Improving Survival and Orchard Performance of "Costata" Persimmon Seedlings by K-NAA and IBA Applications

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ABSTRACT

The present investigation was conducted during the 2018 and 2019 growing seasons on one-year-old persimmon seedlings cv. "Costata" grafted on "Seedy" and "Tarabouls" rootstocks in order to improve its survival percent and orchard perfoprmance. The Seedlings were treated with K-NAA or IBA either by dipping at 3000 mg l^{-1} for 5 seconds or soaking at 500 mg l^{-1} for 24 hours. Obtained results generally showed significant increase in vegetative growth, root biomass and leaf chlorophyll and mineral content by all K-NAA and IBA applications compared to the water treated ones. A highest values of sprouting buds percent (during April, June and August), average shoots number, trunk cross-sectional area, leaf area and canopy volume were recorded with the K-NAA soaking at 500 mg $l^{-1}$for 24 h. Leaf chlorophyll content was highest with K-NAA and IBA soaking in the first season, while K-NAA soaking at 500 mg l^{-1} for 24 h gave the highest values of leaf N, P, K, Fe, Mn and Zn in both seasons. Also, the K-NAA soaking or dipping applications recorded the highest values of average shoot length, increment percnts of shoot length and stem diameter and highest seedlings survival in both seasons. The K-NAA soaking at 500 mg l^{-1} for 24 h gave the highest significant values of root biomass in the first season. Results also showed that seedlings on "Seedy" rootstock surpassed the ones on "Tarabouls" rootstock in all vegetative growth parameters and root biomass, but contained lower leaf N, P, Mn and Zn.

Keywords: Persimmons, Biomass, Auxins, Survival, Field Performance.

INTRODUCTION

Persimmonis a nutritious fruit commonly consumed in several parts of the world. The trees (*Diospyros kaki* L.) are deciduous that grow well in temperate regions. However, it appears to be readily adapted to a wide range of climatic conditions from warm temperate to sub-tropical. Thus, nowadays trees are found to be cultivated in many countries known with its long warm summer such as Egypt. Egyptian climate is suitable for persimmons production, and the summer season helps for favorable fruit growth and maturation. Recentlky, persimmons production and consumption increased significantly worldwide. The Food and Agriculture Organization (FAO) recorded a global production increase from 2417602 tons in 2000 to 3263021 tons in 2005, reaching 4711458 tons in 2018, with China considered as the largest world producer followed by Korea, Japan, Brazil, Azerbaijan and Italy. In Egypt persimmon production has reached 33232 tons in 2017 on total area of 22642 hectares (FAO). The most commonly cultivated cultivar in Egypt is the astringent "Costata" which possess certain advantages, such as adaptability to wide range of climatic conditions, excellent taste and other fruit quality characteristcs (Llacer and Badenes, 2001). The common propagation method of this cultivar in Egypt is by grafting or budding onto the "Tarabouls" rootstocks (root suckers grown from the root system of the mother tree) in February and March below the mother tree, then seedlings separation and planting after one year in the permanent field. As any other deciduous seedlings, they are transported with bare root and thus lose part of the root mass during transplanting, besides its weak rooting, it is expected that a large part of the seedling`s root mass dies after planting. This prompted persimmon growers to use "Seedy" rootstocks (directly grown from seed planting) for grafting instead of the "Tarabouls". Seedlings with Seedy rootstocks are mostly transported in containers with soil covering the root system similar to evergreen ones. This ensures safe transporting with less root damages. However, it increases the cost of seedlings production. Never the less, science persimmons normally produce weak and small portion of root biomass, it is expected that the newly transplanted seedlings show weak and slow growth performance during the first growing season in the permanent orchard and even though after that. Thus, several investigations studied the exogenous treatment with auxins such as indole-3-butyric acid (IBA), indole-3-acetic acid (IAA) and naphthalene acetic acid (NAA) for stimulating and encouraging root initiation, growth and development due to the activation of cambium regeneration, cell division and cell multiplication (Fumuro, 2011; Chaudhary et al., 2018; Mehra and Awasthi, 2019). Therefore, the essential role of auxins in promoting cell division, root initiation and formation in several horticultural crops specially the difficult-to-root ones is reported (Ludwig-Muller, 2000; Fin et and Jaillais, 2012).

In respect of the above facts, the present study aimed to enhance the seedlings survivability and field growth performance of "Costata" persimmons grafted either on "Seedy" (*Diospyros kaki*) or "Tarabouls" (*Diospyros lotus*) rootstocks after treating with IBA or K-NAA. The obtained results would be also economically beneficial in reducing the seedlings production costs.

MATERIALS AND METHODS

Plant materials and treatments

The present investigation was conducted during 2018 and 2019 growing seasons in order to study the effect of potassium α-naphthalene acetate (K-NAA) and indole butyric acid (IBA) on orchard performance of one year old "Costata" persimmon seedlings grafted on "Seedy" (*Diospyros kaki*) and "Tarabouls" *(Diospyros lotus*) rootstocks. Fifty seedlings (25 grafted onto "Seedy" and 25 grafted onto "Tarabouls") were selected as uniform as possible for this study and their root systems were either water treated, dipped for 5 seconds in 3000 mgl^{-1} IBA or K-NAA or soaked for 24 hours in 500 mgl^{-1} IBA or K-NAA. Then seedlings were individually planted in February of both growing seasons in the ground of a private orchard at El-Tarh-region, El-Behera Government and were irrigated with tap water containing systemic fungicide for protection from the roots rotting. The experiment was designed as split plot, with the rootstocks being the main plot and chemical treatments are the subplot. Thus, 2 rootstocks × 5 treatments × 5 replicates = 50 seedlings were used in each experimental season. The effect of all treatments on survival and field growth performance of the "Costata" seedlings in 2018 and 2019 seasons was studied.

Measured parameters

Vegetative growth

Buds sprouting percent, average shoots number and length, shoot length increment, stem diameter, stem diameter increment, leaf and trunk cross sectional areas, canopy volume according to the following equations:

$$\text{Buds Sprouting (\%)} = \frac{\text{Number of sprouted buds}}{\text{Total number of dormant buds}} \times 100$$

$$\text{Shoot Length Increment (\%)} = \frac{\text{Final shoot length - Initial shoot length}}{\text{Initial shoot length}} \times 100$$

Leaf Area = ⅔ length × width

TCSA (cm^2) = $\pi \times (D^2/4)$

D: trunk diameterπ: 3.14

$$\text{Stem Diameter Increment (\%)} = \frac{\text{Final stem diameter - Initial stem diameter}}{\text{Initial stem diameters}} \times 100$$

Canopy Volume (m^3) = $0.5238 \times H \times D^2$

H: canopy height. D: canopy diameter.

Rooting biomass

The above ground biomass of each seedling was measured at the end of the growing season according to Werner and Murphy (2001). The root biomass was calculated with the following equation according to Woomer (2003).

The biomass of the above ground (aerial) and underground parts of each seedling were calculated as follow:

Above ground Biomass = $0.2068 \times dbh^{2.3191}$

Where;

dbh = tree diameter.

Underground Biomass = above ground Biomass × 35%

Seedlings survival

At the end of the growing seasons, the number of survived seedlings out of the total number of seedlings per treatment was counted, and the percentage of survival was calculated.

Leaf chlorophyll and mineral content

Leaf chlorophyll was measured using a Minolta SPAD chlorophyll meter according to the method described by Yadava (1986), and the results were expressed as SPAD units. In addition, leaf N, and P were calorimetrically determined using spectrophotometer according to Evenhuis (1976) and Murphy and Riley (1962), respectively. Leaf K content was determined using a flame photometer. Leaf Fe, Mn, and Zn were measured by Perkin Elmer Atomic Absorption Spectrophotometer (model α1502 LAXCO, made in USA). The concentrations of nitrogen, phosphorus, and potassium were expressed as percent on a dry weight basis, while those of iron, manganese and zinc were expressed in mg l^{-1} on a dry weight basis.

Statistical Analysis

The analysis of variance (two-way ANOVA) according to Petersen (1985) was carried out using the statistical analysis system (SAS Institute, 2001). Comparisons among means of the studied treatments for each parameter were obtained according to the least significant difference test (LSD) at 0.05 level of significance according to Snedecor and Cochran (1989). The sprouting bud's percent, average shoot's length increment, stem diameter increment and survival offered as a percentage in Tables only.

RESULTS

Main effect of K-NAA and IBA

Regading the main effect of K-NAA and IBA on vegegative growth, the obtained results in Table (1). The data showed a significant increase in all vegetative growth parameter sand root biomass of the "Costata" seedlings by all K-NAA and IBA applications as compared with the water in both seasons.

The results of the present study showed that the highest average shoots number of the "Costata" seedlings resulted in the soaking in K-NAA 500 mg

l^{-1} for 24 h compared to all other treatments in both seasons. Also, the K-NAA treatments either by dipping or soaking resulted in a significant increase in shoot length in the first season compared to the IBA and water treatments. The dipping K-NAA treatment resulted in a significantly longer shoots than the soaking treatment in the 2019 season. Data of both seasons indicated that, the K-NAA dipping and soaking treatments, as well as the dipping in IBA resulted in a significant increase in leaf area compared to the soaking IBA treatment. Moreover, the highest significant value of the trunk cross-sectional area of the "Costata" scions was recorded by soaking in K-NAA at 500 mg l^{-1} for 24 h compared to all other treatments in the first season. However, results of the second season showed that, both soaking and dipping treatments of K-NAA, as well as, the soaking treatment of IBA did not significantly differ among each other and gave significantly higher cross-sectional area than the dipping method and water treatments. In addition, the soaking method of K-NAA at 500 mg l^{-1} for 24 h recorded the highest value of canopy volume of the "Costata" scions compared to the IBA and water treatments in both growth seasons. Moreover, the results generally indicated that the more effective treatment in increasing the root biomass in the first season were the soaking in K-NAA 500 mg l^{-1} for 24 h. However, in the second season, all K-NAA and IBA treatments did not show significant different either by dipping or soaking among each other.

As for the effect of K-NAA and IBA applications on the percentage of sprouting buds, average shoot length increment, stem diameter increment and survival of "Costata" seedlings during 2018 and 2019 is presented in Table (2). Regardless the rootstock influence, obtained results showed a gradual increase in the sprouting buds, average shoot length increment, stem diameter increment and survival percent of "Costata" scion. The results also showed that the highest sprouting buds percent was recorded with the soaking method of K-NAA at 500 mg l^{-1} for 24 h followed by soaking in IBA at 500 mg l^{-1} for 24 h in April, June and August of both seasons. In addition, the highest average shoot length increment value was obtained with dipping in K-NAA at 3000 mg l^{-1} for 5 s in both experimental growth seasons, followed by soaking in K-NAA at 500 mg l^{-1}. The results obtained of the stem diameter increment indicated that the highest increase was recorded with K-NAA at 500 mg l^{-1} by soaking method for 24 h followed by dipping in K-NAA at 3000 mg l^{-1} for 5 seconds. Moreover, the results generally indicated that the most effective treatments for increasing the survival percentage of "Costata" seedlings were in the K-NAA treatments as well as the soaking treatment of IBA in both experimental seasons.

Concerning the main effect of K-NAA and IBA applications on the leaf chlorophyll content of "Costata" seedlings in 2018 and 2019seasons are shown in Table (3). The findings of the present investigation, generally, indicated that all applications of K-NAA and IBA significantly increased leaf chlorophyll content as compared with the water treatment. In addition, the results of the first season showed that SPAD readings were higher in the soaking method of K-NAA at 500 mg l^{-1} for 24 h. On the other hand, the results of the second season showed that all K-NAA and IBA applications did not significantly differ among each other and resulted in higher leaf chlorophyll content than the water treatment.

The effect of K-NAA and IBA applications on leaf mineral content of "Costata" seedling is presented in Table (3). Regarding the main effect of K-NAA and IBA, and regardless of the rootstock effect, the obtained results showed a significant increase in the leaf mineral content of the "Costata" seedlings by all K-NAA and IBA applications as compared with the water in both seasons, except the IBA dipping treatment did not significantly differ between them in the leaf nitrogen and potassium 'in the first season' and iron content 'in the second season'.

The leaf nitrogen content of the "Costata" scions increased by the dipping and soaking treatments of both K-NAA and IBA compounds as compared to the water treatment in both seasons, with the different not to be significant enough for the IBA dipping treatment in the first season only. While, in the second season the K-NAA soaking resulted in significantly the highest leaf nitrogen content compared to all other treatments. Similar trend was obtained in leaf phosphorus content of "Costata" scions in both seasons. The highest significant value of leaf potassium content was recorded with soaking K-NAA at 500 mg l^{-1} for 24 h in first season. The soaking and dipping K-NAA resulted in similar leaf potassium content in the second season. Data in both seasons indicated that no significantly different occurred between the soaking treatment of K-NAA and the soaking treatment of IBA. In addition, the findings of the present study, generally, indicated that the leaf manganese content was higher in the soaking method of K-NAA at 500 mg l^{-1} for 24 h than the dipping method in 3000 mg l^{-1} of K-NAA and the dipping or the soaking of IBA in both seasons. Moreover, the results showed that the soaking method of K-NAA at 500 mg l^{-1} for 24 h recorded the highest value of the leaf zinc content of the "Costata" scion when compared to the other chemical treatments and water treatment in both growth seasons.

Table 1: Main effect of K-NAA and IBA applications on the average shoots number, average shoot length, Leaf area, trunk cross sectional area, canopy volume and root biomass of "Costata" seedlings during the 2018 and 2019 growing seasons.

Application	Average shoots number	Average shoot length (cm)	Leaf area (cm^2)	Trunk cross sectional area (cm^2)	Canopy volume (m^3)	Root biomass (Kg)
2018						
Water	4.0_d	6.21_c	67.41_c	1.815_d	0.028_d	0.195_c
IBA 3000 mg l^{-1} for 5 s.	6.7_c	24.95_b	110.16_{ab}	2.855_c	0.090_c	0.334_b
IBA 500 mg l^{-1} for 24 h.	8.7_b	23.59_b	102.65_b	2.942_{bc}	0.121_b	0.339_b
K-NAA 3000 mg l^{-1} for 5 s.	9.4_b	34.78_a	113.27_{ab}	3.118_b	0.159_a	0.366_b
K-NAA 500 mg l^{-1} for 24 h	10.6_a	34.70_a	116.07_a	3.804_a	0.171_a	0.457_a
2019						
Water	2.7_d	3.95_d	67.05_c	1.885_c	0.022_d	0.210_b
IBA 3000 mg l^{-1} for 5 s.	4.9_c	9.55_c	108.54_a	2.831_b	0.105_c	0.327_a
IBA 500 mg l^{-1} for 24 h.	6.4_{bc}	9.13_c	100.29_b	3.205_a	0.138_c	0.367_a
K-NAA 3000 mg l^{-1} for 5 s.	7.1_b	13.19_a	112.31_a	3.228_a	0.182_b	0.378_a
K-NAA 500 mg l^{-1} for 24 h	9.1_a	11.30_b	111.19_a	3.198_a	0.219_a	0.378_a

Means followed by the same letter(s) in the same column or row are not significantly different according to the least significant difference (LSD) at 0.05 level.

Table 2: Main effect of K-NAA and IBA applications on the sprouting bud's, average shoot's length increment, stem diameter increment and survival of "Costata" seedlings during the 2018 and 2019 growing seasons.

Application	Sprouting bud's (%)			Average shoot's length increment (%)	Stem diameter increment (%)	Survival percent (%)
	April	June	August			
2018						
Water	15.85	19.23	25.08	521	25.77	60
IBA 3000 mg l^{-1} for 5 s.	23.58	27.68	38.15	2395	47.94	90
IBA 500 mg l^{-1} for 24 h.	32.5	36.23	57.65	2259	53.34	100
K-NAA 3000 mg l^{-1} for 5 s.	29.93	33.43	53.65	3378	55.20	100
K-NAA 500 mg l^{-1} for 24 h	37.18	42.24	63.73	3370	60.46	100
2019						
Water	8.80	13.48	25.10	295	29.77	40
IBA 3000 mg l^{-1} for 5 s.	13.59	17.83	35.70	856	52.79	80
IBA 500 mg l^{-1} for 24 h.	17.93	23.59	45.97	814	54.72	90
K-NAA 3000 mg l^{-1} for 5 s.	19.63	22.63	43.33	1219	58.78	100
K-NAA 500 mg l^{-1} for 24 h	22.10	32.80	59.99	1030	61.68	100

Table 3: Main effect of K-NAA and IBA applications on the leaf chlorophyll, N, P, K (%) and Fe, Mn and Zn (Mg l^{-1}) of "Costata" seedlings during the 2018 and 2019 growing seasons.

Application	Chlorophyll	N	P	K	Fe	Mn	Zn
2018							
Water	50.18_d	1.81_c	0.175_c	1.23_c	134.75_c	55.00_d	21.00_c
IBA 3000 mg l^{-1} for 5 s.	59.72_c	2.02_{bc}	0.215_b	1.27_c	140.00_b	59.50_c	24.00_b
IBA 500 mg l^{-1} for 24 h.	63.93_{ab}	2.26_{ab}	0.230_b	1.33_b	144.75_{ab}	63.75_b	24.75_b
K-NAA 3000 mg l^{-1} for 5 s.	63.41_b	2.20_{ab}	0.265_a	1.37_b	141.25_b	63.50_b	25.50_b
K-NAA 500 mg l^{-1} for 24 h	65.84_a	2.47_a	0.270_a	1.48_a	149.00_a	67.00_a	30.00_a
2019							
Water	54.88_b	1.83_d	0.190_d	1.23_c	132.00_c	49.00_d	19.50_d
IBA 3000 mg l^{-1} for 5 s.	63.40_a	2.03_c	0.220_c	1.28_b	137.25_c	56.75_c	22.00_c
IBA 500 mg l^{-1} for 24 h.	63.87_a	2.10_c	0.250_b	1.29_b	158.75_{ab}	62.50_b	24.00_b
K-NAA 3000 mg l^{-1} for 5 s.	63.16_a	2.30_b	0.245_b	1.39_a	153.25_b	61.50_b	24.00_b
K-NAA 500 mg l^{-1} for 24 h	64.47_a	2.48_a	0.280_a	1.41_a	164.25_a	66.00_a	28.00_a

Means followed by the same letter(s) in the same column or row are not significantly different according to the least significant difference (LSD) at 0.05 level.

Main effet of rootstocks

As for the main effect of rootstocks, regardless of the K-NAA and IBA applications, the obtained results in Tables (4) and (5) showed that the persimmon seedlings on “Seedy” rootstock surpassed “Tarabouls” rootstock in all vegetative growth parameter sand root biomass.

Additionally, the obtained results in Table (6) showed that the persimmon seedlings on “Tarabouls” rootstock surpassed “Seedy” rootstock intheir leaf nitrogen, phosphorus, manganese and zinc content. Also, the findings of both seasons showed no statistically significant difference between both rootstocks in their effect on the leaf chlorophyll, leaf potassium and iron content of the “Costata” scion.

DISCUSSION

K-NAA and IBA effect

Results of the present study recorded improvement in the vegetative growth of “Costata” seedlings by all K-NAA and IBA applications as indicated by their positive influence in enhancing buds sprouting percentage, increasing the number of sprouted buds, shoot number and length, as well as, stem diameter, trunk cross sectional and leaf areas and canopy volume. Also, significant increases in leaf chlorophyll and mineral content of the Costata seedlings were recorded by the NAA and IBA applications. In the mean time, the seedlings root biomass was clearly superior by K-NAA and IBA compared to the water treatment. Similar findings for other fruit species were previously accredit (Kaur et al., 2002; Rymbai and Reddy, 2010; Bemkaireima et al., 2012; Mewar and Naithani, 2016; Kaur, 2017). Dhatrika Rani et al. (2018) working on guava, attributed the acceleration of photosynthesis activity to the increased leaf chlorophyll content due to increasing in leaf area by IBA treatment. Exogenous application of NAA and IBA is reported to enhance absorption activity of the roots (Yusnita et al., 2018). Accordingly, the high root biomass obtained in the present study might have helped in better water and nutrients uptake, which led to increasing leaf mineral content and leaf area, thus increasing the efficiency of the photosynthesis process, resulting in enhancing the different vegetative growth parameters studied in the presnt investigation.

The positive effects of NAA and IBA on enhancing rooting would be cleared by the explanations mentioned by Weaver (1972) who stated that the increase in roots number by IBA treatment might be due to the IBA influence on cell wall plasticity and acceleration of cell division thus, the development and growth of roots. Also, Nanda (1975) reported the important role of IBA in mobilizing reserved food materials, elongation of meristemic cells, as well as, the differentiation of cambial initials into root primordial. The mechanisms by which IBA and NAA stimulate root formation could be explained as stated by Yan et al. (2014). They mentioned that, IBA effect could be through its conversion to IAA, the increase of internal free-IBA, the enhancement of tissue sensitivity to IAA, enhancement of the endogenous IAA synthesis or the action of IAA synergistically, while, the stimulatory effect of NAAto induce root formation would probably be associated with a remarkable increase of polyphenol oxidase (POD) and inhibition of IAA-oxidase (IAAO), thus preventing IAA degradation and increasing its activity. IAA- oxidas is an enzyme that catalyzes oxidation of IAA, or breaks down endogenous auxin. Polyphenol oxidase is stated to be implicated in an important step of the root formation, during the metabolism of auxins and the process of lignification.

Rootstock effect

Results of the present study showed superiority of the “Seedy” rootstock in encouraging growth and survival of the “Costata” seedlings compared to “Tarabouls” stock. This is clear in the better enhancement of the measured growth parameters during both growing seasons. The growth and development of a grafted plant is inherently a function of scion genotype, but also the rootstock plays a critical role. A “hormone message concept” dictates that hormones are produced in one part of the plant and affect a remote part. Auxin is produced in shoot apexes and is translocated to the root where it affects root development, morphology and functioning. Auxin has also been shown to affect the production and activity of cytokinins which are known to be produced in the root and translocated to the shoot where they control important developmental processes such as shoot growth and productivity (Albacete et al., 2008; Aloni et al., 2010). Accordingly, obtained findings of the present study might probably reveal to the possibility of a better hormonal message obtained between the “Costata” scions and “Seedy” rootstock, than between the “Costata” scions and the “Tarabouls” stock. Therefore, there might have been better rootstock-scion interelation, better rootstock-scion union and better rootstock-scion communication between “Costata” scion on “Seedy” rootstock than the ones on “Tarabouls”. This means that both “Costata” scion and “Seedy” rootstock compatibly and positively affected the growth and development of each other. This is evident in the obtained results as “Costata” scions had high shoots number, shoot length, stem diameter, trunk cross sectional and leaf areas, when grafted on “Seedy” rootstock compared to the “Tarabouls”. In accordance, this vegetative growth improvement appeared in the more root biomass recorded in the “Seedy” stocks than “Tarabouls”.

Table 4: Main effect of rootstock on the average shoots number, average shoot length, Leaf area, trunk cross sectional area, canopy volume and root biomass of "Costata" seedlings during the 2018 and 2019 growing seasons.

Rootstock	Average shoots number	Average shoot length (cm)	Leaf area (cm^2)	Trunk cross sectional area (cm^2)	Canopy volume (m^3)	Root biomass (Kg)
2018						
Tarabouls	6.52_b	23.71_b	85.56_b	2.059_b	0.069_b	0.227_b
Seedy	9.24_a	25.98_a	118.26_a	3.754_a	0.159_a	0.449_a
2019						
Tarabouls	4.8_b	8.12_b	85.92_b	2.562_b	0.075_b	0.291_b
Seedy	7.28_a	10.73_a	113.84_a	3.178a	0.192_a	0.370_a

Means followed by the same letter(s) in the same column or row are not significantly different according to the least significant difference (LSD) at 0.05 level.

Table 5: Main effect rootstock on the sprouting bud's percent, average shoot's length increment percent, stem diameter increment percent and survival percent of "Costata" seedlings during the 2018 and 2019 growing seasons.

Application	Sprouting bud's (%)			Average shoot's length increment (%)	Stem diameter increment (%)	Survival percent (%)
	April	June	August			
2018						
Tarabouls	23.95	28.74	46.79	2271	45.47	84
Seedy	31.66	34.78	48.51	2498	51.61	96
2019						
Tarabouls	13.94	18.34	36.81	712	36.53	80
Seedy	18.88	25.78	47.22	973	66.57	84

Table 6: Main effect rootstockon the leaf chlorophyll, N, P, K (%) and Fe, Mn and Zn (Mg l^{-1}) of "Costata" seedlings during the 2018 and 2019 growing seasons.

Application	Chlorophyll	N	P	K	Fe	Mn	Zn
2018							
Tarabouls	60.75_a	2.38_a	0.252_a	1.35_a	144.90_a	64.30_a	27.00_a
Seedy	60.47_a	1.94_b	0.210_b	1.32_a	139.00_a	59.20_b	23.10_b
2019							
Tarabouls	62.63_a	2.35_a	0.254_a	1.36_a	151.40_a	62.40_a	25.00_a
Seedy 61.28_a		1.95_b	0.220_b	1.27_a	146.80_a	55.90_b	22.00_b

Means followed by the same letter(s) in the same column or row are not significantly different according to the least significant difference (LSD) at 0.05 level.

CONCLUSION

Finally, according to the enhancement of growth performance of the Costata seedlings obtained in the present study by the different K-NAA and IBA treatments, especially the soaking method of K-NAA at 500 mg l^{-1} for 24 h. Costata growers might be guided for the possibility of transporting the seedlings from the nursery bare rooted and planting in the permenant orchard after treating with either K-NAA or IBA, which wouldin term lower the production costs of seedlings.

REFERENCES

Albacete, A., Ghanem, M. E., Martinez-Andujar, C., Acosta, M., Sanchez-Bravo, J., Martinez, V., Lutts, S., Dodd, I. C., & Pérez-Alfocea, F. (**2008**). Hormonal changes in relation to biomass partitioning and shoot growth impairment in salinized tomato. *J. Exp. Bot.* ***59***: 4119–4131.

Aloni, B., Cohenb, R., Karnia, L., Aktasc, H., &Edelsteinb, M. (**2010**). Hormonal signaling in rootstock scion interactions. *Sci. Hort.*, ***127***: 119–126.

Bemkaireima, K., Angami, T., & Singh, M. S. (**2012**). Response of different size and growth regulator on cuttings of passion fruit var. Purple (*Passiflora edulis* var. *edulis* Sims), *Asian J. Hort.*, ***7*(2)**: 515-520.

Chaudhary, H. L., Tandel, B. M., Patoliya, R. M., &Rathwa, A. D. (**2018**). Effect of type of cuttings and growth regulators on sprouting and growth parameters of wax apple (*Syzygium samarangense* L.). *Int. J. Chem. Stud.*, ***6*(1)**: 73-76.

Dhatrika Rani, T., Srihari, D., Dorajeerao, A.V.D., &Subbaramamma, P. (**2018**). Effect of rooting media and IBA treatments on shoot production and survival of terminal cuttings in guava (*Psidium guajava*) cv. Taiwan pink.Int. *J. Curr. Microbiol. App. Sci.*, ***7*(11)**: 231-242.

Evenhuis, B. (**1976**). Nitrogen determination. Dept. Agric. Res. Royal Tropical Inst., Amsterdam.

FAO. Food and Agriculture Organization of United Nation. Statistics Division. http://www.fao.org.

Finet, C., &Jaillais, Y. (**2012**). Auxology: when auxin meets plant evo–devo. *Dev. Biol.*, ***369***: 19–31.

Fumuro, M. (**2011**). Effect of several factors on rooting and cultivar differences in rooting abilities of air-layered mango. *Hort. Res.*, ***10*(4)**: 451-459.

Kaur, S. (**2017**). Evaluation of different doses of indole-3-butyric acid (IBA) on the rooting, survival and vegetative growth performance of hardwood cuttings of Flordaguard peach (*Prunus persica* L. Batch). *J. Appl. & Nat. Sci.*, ***9*** **(1)**: 173 – 180.

Kaur, S., Cheema, S. S., Chhabra B. R. & Talwar, K.K. (**2002**). Chemical induction of physiological changes during adventitious root formation and bud break in grapevine cuttings. *Plant Growth Regul.*, ***37*(1)**: 63-68.

Llácer, G., &Badenes, M.L. (**2001**). II kaki: Produzioneemercato. In Proceedings and Abstracts of the "First Mediterranean Symposium on Persimmon", Faenza (Italy), 23-24.

Ludwig-Muller, J. (**2000**). Indole-3-butyric acid in plant growth and development. *Plant Growth Regul.*, ***32***: 219–230.

Murphy, J., & J. R. Riley (**1962**). A modified single solution method for the determination of phosphorus in natural water. *Anal. Chem. Acta.*, ***27***: 31-36.

Mewar, D., & Naithani, D. C. (**2016**). Effect of different IBA concentrations and planting time on stem cuttings of Wild Fig (*Ficus palmata* Forsk.). *Plant Archives*, ***16*(2)**: 959-962.

Mehra, U., & Awasthi, M. (**2019**). Studies on rooting of hardwood stem cuttings using rooting media on Japanese persimmon (*Diospyros kaki* L.) Cv. Fuyu, treated with different concentration of indol-3-butyric acid. *Int. J. Chem. Stud.*, ***7*(3)**: 873-876.

Nanda, K.K. (**1975**). Physiology of adventitious root formation. *Indian J. Plant Physiol.*, ***18***:18-90.

Petersen, R. G. (**1985**). Design and analysis of experiments. Marcel Dekker, Inc. New York: 253-301.

Rymbai, H., & G.S. Reddy (**2010**). Effect of IBA, time of layering and rooting media on air-layers and plantlets survival under different growing nursery conditions in guava. *Indian J. Hort.*, ***67***:99-104.

SAS (**2001**). User's guide: statistics (Release 8.02). Cary, NC: USA: SAS Inst. Inc.

Snedecor, G.W., &Cochran, W. G. (**1989**). Statistical Methods.SeventhEdition.IowaState.Univ. Press. Ames., U. S. A. 507 pp.

Werner, P. A., & Murphy, P. J. (**2001**). Size-specific biomass allocation and water content of above- and below-ground components of three *Eucalyptus* species in a northern Australian savanna. *Aust. J. Bot.*, ***49***: 155-167.

Weaver, R. J. (**1972**). Plant Growth Substances in Agriculture. W. H. Freeman and Company, San Francisco, 504.

Woomer, P.L., (**2003**). Field and laboratory guidelines for carbon characterization in African dry lands. Sustainable Agriculture Centre for Research, Extension and Development in Africa, Nairobi, 20pp.

Yadava, U. L. (**1986**). A rapid and nondestructive method to determine chlorophyll in intact leaves. *Hort. Sci*, ***21***: 1449-1450.

Yan, Y. H., Li, J. L., Zhang, X. Q., Yang, W. Y., Wan, Y., Ma, Y. M., & Huang, L.K. (**2014**). Effect of naphthalene acetic acid on adventitious root development and associated physiological changes in stem cutting of *Hemarthria compressa*. *Plos One*, ***9*(3)**: 1-6.

Yusnita, Jamaludin, Agustiansyah, & Hapsoro, D. (**2018**). A combination of IBA and NAA resulted in better rooting and shoot sprouting than single auxin on Malay apple [*Syzygium malaccense* (L.) Merr. & Perry] stem cuttings. *Agrivita J. Agri. Sci.*, ***40*(1)**: 80–90.

الملخص العربى

تحسين النجاح والأداء البستانى لشتلات الكاكى "كوستاتا" بواسطة البوتاسيوم نفثالين حمض الخليك وحمض الاندول بيوتريك

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اجريت هذه الدراسة خلال موسمين نمو ٢٠١٨، ٢٠١٩ على شتلات كاكى عمر سنة، لدراسة تحسين نسبة النجاح والأداء البستانى لشتلات الكاكى صنف كوستاتا المطعمة على الاصل البذرى والطرابلس في الحقل المستديم بواسطة حمض الإندول بيوتريك (IBA) والبوتاسيوم نفثالين حمض الخليك (K-NAA) إما عن طريق غمس المجموع الجذري لمدة ٥ ثوان بتركيز ٣٠٠٠ مليجرام فى اللترأو نقعه لمدة ٢٤ ساعة بتركيز ٥٠٠ مليجرام فى اللتر فى هذه المركبات. استخدم تصميم القطع المنشقة فى تنفيذ التجربة، مع اعتبار الاصل هو القطع الرئيسية ومعاملات منظمات النمو هي القطع الفرعية. وبالتالى، تم استخدام أصلين مختلفين × ٥ معاملات × ٥ مكررات = ٥٠ شتلة في كل موسم تجريبي.

وأوضحت النتائج المتحصل عليها من الدراسة الحالية أنه بغض النظر عن تأثير الأصول، فإن جميع معاملات (K -NAA)، (IBA) أدت إلى زيادة جميع قياسات النمو الخضري، الكتلة الحيوية للجذور، محتوى الاوراق من الكلوروفيل والعناصر المعدنية مقارنة بمعاملة الماء فى كلا الموسمين. باستثناء، معاملة الغمس فى(IBA) لم تختلف معنويا عن معاملة الماء في محتوى الأوراق من النيتروجين والبوتاسيوم في الموسم الأول ومحتوى الحديد في الموسم الثاني. اعطت معاملة النقع في (K -NAA) بتركيز ٥٠٠ جزء لكل مليون لمدة ٢٤ ساعة أعلى قيم لنسبة البراعم النامية في أشهر أبريل ويونيو وأغسطس، ومتوسط عدد الأفرخ، ومساحة مقطع الجذع وحجم المجموع الخضرى. كما أشارت نتائج كلا الموسمين الى ان معاملات النقع أو الغمس في (K -NAA) سجلت أعلى القيم لمتوسط طول الفرخ ومتوسط نسبة الزيادة في طول الفرخ ونسبة الزيادة فى قطر الساق ونسبة بقاء الشتلات حية. كما أدت معاملات الغمس والنقع فى (K -NAA) وكذلك الغمس في (IBA) إلى زيادة معنوية في مساحة الورقة. بالاضافة الى ذلك، أعطت معاملة النقع في ٥٠٠ مليجرام فى اللتر(K -NAA) لمدة ٢٤ ساعة أعلى قيم للكتلة الحيوية للجذر في الموسم الأول. وتم تسجيل أعلى قيمة لمحتوى الاوراق من الكلوروفيل عند النقع في (K -NAA)، (IBA) في الموسم الأول. أما بالنسبة للمحتوى المعدني للأوراق من عناصر (النتروجين والفوسفور والبوتاسيوم والحديد والمنجنيز والزنك) فان أعلى قيم لمحتوى الاوراق من هذه العناصر كانت في معاملة النقع في (K -NAA) بتركيز ٥٠٠ مليجرام فى اللترلمدة ٢٤ ساعة في كلا الموسمين. بغض النظر عن تأثير المعاملات، تفوقت شتلات الكاكي المطعمة على الاصل "البذرى" على الشتلات المطعمة على اصل "الطرابلس" في جميع قياسات النموالخضري والكتلة الحيوية للجذر. بينما تفوقت الشتلات المطعمة على أصل "الطرابلس" على الشتلات المطعمة على الاصل "البذرى" في محتوى الورقة من النيتروجين والفوسفور والمنجنيز والزنك.