has been used in agriculture to increase crop growth and production. Moringa leaf extract (MLE) is effective due to its high level of mineral elements, protein, vitamins, carbohydrates, fibre, phenolics and free proline. Moreover, MLE includes considerable levels of phytohormones such as auxins, cytokinins, and gibberellins. Additionally, MLE is a beneficial chemical that promotes plant growth and root development. Khalek *et al*. (2008) indicated that root formation was positively affected by moringa leaf extract (MLE) of olive cuttings. Ovaskainen *et al*. (2016) showed that moringa leaf extract (MLE) gave

significantly higher total number of roots, total length of roots and length of the longest root in semi-hardwood cuttings of Parkia biglobos.

Various seaweed species have demonstrated phytoregulators action, which is most likely due to the presence of bioactive substances such as phytohormones, proteins, carbohydrates and mineral elements. Furthermore, seaweed extracts have been found to be not only naturally rich in phytohormones but also capable of promoting endogenous production of cytokinins, auxins and gibberellins (Dmytryk and Chojnacka 2018, Patel and Mukherjee 2021 and Ali *et al*., 2021). Some scientists suggested that mode of action of seaweed extract may be to enhances uptake of macro- and microelements and their translocation within plants, increases the respiration rate and root growth, participates in photosynthesis and other metabolic processes (Bai *et al*., 2007). Seaweed extract was demonstrated to increase both rooting percentage and root fresh weigh as well as vegetative growth parameters such as shoot number and shoot length of two cuttings of hybrid tea rose, i.e., 'Michelangelo' and 'Cosmos' showing its applicability for replacing synthetic rooting promoters Traversari *et al*., (2022). Krajnc *et al*. (2012) stated that seaweed extracts have been successfully used for the promotion of rooting in a variety of ornamental plants such as pelargonium cuttings.

The parenchyma tissue of Aloe vera leaves contains 99.5% water-soluble and the remaining 0.5 - 1% solid material contains many other compounds such as auxins, amino acids, vitamins, minerals, polysaccharides, enzymes, phenolic compounds and organic acids (Ni *et al*., 2004, Boudreau and Beland, 2006, Surjushe *et al*., 2008, Chatterjee et al., 2013 and Raman *et al*., 2013). The effects of Aloe vera gel was statistically comparable on number of rooted cuttings, number of roots per stem cutting, length of the longest and shortest roots and rooting time. These results may be back to the application of Aloe vera gel in plant propagation, where Aloe vera gel contains vital elements to support plant growth. These include enzymes, carbohydrates, vitamins, amino acids, and plant hormones, as well as, the gel exhibits antimicrobial activity against plant-pathogenic fungi (Hayat *et al*., 2016 and Han and Uda, 2018). Uddin *et al*. (2020) studied the effect of Aloe vera gel treatment of grapevine cutting and showed that Aloe vera gel treatment had a prominent influence on survival vine length, vine diameter, root number, root length, as well as leaf chlorophyll.

Conclusion

From the obtained results, it could be concluded that to get the best rooting %, root length, root number, root fresh weight (g/plant), root dry weight (g/plant), plant height (cm), branch number, stem diameter (mm), leaf number, shoot fresh weight (g/plant), shoot dry weight (g/plant), total chlorophyll content (SPAD) and total carbohydrates % of rose cuttings recommended use the mixture of sand + palm peat (1:1 v:v) with moringa leaf extract (MLE) at 4% during growing seasons.

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محفزات النمو الحيوية كبدائل للهرمونات الصناعية لتعزيز التجذير، النمو الخضري والمكونات الكيميائية في عقل الورد تحت أوساط نمو مختلفة

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الملخص

الهدف من الدراسة الحالية هو تقييم أوساط التجذير ومحفزات النمو الحيوية وتفاعلاتها على التجذير والنمو الخضري والمكونات الكيميائية لعقل الورد .هذا العمل تم وضعه في تجربة عاملية، العامل الرئيسي (أوساط التجذير) يتكون من ثلاث بيئات، على النحو التالي: الرمل وبيتموس النخيل والرمل + بيتموس النخيل (1:1 v:v) ، بينما يتكون العامل الثانوي من سبع معاملات ، على النحو التالي: الكنترول (ماء الحنفية) ، مستخلص جيلي الصبار (AVE) بنسبة 2 و 4٪، مستخلص أوراق المورينجا (MLE) بنسبة 2 و 4% ومستخلص الأعشاب البحرية (SWE) بنسبة 2 و 4٪ كمعاملات لنقع العقل. أظهرت البيانات التي تم الحصول عليها أن وسط نمو الرمل + بيتموس النخيل (1:1 v:v) تسبب في زيادة معنوية في جميع صفات الورد، والتي تشمل النسبة المئوية للتجذير، طول الجذور، عدد الجذور، الوزن الطازج للجذور والوزن الجاف للجذور، طول النبات، عدد الأفرع ، قطر الساق، عدد الأوراق، الوزن الطازج للنبات والوزن الجاف للنبات، محتوى الكلوروفيل الكلي والكربوهيدرات الكلية٪. أما بالنسبة لمعاملات نقع العقل مع محفزات النمو الحيوية، فقد وجد أن معظم التركيزات زادت بشكل كبير من هذه الصفات محل الدراسة، مقارنة بالكنترول. بوضوح، تم الحصول على أعلى القيم عن طريق نقع عقل الورد في مستخلص أوراق المورينجا (MLE) عند 4 ٪ بالمقارنة بالكنترول. فيما يتعلق بالتفاعل بين عاملي الدراسة التي تم فحصهما، تم الحصول على أفضل النتائج في تجذير ونمو عقل الورد باستخدام خليط من أوساط النمو التي تتكون من الرمل + بيتموس النخيل (1:1 v:v) مع مستخلص أوراق المورينجا بنسبة 4 ٪ أو مستخلص أوراق المورينجا بنسبة 2 ٪، في معظم الحالات خلال موسمي التجربة.

الكلمات المفتاحية: *الورد الهجين، تجذير العقل، أوساط الإكثار، محفزات النمو الحيوية.*