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Effect of spraying with Moringa plant extract and potassium silicate on some vegetative growth indicators of banana seedlings obtained from tissue culture Musa spp

[1]Riyadh Mhawesh Al-Muhe , [2]Mahmmod S. Abdul-Wahid

1,2College of Agriculture and Marshes, Thi-Qar University, Thi-Qar, Iraq.

[1]*E-mail: riyadhalwayly@gmail.com*

[2]*E-mail: prof.dr.msa72@gmail.com*

Abstract

The field experiment was conducted in one of the covered greenhouses in Al-Saran affiliated with the College of Agriculture and Marshes, University of Dhi Qar for the 2022-2023 growing season on banana seedlings of the Grand Nine variety resulting from tissue culture in order to determine the effect of Moringa extract and potassium silicate on the vegetative growth characteristics on 2/5/2023. Aged 3 to 4 months, 48 identical offspring were chosen. First, spraying with Moringa leaves extract at four concentrations (0, 5, 10, and 15) g L-1; second, spraying with potassium silicate at four concentrations (0, 1, 2, and 3) ml L-1.

The statistical analysis revealed that Moringa extract at a concentration of 15 g L-1 was superior in terms of all vegetative growth characteristics (plant height (104.38 cm), stem diameter (71.60 mm), number of leaves (10.60), plant leaf-1, and leaf area (1,535.05 square millimeters). cm2, the wet weight of the shoot is (1084.3) g, the dry weight is (120.45 g), and the rate of root propagation is (9.65) g per square centimeter per day. 2 kg-1.

The results of the statistical analysis demonstrated the superiority of potassium silicate at a concentration of 3 ml L-1 in all vegetative growth characteristics (plant height (95.90) cm, stem diameter (67.08) mm, number of leaves (9.28) plant leaf-1, leaf area (1,368.0) cm2, and plant weight (13,680.00 g)). The wet weight of the shoot is (943.9) g, its dry weight is (104.14 g), and its rate of root propagation is (9.71) g.2 kg-1,

As for the combinations, the combination of Mornica extract and potassium silicate at a concentration of (15 g L-1 x 3 ml L-1) performed the best in terms of vegetative characteristics, plant height (125.67 cm), stem diameter (84.80 mm), and number of leaves (13.40). -1, leaf area (1912.22 cm2), shoot wet weight (1417.5) g, shoot dry weight (157.5) g, and root spread rate (11.4) g 2 kg-1.

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I. INTRODUCTION

Musa spp. are members of the Musaceae family. It is a large herbaceous perennial plant. There are hundreds of banana varieties, and they come in various shapes (Cronanuer and Krikorian, 1984)

Bananas have multiple applications because they are an ideal and inexpensive food source. They are rich in carbohydrates, which account for roughly (30%) of their fresh weight. They are also abundant in minerals and vitamins. In addition, every 100 g of fruit pulp contains 100 calories. The plant's parts are utilized as insecticides, antioxidants, biogas, livestock feed, raw materials for rope production, and textile materials. It is employed in numerous industries (Mohapatra et al., 2010)

Moringa leaf extract is one of the most well-known natural nutritional supplements for sustainable agriculture due to its contribution to providing the plant with nutrients and growth regulators that enhance plant growth, as well as containing cytokinins including zeatin. It contributes to supplying the plant with essential nutrients and natural growth regulators, thereby enhancing the quantity and quality of production (Jain et al., 2020)

The presence of the essential macronutrients for plant growth and development, as well as potassium silicate, the primary source of silicon, plays an important role in plant growth and development (Sardans and Peñuelas, 2021)

Due to the absence of a study in Iraq on the treatment of banana plants resulting from tissue culture, the importance of Moringa extract and its high nutrient content, and the need of bananas for potassium silicate due to the large size of the leaves and their high consumption, this study was proposed to test the efficacy of various concentrations of Moringa plant extract and potassium silicate in enhancing banana plant growth. Bananas' vegetative characteristics.

II. MATERIALS AND METHODS

The field experiment was conducted in one of the covered greenhouses in Al-Saran affiliated with the College of Agriculture and Marshes - University of Thi-Qar during the growing season 2022-2023 on offshoots of the Banana plant Grand Nine variety, for the purpose of determining the effect of Moringa extract and potassium silicate on the vegetative growth characteristics. Seedlings and planting medium were prepared, then planted with supports, and seedlings were cared for as required by weeding, pest control, and irrigation.

As a global experiment, the study included two factors: spraying with Moringa leaf extract at four concentrations (0, 5, 10, and 15 g L-1) and spraying with liquid potassium silicate compound (potassium silicate concentration 35%) at four concentrations (0, 1, 2, and 3 ml L-1).

The first date was 21/2/2023, and the remaining sprays were separated by ten days, with a total of six sprays for all study transactions. The experiment was designed using a Completely Randomized Design, and the data were statistically analyzed

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using GENESTAT, 2012 software. The means were compared using the 0.05 probability level for the least significant difference.

The investigated characteristics:

Plant height (cm) A metric tape was used to measure the plant's height from its point of attachment in the soil to its top.

False leg diameter (mm) At a height of 4 cm above the soil surface, measure the leg diameter using a Caliper Vernier.

Number of leaves (1 leaf per plant) For each seedling, the number of leaves was determined, and the average for each treatment was calculated.

Leaf area (in cm2 per plant) The length and width of three leaves were measured, averaged, and multiplied by a constant in accordance with the following law: - Leaf area equals (leaf length x leaf width) multiplied by 0.80.

Fresh weight of the total vegetation (g) Three plants were selected at random for each experimental unit; after cleaning them of dust, the vegetative total was separated from the root system; their fresh weight was recorded on a sensitive scale; and the average weight in g for each treatment was calculated.

Shoot weight (in g): After determining the soft shoot's weight, it was dried in an electric oven at 70 degrees until its weight was stable. The dry weight of the food was measured, and the average dry weight of the food was calculated.

The rate of root development and spread (weight / weight). The diameter of the false stem was used to determine the weight of the soil, which was then dried and the roots extracted before being weighed.

III. RESULTS AND DISCUSSION

1 plant height (cm)

The results of a survey conducted by the American Society for the Prevention of Cruelty to Animals show that the use of pesticides in the workplace has a positive impact on public health. The extract of hormones, including gibberellin, which is responsible for cell elongation and division, increased the height of citrus seedlings with the addition of Moringa leaves extract. This result was consistent with what was observed and with (Nasir et al., 2020)

As for potassium silicate, the results of the same table indicate that treatment b3, with an average height of (95.90) cm, is superior to the control treatment b0, which produced the shortest plants (73.61 cm) in height. The reason may be due to silicon, which plays a role in improving the efficiency of photosynthesis and increasing the efficiency of roots in absorbing the nutrients necessary for plant growth and development (Liang et al., 2005). This result agreed with (Panchal et al.,2020) in that the potassium silicate treatment of banana plants produced the best results in terms of plant growth.

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The bilateral interaction between (moringa extract and potassium silicate) also led to the emergence of positive results, as the a3b3 treatment (15 g L - 1 x 3 ml L -1) outperformed the other treatments and yielded the highest average plant height of 125.67 cm, whereas the comparison treatment (0 x a0b) yielded the lowest value for the same trait at 45.47 cm.

Table 1: Effect of spraying Moringa leaf extract and potassium silicate on plant height (cm) and their interaction.

Moringa Extract Concentrations (g L−1)	Potassium silicate concentration (ml L−1)				Moringa extract average
	0	1	2	3	
0	45.47	63.33	68.67	77.73	63.80
5	78.00	79.50	81.17	83.53	80.55
10	77.77	81.20	88.83	96.67	86.12
15	93.20	97.67	101.00	125.67	104.38
Potassium silicate average	73.61	80.42	84.92	95.90	
LSD 0.05					
a= 2.632		b = 2.632		a*b= 5.264	

2 Length of the false leg in millimeters

The results of Table (2) indicated that spraying with Moringa extract resulted in a significant increase in the diameter of the false stem, if the treatment a3 excelled with an average of (71.60) mm while the comparison treatment gave a0 the lowest average of (51.21 mm), and the reason may be attributed to the fact that the extract contains Plant hormones such as auxins, gibberellins, and cytokinins, as in the appendage (Mvumi et al., 2013)the same conclusion as(Medan, 2023)

As for potassium silicate, the same table reveals that treatment b3, with an average stem diameter of 67.08 mm, is superior to the control treatment b0, which produced the smallest stem diameter of 52.85 mm. It may be due to potassium's role in root growth, the development of root system structure, and corresponding cellular functions. Increasing the absorption of elements and improving plant growth (Sustr et al., 2019) led to the same conclusion as (Sathappan et al.) and (Sathappan et al., 2021) for the banana plant.

The interaction between (moringa extract and potassium silicate) also yielded positive results, as the a3b3 treatment (15 g L - 1 x 3 ml L-1) outperformed the other treatments and recorded the highest mean value for this characteristic, which was

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(84.80) mm, whereas the control treatment yielded (0x0) mm. The minimum value for the same characteristic was 42.77 mm.

Table 2: Effect of spraying with Moringa leaf extract and potassium silicate on pseudopodia diameter (mm) and their interaction.

Moringa Extract Concentrations (g L−1)	Potassium silicate concentration (ml L−1)				Moringa extract average
	0	1	2	3	
0	42.77	55.03	47.37	57.50	51.21
5	52.11	55.30	58.73	61.23	56.84
10	55.00	57.87	62.90	64.77	60.13
15	61.51	68.20	71.87	84.80	71.60
Potassium silicate average	52.85	57.72	62.13	67.08	
LSD 0.05					
a=2.218		b =2.218		a*b=4.437	

3 amount of leaves (leaf plant-1)

The results of Table (3) indicated that spraying with Moringa extract significantly increased the number of leaves per plant, if the a3 treatment excelled with an average of (10.60) leaf of plant-1, while the comparison treatment gave a0 the lowest average of (7.44) leaf plant-1, and possibly that For the role of Moringa extract in enhancing the content of carotene and chlorophyll due to the hormones, minerals, and vitamins it contains, which delay the aging process. This result was consistent with the conclusion reached (Aslam et al., 2016) in the banana plant (Athani et al., 2019).

As for potassium silicate, the results of the same table indicate that treatment b3 with an average of (9.28) leaves plant-1 is superior to the control treatment b0, which produced the fewest leaves with a total of (7.12) leaves plant-1. This is consistent with (Islam et al., 2020), which states that potassium has a positive effect on the morphological characteristics of bananas, including the number of leaves.

The bilateral interaction between (moringa extract and potassium silicate) also resulted in favorable outcomes, as the a3b3 treatment (15 g L - 1 x 3 ml L-1) outperformed the other treatments and recorded the highest average in this trait, which

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reached (13.40) leaf plant-1, while it gave the Comparison treatment (0x0) the lowest value in the same trait, which was (6.67) leaf plant-1.

Table 3: The effect of spraying with Moringa leaf extract and potassium silicate on the number of leaves (1 leaf) and their interaction.

Moringa Extract Concentrations (g L−1)	Potassium silicate concentration (ml L−1)				Moringa extract average
	0	1	2	3	
0	6.67	7.67	7.67	7.77	7.44
5	6.67	7.67	7.57	7.67	7.39
10	7.50	7.67	7.97	8.27	7.85
15	7.67	9.00	12.33	13.40	10.60
Potassium silicate average	7.12	8.00	8.88	9.28	
LSD 0.05					
a= 0.829	b = 0.829		a*b=1.659		

4 leaf area (cm2 plant-1)

We note from Table (4) that spraying with Moringa extract significantly increased leaf area, if the b3 treatment excelled with an average of 1,535.05 cm 2, while the comparison treatment A0 gave the lowest average of (662.20) cm 2, and the reason may be due to the presence of nitrogen, which enters the The formation of proteins, amino acids, and nucleic acids, in addition to its entry into the formation of chlorophyll pigment, which helps in increasing the leaf area. The positive results of photosynthesis may also be attributable to the increase in leaf area promoted by Moringa extract (Khan et al., 2020), and this result is consistent with what was discovered (Hassan et al., 2019) on olive trees.

As for potassium silicate, the results of the same table indicate that treatment b3, with an average leaf area of (1362.80) cm 2, is superior to treatment b0, which yielded the smallest leaf area of (941.15) cm 2, and that the presence of potassium, which works to swell leaves and expand cells (Prado et al., 2021), is responsible for this difference. The result concurred with previous findings (Athani et al.,2019) regarding the banana plant.

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The interaction between (moringa extract and potassium silicate) also produced positive results, as the a3b3 treatment (15 g L - 1 x 3 ml L-1) outperformed the other treatments and yielded the greatest average leaf area (1912.22 cm2), whereas the control treatment yielded (0x0). The minimum value for the same characteristic was 528.36 cm2.

Table 4: Effect of spraying with Moringa leaf extract and potassium silicate on leaf area (cm2 plant-1) and their interaction.

Moringa Extract Concentrations (g L−1)	Potassium silicate concentration (ml L−1)				Moringa extract average
	0	1	2	3	
0	528.36	621.45	715.00	784.00	662.20
5	868.00	910.33	1072.00	1216.00	1016.58
10	1143.26	1384.10	1475.40	1539.00	1385.44
15	1223.00	1471.00	1534.00	1912.22	1535.05
Potassium silicate average	941.15	1096.72	1199.10	1362.80	
LSD 0.05					
a= 64.4		b = 64.4		a*b= 128.9	

5 weight of fresh shoots

The results of Table (5) indicated that spraying with Moringa extract resulted in superior fresh weight of the shoot (gm), if the a3 treatment excelled with an average of (1084.3) g while the comparison treatment a0 gave the lowest average amounting to (343.3) gm. This increase could be attributed to the positive effect of Moringa on the characteristics of vegetative growth, which increased significantly with increasing concentration of the extract. The amino acids present in the extract play vital roles in increasing the direction and rate of metabolic processes, thereby increasing the dry matter and plant weight (Kocira et al., 2021). Alternatively, the increase may be attributable to the extract's high concentrations of carbohydrates, vitamins, proteins, and phenolic compounds (Xiong et al., 2021) in addition to the extract's hormone content. On pomegranate trees, the presence of phytochemicals such as auxins, gibberellins, and cytokinins led to an increase in vegetative body weight and was consistent with the results (Kamel, 2015).

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As for potassium silicate, the same table reveals that treatment b3 with an average fresh weight of (943.9) g is superior to the control treatment b0, which yielded the lowest fresh weight of (536.8) gm. The use of potassium silicate, which aided in promoting the vegetative growth of bananas, was consistent with this result (Aziz et al., 2023) in this regard.

The interaction between (moringa extract and potassium silicate) also produced positive outcomes, as the a3b3 treatment (15 g L-1 x 3 ml L-1) outperformed the other treatments and yielded the highest average fresh weight of (1,417.5) g, whereas the comparison treatment yielded (0x0) g. The minimum value for the same trait was (291.8) g.

Table 5: Effect of spraying with Moringa leaf extract and potassium silicate on the fresh weight of shoots

Moringa Extract Concentrations (g L−1)	Potassium silicate concentration (ml L−1)				Moringa extract average
	0	1	2	3	
0	291.8	320.6	360.4	400.5	343.3
5	440.1	590.2	678.8	847.5	639.1
10	611.1	728.7	930.2	1110.3	845.1
15	804.4	997.8	1117.6	1417.5	1084.3
Potassium silicate average	536.8	659.3	771.8	943.9	
LSD 0.05					
a= 17.4		b = 17.44		a*b 34.88	

(g) and their interaction.

6 Weight of dry shoots (g)

As shown in Table (8), spraying with Moringa extract significantly increased the dry weight of the shoot, with the a3 treatment achieving an average of 120.45 g compared to 37.08 g for the a0 control. The reason for this increase is due to the growth characteristics that excelled in treatment a3 . thus the dry weight of the shoot increased, or it may be attributed to stimulating the transfer of nutrients from the leaf to other parts of the plant by the action of moringa extract, which improves plant growth, and this is consistent with what found (Al-Sabbagh et al., 2020) on the orange trees.

As for potassium silicate, the results of the same table indicate that treatment b3 is superior to the control treatment b0, which produced the least amount of weight (59.23 gm). Increasing the size of the mesenchyme and consequently the plant's

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weight (Costa et al., 2021) is consistent with his finding (Rangwala et al., 2021) that potassium silicate spraying led to a significant increase in the wet and dry weight of banana plants.

The bilateral interaction between (moringa extract and potassium silicate) also yielded positive results, as the a3b3 treatment (15 g L - 1 x 3 ml L -1) outperformed the other treatments and recorded the highest average dry weight of the shoot (157.50) g, while the comparison treatment (0x0) yielded the lowest value for the same trait (32.42) g

Table 8: Effect of spraying with Moringa leaf extract and potassium silicate and their interaction on shoot dry weight (g) of tissue-cultured banana seedlings.

Moringa Extract Concentrations (g L−1)	Potassium silicate concentration (ml L−1)				Moringa extract average
	0	1	2	3	
0	32.42	32.71	39.17	44.01	37.08
5	48.19	64.15	73.78	92.12	69.56
10	67.90	80.97	103.35	122.92	93.79
15	88.40	111.28	124.64	157.50	120.45
Potassium silicate average	59.23	72.28	85.24	104.14	
LSD 0.05					
a= 1.921		b = 1.921		a*b= 3.842	

7 Rate of root propagation (g 2 kg-1 w/w)

Figure 1 shows that spraying with Moringa extract increased the rate of root growth by a significant amount. The a3 treatment did the best, with an average of 9.65 g 2 kg-1, while the a0 control treatment did the worst, with an average of 7.41 g 2 kg-1. Organic amendments are important for improving and speeding up plant growth because they have the right amounts of nutrients and also help improve the soil's physical and chemical properties. They are also good for the environment (Emirates et al., 2008), which is good for the growth and spreading of roots.

As for potassium silicate, the same table demonstrates the superiority of treatment b3 with an average of (9.71) g 2 kg-1 over the control treatment b0, which produced the lowest root propagation rate concentration of (6.77) g 2 kg-1. This

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increase in silicon accumulation in the roots of cultivated seedlings can be explained by the expansion of the endoderm (Castro et al., 2009), which is consistent with finding (Asmar et al., 2013) for the banana plant.

The interaction between (moringa extract and potassium silicate) also yielded positive results, as the a3b3 treatment (15 g L-1 x 3 ml L-1) outperformed the other treatments and recorded the highest average chlorophyll concentration of (11.40) g 2 kg-1 in comparison to the other treatments. When the comparison treatment (0x0) produced the lowest value for the same characteristic, it totaled (5.47) g 2 kg-1.

	s1	s2	s3	s4
m1	5.47	7.6	8.1	8.5
m2	6.53	8.2	8.8	9.1
m3	7.3	8.1	9.6	9.86
m4	7.8	9.1	10.3	11.4

Figure 1 depicts the impact of spraying banana seedlings with potassium silicate and Moringa leaf extract, as well as their interaction, on the rate of growth and root propagation (g 2 kg-1)

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