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Effect of Soil Type and IBA Concentrations on some Vegetative Growth Traits of 'Siwi' Date Palm offshoots.

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Abstract

This study was conducted to determine the effect of soil type and different concentrations of IBA on stimulating the rooting of weak ground offshoots of the Siwi date palm after being separated from the mother plant and grown in pots. This experiment was carried out in a private orchard in New Valley Governorate, Egypt for the experimental seasons 2022 and 2023. A factorial experiment was conducted according to RCBD with three replicates and 12 treatments; different forms of mixed soil with 1- sand : silt as 1:1 ratio; 2- sand : silt : peat moss as 1 : 0.5 : 0.5 ratio ; 3- sand : silt : peat moss as 1 : 1 : 1 ratio; and treatment with the growth regulator IBA, four concentrations at 0, 250, 500 and 750 ppm by soaking. The results showed that all different concentrations of IBA with different forms of soil induced a remarked promotion in the No. of the new leaves/ offshoot, Trunk circumference at the base (cm), Trunk length, Length of the first new leaf (cm), dry weight (D.W) the first new leaf (g) and fresh weight (F.W) the first new leaf (g) compared with water-sprayed palms (control). The best results with regards to using a form of sand : silt : peat moss as 1 : 1 : 1 ratio combined with the concentration of IBA 250 ppm which is significantly superior in this concern compared with either control (water spray) or other treatments, thus it could be recommended that to get quality date palms offshoots with soaked offshoots on IBA 250 ppm with cultured in sand : silt : peat moss as 1 : 1 : 1 ratio.

Keywords: 'Siwi' date palm, Offshoots, IBA, Different soil.

Introduction

Date palm *(Phoenix dactylifera* L.,) is a monocotyledonous, dioecious member of the Palmaceae family. It is considered the tree of life and is one of the oldest fruit trees in the world because of its resilience, low water needs, long-term productivity, and multi-functionality.

A common fruit tree in the Middle East, North Africa, Arabia, and hot, arid regions of the world is the date palm [1,2,3]. Eleven nations in the Arab-Muslim world account for 94.0% of global production, making it the primary production region. Egypt came in first, followed by Saudi Arabia and Iran [4]. According to the Egyptian Ministry of Agriculture statistics for 2023 year the total number of fruitful female palms reached 14636968 with a total production of 1703375 tons according to the latest statistics from **the Ministry of Agriculture, Egypt (2023)**.

Dates are considered a nutrient-dense and high-energy food since they are rich in sugars that provide you a quick energy boost, as well as minerals, vitamins, phenol, flavonoids, anthocyanins, and carotenoids with beneficial properties. They also contain 1180 Kl of energy per 100 [5].

The two types of offshoots that are usually used to propagate date palms are aerial and ground offshoots. The development of vegetative buds beneath or above the ground surface produces offshoots. Offshoots create an orchard that is exactly like the parent plants. Dates are also seed-propagated for variety creation. About half of the seedlings that have grown are male and female. Tissue culture methods, which are costly, time-consuming, and require specialized knowledge, are also used for vegetative propagation. Therefore, suckers and offshoots are the commercial technique of propagation [6].

Even with the widespread use of tissue culture techniques, date palms are still propagated using offshoots. Farmers typically remove the weak offshoots that palm trees occasionally generate, which causes large financial losses. Researchers advise making investments in this area to create and restore palm orchards, especially those with valuable and costly varieties [6,7].

Certain kinds of plant cuttings have a lot of substances that promote roots but not enough auxins. As a result, adding auxins to these cuttings significantly enhances rooting. The cuttings' reaction to the wounding is caused by the formation of callus, which is followed by the growth of roots along the wound area because tissues that are prone to wounding promote cellular division based on the buildup of natural auxins and carbohydrates. This increases transpiration speed and produces ethylene, which is crucial for the adventitious root formation process [8].

As a growth regulator, indole butyric acid (IBA) promotes the elongation and splitting of the primary root cells, which increases the number and length of roots and shortens the time it takes for adventitious roots to appear in various plant species [9]. IBA and injuring the bases of offshoots are two compounds that promote rooting. These compounds

led to a notable rise in the percentage of rooting, the quantity and length of roots, the number of new leaves, and the fresh and dry weight of the initial leaf and roots [10].

Applied Siwi and Omhaat cultivars date palm offshoots (with 2000, 3000, and 4000 mg/L IBA and NAA especially 3000 mg/L produced the best rate of offshoot growth success, as well as the best rate for the number and length of roots, the number of new palm fronds, and the percentage of dry matter in leaves when compared to the control treatment [11].

Offshoots of high-quality commercial cultivars have historically been difficult to root and have a short lifespan [12]. Different root-promoting compounds that can improve rooting but lack enough levels of root-promoting hormone, such as auxins, can be used to plant aerial offshoots after roots have developed [13]. Consequently, rooting is significantly enhanced when auxins are added to these offshoots [14]. Aerial offshoots can establish healthy roots if they are given the right rooting substrate together with the rooting hormone, according to previous research.

This study's goal is to increase the number of commercially desirable and high-quality palm cultivars, like the Siwi date palm, by using treatments that encourage both normal and weak ground offshoots to form a strong root mass. This will increase the success rate of the seedlings after planting, allowing farmers to profit from propagation and generate additional revenue. to boost the success rate of branch development following planting to reap the benefits and provide palm producers with an extra revenue stream.

Materials and methods

The study was conducted during 2022-2023 seasons in at a private orchard in New Valley Governorate, Egypt., to studied the stimulating rooting of weak ground offshoots of Siwi date palm. the offshoots were separated with the age of 2-3 years and weights (8-10 kg) in March. The offshoots' side leaves were cut off in up to three rows. The central leaf was left open to allow for the growth of new leaves, while the other leaves on the apical points were trimmed to mid-length to protect them. To prevent contamination, the bases of the offshoots were immersed in a fungicide solution containing 1.5 g/L for five minutes before planting. Twelve treatments and three replicates were used in a factorial experiment using a Randomized Complete Block Design (RCBD). Included is the effect of two elements working together to stimulate weak ground-rooted offshoots after treating the ground-rooted offshoots' separation zone with indole butyric acid (IBA).

Two factors were included in the factorial experiment: the first factor is a form of mixed soil and the second factor is different concentrations of IBA and combined in the two factors in this study.

Table (1): The following treatments were used in this study:

IBA (0 ppm)	1- **Soil type 1**	**5- Soil type 2**	**9- Soil type 3**
IBA (250 ppm)	**2- Soil type 1**	**6- Soil type 2**	**10- Soil type 3**
IBA (500 ppm)	**3- Soil type 1**	**7- Soil type 2**	**11- Soil type 3**
IBA (750 ppm)	**4- Soil type 1**	**8- Soil type 2**	**12- Soil type 3**

Experimental layout:

The differential treatments (combinations between two parameters included in this study) were arranged using a completely randomized block design with three replications. Three offshoots were used to symbolize each replication. As a result, the projected number of offshoots needed for each study was as follows: To represent the type of soil and different concentrations of IBA, thirty-six healthy uniformed and disease/insect-free Siwi date palm offshoots were carefully chosen. In addition, 36 more offshoots were planted to create a reserve. For this experiment, Within the 12 offshoots of each category, the examined treatments were grouped.

Application time and methods:

The effect of two factors and the combination between them in the stimulation of rooting of offshoots with different forms of mixed soil with 1- sand : silt as 1:1 ratio; 2- Sand : Silt : Peat moss as 1 : 0.5 : 0.5 ratio ; 3- Sand : Silt : Peat moss as 1 : 1 : 1 ratio. and a substance (IBA) Indole Butyric acid at concentrations (0, 250, 500 and 750 ppm IBA) by soaking the offshoots in a solution containing the different concentrations of IBA. After the treatments were applied, the offshoots were grown in 50 cm diameter pots that were 43 cm deep. This was done to prevent water from penetrating the soil because of the offshoot stem's vast area at the soil's surface. The offshoots received direct watering, with two liters of water per offshoot every day for three days. After that, the irrigation rate was lowered by one every three days.

Data and Measurements:

The following properties were studied in April 2023 and 2024, over a year following the offshoots' planting and treatment administration, the response to the treatments investigated was evaluated by determining changes exhibited in the following vegetative growth parameters: No. of the new leaves/ offshoot, Length of the first new leaf (cm), Trunk circumference at the base (cm), Trunk length,

Dry weight (D.W) the first new leaf (g) and Fresh weight (F.W) the first new leaf (g)

Statistical analysis:

All data obtained in both the 2023 and 2024 experimental seasons were subjected to analysis of variance according to [15]. Moreover, differences among means were significantly distinguished by using letters according to [16] at the 5% level was used to compare the mean values.

1. Results and discussion

Effect of Soil type and IBA concentrations on some vegetative growth traits of Siwi Date Palm (*Phoenix Dactylifera* L. CV.) Offshoots during 2022 & 2023 experiential seasons.

3.1. Length of the first new leaf (cm) and No. of the new leaves/ offshoots

Table (2) indicates that the offshoots were significantly higher in Length of the first new leaf (cm) and No. of the new leaves/ offshoots in 2022 & 2023 seasons with soaked offshoots on IBA 250 ppm combined with the type of soil sand : silt : peat moss (1 : 1 : 1 ratio) reaching 112.90 & 112.50 cm and 4.22 & 4.67 new leaves Sequentially for both seasons compared to control which gave the lowest rate of the Length of the first new leaf (cm) and No. of the new leaves/ offshoots. while the results of the statistical analysis indicated that the rest of the treatments were in the middle between the two treatments mentioned above.

Table (2): Effect of soil type and IBA concentrations on length of the first new leaf (cm) and No. of the new leaves/ offshoots Traits of Siwi date palm offshoots during 2022 & 2023 experiential seasons

treatments	Length of the first new leaf (cm)							
Soil type	Season 2022			Mean*	Season 2023			Mean*
IBA concentration	Sand : silt (1:1 ratio)	Sand : Silt : Peat moss (1 : 0.5 : 0.5 ratio)	Sand : Silt : Peat moss (1 : 1 : 1 ratio)		Sand : silt (1:1 ratio)	Sand : Silt : Peat moss (1 : 0.5 : 0.5 ratio)	Sand : Silt : Peat moss (1 : 1 : 1 ratio)	
T1- IBA zero ppm	60.18l	62.12k	63.20j	**61.83D**	59.85l	63.07k	65.05j	**62.66D**
T2- IBA 250 ppm	98.58c	102.40b	112.90a	**104.70A**	100.10c	103.40b	112.50a	**105.30A**
T3- IBA 500 ppm	81.73f	84.82e	87.7.42d	**84.66B**	82.08f	84.22e	88.08e	**84.79B**
T4- IBA 750 ppm	71.17i	74.40h	78.35g	**74.64C**	71.93i	75.62h	78.92g	**75.49C**
Mean**	**77.92C**	**80.95B**	**85.47A**		**78.48C**	**81.59B**	**86.14A**	
	No. of the new leaves/ offshoot							
T1- IBA zero ppm	2.33f	2.56ef	2.78e	**2.56D**	2.44e	2.56de	2.56de	**2.52C**
T2- IBA 250 ppm	3.78bc	4.11ab	4.22a	**4.04A**	2.56de	3.67bc	4.67a	**3.63**
T3- IBA 500 ppm	3.56cd	3.78bc	3.78bc	**3.71B**	3.44bc	3.67bc	3.78b	**3.63A**
T4- IBA 750 ppm	2.78e	3.22d	3.56cd	**3.19C**	2.56de	2.89d	3.33c	**2.93B**
Mean**	**3.11B**	**3.44A**	**3.56A**		**2.75C**	**3.20B**	**3.58A**	

Means followed by the same letter/s within each column didn`t significantly differ at 5 % level.

3.2. Trunk length (cm) and trunk circumference at the base (cm)

In this regard, two trunk characteristics dealing with Trunk Length (cm) and Trunk circumference (cm) in response to types of soil and different concentrations of IBA were investigated. Data obtained during 2022 & 2023 seasons are presented in Table (3).

It is quite evident that these investigated trunk characteristics indeed trunk Length (cm) and Trunk circumference (cm) followed typically the same trend previously detected with both the Length of the first new leaf (cm) and No. of the new leaves/ offshoots. Since, T2- soaked offshoots on 250 ppm combined with soil type sand : silt : peat moss (1 : 1 : 1 ratio) as 54.17 & 55.30 cm and 51.30 & 52.42 cm Sequentially for both seasons surpassed significantly all investigated treatments as the increase over control was concerned during both experimental seasons. on the other hand, displays obviously that three investigated treatments with IBA and soil type increased trunk Length (cm) and Trunk circumference (cm) over control.

Table (3): Effect of soil type and IBA concentrations on Trunk length (cm) and Trunk circumference at the base (cm) Traits of Siwi date palm offshoots during 2022 & 2023 experiential seasons

treatments	Trunk Length (cm)							
Soil type	Season 2022			Mean*	Season 2023			Mean*
IBA concentration	Sand : silt (1:1 ratio)	Sand : Silt : Peat moss (1 : 0.5 : 0.5 ratio)	Sand : Silt : Peat moss (1 : 1 : 1 ratio)		Sand : silt (1:1 ratio)	Sand : Silt : Peat moss (1 : 0.5 : 0.5 ratio)	Sand : Silt : Peat moss (1 : 1 : 1 ratio)	
T1- IBA zero ppm	30.07i	32.87h	36.31g	**33.08D**	31.60k	34.92j	35.82i	**34.11D**
T2- IBA 250 ppm	48.30c	51.23b	54.17a	**51.23A**	49.52c	53.04b	55.30a	**52.62A**
T3- IBA 500 ppm	43.27d	44.10d	47.40c	**44.2B**	44.93e	47.53d	40.12h	**44.19B**
T4- IBA 750 ppm	39.17f	39.87ef	40.67e	**39.9C**	40.78gh	41.23fg	41.70f	**41.24C**
Mean**	**40.20C**	**42.02B**	**44.63A**		**41.71C**	**44.18A**	**43.23B**	
	Trunk circumference at the base (cm)							
T1- IBA zero ppm	25.30g	26.37g	28.52fg	**26.73D**	26.27j	27.52i	30.55h	**28.11D**
T2- IBA 250 ppm	45.97b	47.17b	51.30a	**48.14A**	47.37c	48.12b	52.42a	**49.30A**
T3- IBA 500 ppm	39.45cd	41.93c	42.63c	**41.34B**	40.38e	40.87e	43.58d	**41.61B**
T4- IBA 750 ppm	31.03ef	31.93e	37.51d	**33.49C**	30.37h	35.90g	37.48f	**34.58C**
Mean**	**35.44B**	**36.85B**	**39.99A**		**36.10C**	**38.10B**	**41.01A**	

Means followed by the same letter/s within each column didn`t significantly differ at 5 % level.

1.3. F.W. the first new leaf (g) and Dry weight (D.W) the first new leaf (g)

Table (4) displays all treatments investigated substances of IBA and soil type and interactions increased significantly in both F.W. the first new leaf (g) and D.W. the first new leaf (g) of offshoots Sewi date palm cv. as compared to the analogous ones of control (water spray) during 2022 and 2023 seasons.

The statistical analysis's findings showed that the handling of interaction between IBA at a concentration of 250 ppm and type of soil as sand : silt : peat moss (1 : 1 : 1 ratio) was the best and most effective treatment compared to the others of F.W. the first new leaf (g) and D.W. the first new leaf (g). F.W. the first new leaf (g) which reached 84.92 and 85.62 (g) in both seasons. And, D.W. the first new leaf (g) which reached 44.23 and 45.30 on both seasons offshoot.

Table (4): Effect of soil type and IBA concentrations on Fresh weight **(F.W) the first new leaf (g) and D.W. the first new leaf (g) Traits of Siwi date palm offshoots during 2022 & 2023 experiential seasons**

treatments	F.W. the first new leaf (g)							
Soil type	Season 2022			Mean*	Season 2023			Mean*
IBA concentration	Sand : silt (1:1 ratio)	Sand : Silt : Peat moss (1 : 0.5 : 0.5 ratio)	Sand : Silt : Peat moss (1 : 1 : 1 ratio)		Sand : silt (1:1 ratio)	Sand : Silt : Peat moss (1 : 0.5 : 0.5 ratio)	Sand : Silt : Peat moss (1 : 1 : 1 ratio)	
T1- IBA zero ppm	62.78j	66.43i	67.89h	**65.70D**	63.90j	66.65i	68.65h	**66.40D**
T2- IBA 250 ppm	79.19c	80.35b	84.92a	**81.49A**	80.25c	81.72b	85.62a	**82.53A**
T3- IBA 500 ppm	75.57e	76.37e	77.42d	**76.45B**	74.98e	74.63e	76.67d	**75.43B**
T4- IBA 750 ppm	70.97g	71.48g	73.16f	**71.87C**	70.75g	73.10f	74.95e	**72.93C**
Mean**	**72.13C**	**73.66B**	**75.85A**		**72.47C**	**74.03B**	**76.47A**	
	D.W. the first new leaf (g)							
T1- IBA zero ppm	31.52k	33.74j	34.76i	**33.34D**	33.13k	34.94j	36.07i	**34.71D**
T2- IBA 250 ppm	41.00c	41.41b	44.23a	**42.21A**	41.88c	42.59b	45.30a	**43.26A**
T3- IBA 500 ppm	39.12e	39.24e	39.84d	**39.40B**	39.98e	40.15e	40.60d	**40.24B**
T4- IBA 750 ppm	36.32h	37.00g	37.75f	**37.03C**	37.19h	37.71g	38.78f	**37.89C**
Mean**	**36.99C**	**37.85B**	**39.15A**		**38.05C**	**38.85B**	**40.19A**	

Discussion

The interaction between plant growth regulators, particularly Indole-3-butyric acid (IBA), and soil types plays a significant role in influencing the early vegetative growth and development of Siwi date palms. Key growth parameters such as leaf length, number of leaves per offshoot, trunk length and girth, and leaf biomass are all influenced by these factors.

The application of IBA significantly enhances the length of the first new leaf, primarily due to its role in stimulating cell elongation and promoting auxin-regulated growth processes [8] Moreover, the type of soil contributes substantially to loamy soils, rich in organic matter and nutrients, which tend to support better root development and nutrient uptake, leading to longer leaf emergence and development [17]. IBA also stimulates root proliferation, which indirectly improves nutrient absorption and promotes leaf elongation.

A greater number of new leaves per offshoot is often observed with IBA application, especially when coupled with fertile, well-drained soils like sandy-loam or loam soils. Auxin-based compounds like IBA enhance apical dominance and shoot development, thereby increasing leaf initiation rates [18]. Soil with balanced moisture-holding capacity and aeration further supports shoot growth by facilitating proper root respiration and nutrient cycling.

The trunk girth is a key indicator of vegetative robustness. IBA-treated offshoots planted in loamy or clay-loam soils generally exhibit greater basal girth, likely due to improved mechanical support and nutrient retention. The combination of IBA and nutrient-rich soils promotes secondary growth, enhancing stem diameter through enhanced cambial activity [19].

IBA promotes higher fresh weight due to increased cell division and water uptake in leaf tissues. Soils with good water-holding capacity, such as loam and clay loam, further support this effect by reducing water stress and increasing leaf turgidity [20]. IBA-enhanced root systems improve water absorption, thus positively influencing leaf hydration status.

The dry matter accumulation increases with IBA, indicating improved photosynthetic efficiency and structural biomass development. Plants in loamy soils, due to their balanced nutrient and water availability, tend to produce higher dry weights, reflecting better carbon assimilation and metabolite accumulation [17,21]. This supports the potential role of IBA in not only stimulating water content but also enhancing physiological and biochemical processes for biomass formation.

Conclusion

The combined application of IBA and optimal soil type (especially Sand, Silt and Peat moss soils) significantly improves the vegetative growth performance of Siwi date palm offshoots, including leaf elongation, number of leaves, trunk parameters, and biomass production. IBA enhances root development, leading to better nutrient and water uptake, while soil properties mediate the availability of these essential growth resources. The findings suggest that proper integration of plant growth regulators and soil management is vital for optimizing the propagation and early development of Siwi palms.

According to the above-mentioned results, it is concluded that the application of different mixed soil combined with IBA in different concentrations by soaking gave good root initiation, particularly soil with sand : silt : peat moss as 1 : 1 : 1 ratio interaction with IBA as concentration 250 ppm is especially beneficial when it comes to rooting weak date palm offshoots. Commercial adoption of this kind of soil and growth regulator application is possible for siwi date palms. We may readily take advantage of those weak, difficult-to-root offshoots in this way.

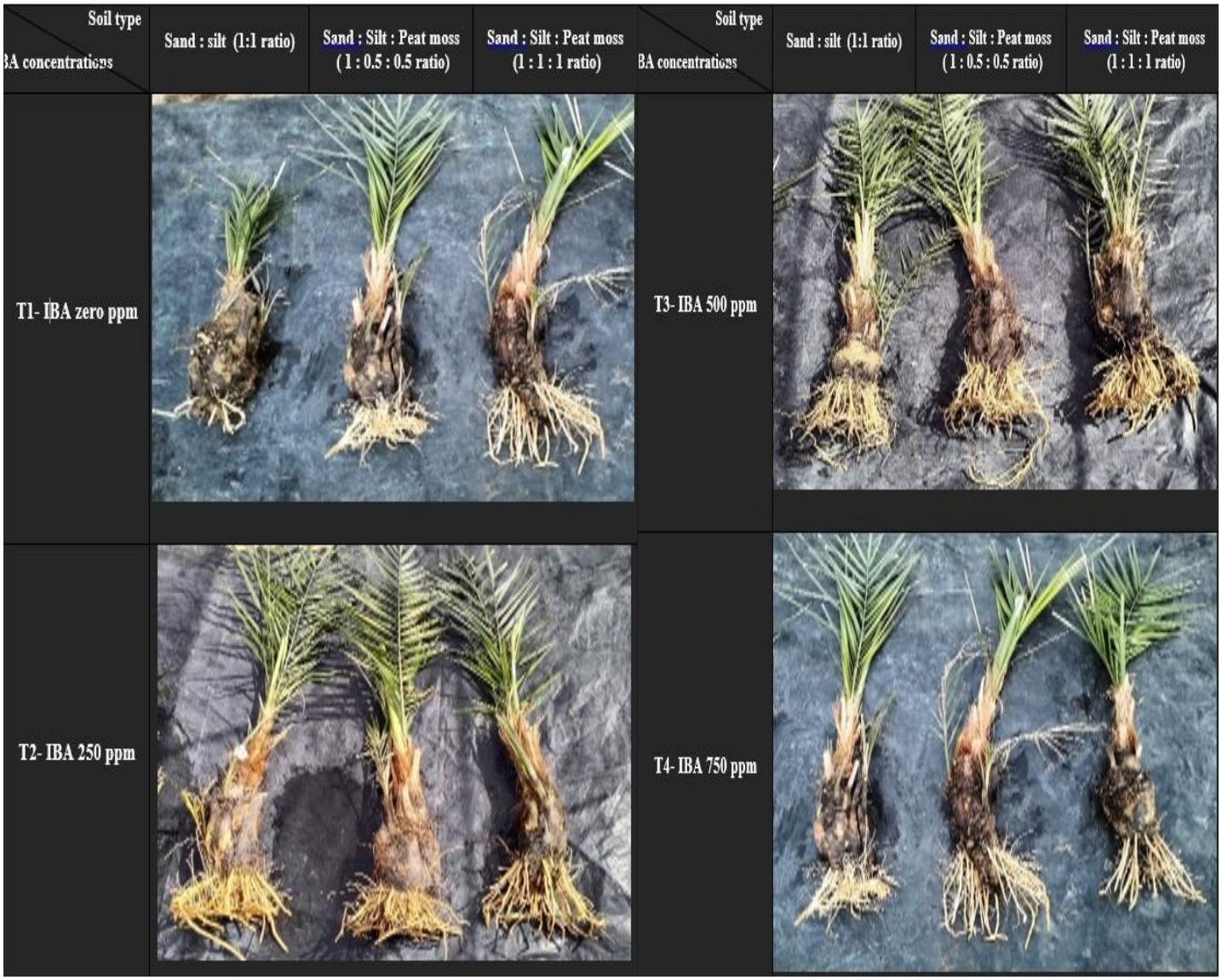

Photo (1): Effect of soil type and IBA concentrations on some vegetative growth traits of Siwi date Ppalm offshoots during 2022 & 2023 experiential seasons.

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