Indian Journal of Ecology (2022) 49 Special Issue (18): 135-141

Manuscript Number: S-791
NAAS Rating: 5.79

Response of Olive Trees to Spraying with Salicylic Acid, Thidiazuron, and Marine Algae Extract to Mineral Elements in the Leaves and Some Fruit Characteristics

Noor T. Abd AL-Shabani and Hameed H. Al-Ali

Department of Horticulture College of Agriculture, University of Anbar. Iraq
E-mail: noortahaa1991@gmail.com

Abstract: A factorial field experiment was carried out in the Jazirah region, Ramadi during the 2020 growing season to study the effect of foliar spraying with salicylic acid (S) and growth regulator TDZ (T). Besides, marine algae extract with nanotechnology (N) on mineral elements in the leaves and some characteristics of olive fruits Khestawi variety. The experiment included three factors, where the spraying with three levels of salicylic acid (200, 100, 0 mg L^{-1}) and second factor is spraying with three levels of TDZ growth regulator (6,3,0 mg L^{-1}), the third factor, spraying with marine algae extract at a concentration of (2,1,0 ml L^{-1}). The results showed the superiority of S2 content of N, P and K in the leaf and the fruits dry weight. The T_2 was superior in phosphorous content the leaf (0.1474%), potassium content (0.7630%) and the fruits dry weight of (21.57 g). Furthermore, spraying algae extract solution with a concentration of 2 mg L^{-1} was superior in the percentage of potassium (0.7685%), the fruit length (24.167 mm), and the percentage of fruits dry weight (21.84%), while the treatment 1 ml L^{-1} for algae extract solution was superior in the percentage of nitrogen (1.7211%), phosphorus (0.1437%), and the fruit diameter (17.80 mm). The combined effect of study factors showed an effect on most of the studied traits.

***Keywords*:** *Olea europaea* L., Organic matter, Growth regulators, Nanotechnology

Olive (*Olea europaea* L.) is among the most important evergreen fruit trees belongs to the Oleaceae family, where its cultivation is spread between latitudes 30-45 north of the equator, and this spread is closely related to the economic importance and the great social environment of olives in those countries. Olive trees in Iraq are estimated at 1341339 trees and their average productivity is about 34,501 tons, while the average productivity of one tree is about 25.72 kg $tree^{-1}$. Al Khestawi variety is one of the local Iraqi varieties that spread in central and northern Iraq. , the phenomenon of alternate fruit-bearing in olive trees is one of the widespread problems, and the emergence of this phenomenon depends on many factors such as type, variety, environmental conditions. Although it is a phenomenon controlled by genetic factors, numerous materials that limit the phenomenon of alternate fruit bearing were used, among them is salicylic acid (SA), which is a growth regulator and has an anti-effect of abscisic acid (ABA) in the leaves and increases the levels of chlorophyll and carotenoid pigments. Number of studies has indicated the positive effect of salicylic acid on the characteristics of vegetative growth, leaf content of N.P.K minerals, and fruit characteristics for species of fruit trees (Ahmed et al 2019). The plant growth regulator (TDZ), which is one of the synthetic cytokines from the phenylurea group, has a high long-term activity compared to the cytokinins of the adenine group. The physiological activities include the effect on breaking the apical dominance, the movement, transmission, and elements metabolism in the site of the treated tissues, delaying the degradation of chlorophyll, resistance to stress, and increasing the size of fruits. The study results proved that spraying some fruit trees with TDZ growth regulator led to a significant superiority in the shoot properties and leaf content of NPK elements, as well as improved the fruiting characteristics of fruit trees (Assad 2014). Including the marine algae extract, this is among the important organic sources used in agricultural production as a supplement to fertilizers and not a substitute for them. Ahmed et al (2019) showed that spraying olive trees with marine algae extract resulted in a significant superiority in the vegetative growth characteristics, nitrogen content, and some minerals content in the leaves, which was positively reflected in the fruiting characteristics of olive fruits. Therefore, this study aimed to investigate the effect of different levels of growth regulators salicylic and (TDZ) and marine algae extract produced with nanotechnology and their interactions in the chemical content of olive leaves (Khestawi variety) and their effect on the shape and size of fruits.

MATERIAL AND METHODS

A field experiment was carried out in one of the orchards located in the Jazirah region in the city of Ramadi at longitude

43° 17'31.9 "E and latitude 33 ° 28'23.4" N for the period from March 2020 until November 2020. Eighty-one olive trees of the 10-year-old "Khestawi variety" were selected as homogeneous as possible to study the effect of spraying with growth regulators salicylic and TDZ and marine algae extract with nanotechnology in some vegetative and fruiting characteristics of olive trees (Khestawi variety). Thus, a factorial experiment was carried out with three factors according to a randomized complete block design with three replicates for each treatment. The first factor included spraying the shoots of trees with salicylic acid produced by China / HI-SKY Chemicals Co., Ltd. with a concentration of the active substance by 99.8% in three concentrations. The first one without spraying the growth regulator solution (comparison treatment), symbolized by S_0, spraying the growth regulator solution (SA) at a concentration of (100 mg L^{-1}) symbolized by S_1, and spraying the growth regulator solution (SA) at a concentration of (002 mg L^{-1}) symbolized by S_2. The second factor includes spraying of trees with the TDZ growth regulator solution produced by (DIREVO Industrial Biotechnology Germany), with a concentration of the active ingredient is (99%) in three concentrations. The first one (comparison treatment symbolized by T_0, spraying the growth regulator solution (TDZ) with a concentration of (3 mg L^{-1}), symbolized by T_1, and spraying the growth regulator solution (TDZ) at a concentration of (6 mg L^{-1}) symbolized by T_2. The third factor included spraying the shoots of trees with algae extract with nanotechnology (Super Fifty) manufactured by Agricens (Izmir - Turkey) in three levels, which include without spraying algae extract with nanotechnology (comparison treatment) symbolized by N_0. Besides, spraying algae extract solution with a concentration (1 mg L^{-1}) symbolized by N_1, and spraying algae extract solution with a concentration of (2 mg L^{-1}) symbolized by N_2, the fertilizer recommendation for it is (1 - 1 mg L^{-1}) according to the manufacturer.

The data were analyzed according to the commercial GenStat statistical program, and the arithmetic averages were compared using the L.S.D at a probability level of 0.05. Then, the treatments were randomly distributed among experiment units for each of the three replicates. The trees were treated with salicylic acid and a growth regulator, as well as algae, extract with nanotechnology using a (100 liters) holder with the addition of a few drops of the diffuser to the spray solution to reduce the surface tension of the water. The mobile nylon barrier is placed between the trees when spraying to prevent the transmission of the foliar solution spray. The spraying process was carried out in the evening until the trees were completely wet, and the process was carried out at the following dates:

Table 1. Components of the nano-extract (TDZ)

Parameters	Percent
Organic matter	21
Alginic acid	0.8
Gibberellic acid	0.02
Water soluble potassium oxide	5
pH range	8.8-10.8

Salicylic acid (SA)	Growth regulator (TDZ)	Marine algae extract
First Spray: 2 March, 2019	First spray: at the beginning of emerging buds 10 March	First spray: 23 March
Second spray: 2 April	Second spray: 10 April	Second spray: full flowering stage 23 April
Third spray: 2 May	Third spray: 10 May	Third spray: 23 May

Studied Traits

Estimation of the total nitrogen content in leaves: The nitrogen content was estimated by Semi - micro kjeldal method (AOAC, 1980), where the following equation was applied to estimate the nitrogen content.

$$\% \text{ Nitrogen} = \text{volume of HCl acid} \times N\,(0.01) \times 0.014 \times 100$$

Estimation of phosphorous content in leaves: It was estimated according to the method mentioned in AOAC (1980) using a spectrophotometer of ultraspectronic supplied by the American company LKB at a wavelength of 620 nm. Then, the reading was projected into the standard curve of pure phosphorous, and the phosphorous concentration was calculated after multiplying the result by dilution and dividing by the sample weight, according to the equation:

$$\text{Phosphorus } \% = \text{final phosphorus concentration} \times 50 \times 100 \times 100 \times 100$$

Estimation of potassium content in leaves: Total potassium levels were estimated by semi-micro kjeldal method (AOAC, 1980) with a Flame photometer type PGI 2000 Automatic flame photometer of English origin. Accordingly, this device gave the potassium concentrations directly after projecting the reading on the standard potassium curve automatically, after which the final concentration was multiplied by the dilution ratio and the result was divided by the weight of the dry sample.

Fruit length (mm): 20 fruits were selected at the harvest randomly for each treatment. Their length was measured for each fruit separately

Diameter of the fruit (mm): 20 fruits were selected at the harvest randomly for each treatment, and the diameter of each fruit was measured separately and its value was recorded from which the average diameter of the fruit was obtained by dividing the total number by the number of fruits.

Percentage of dry matter in fruits: This percentage was calculated from the wet and dry weight of samples taken in October during the two study seasons for twenty fruits for each treatment as follows:

$$\% \text{ of dry matter} = \frac{\text{Dry weight}}{\text{Wet weight}} \times 100$$

RESULTS AND DISCUSSION

Nitrogen content in leaves (%): The spraying with salicylic acid had a significant effect on the nitrogen content in the leaves with increasing concentration. Therefore, the salicylic S_2 achieved the highest nitrogen content (1.7159%), followed by treatment S_1, which in turn did not differ significantly from the comparison treatment, which gave the lowest (1.6889%) (Table 2). The increase in nitrogen content as a result of treating olive trees with salicylic acid is due to its role in stimulating vital activities that led to an improvement in the characteristics of vegetative growth and increase the efficiency of absorption and transfer of nutrients to plant parts and this helped increase the nitrogen content of leaves. Hussien (2017) and Ahmed et al (2018) observed significant increase in nitrogen content in the leaves of that was treated with salicylic acid. Similarly, the results showed a signif0icant effect of the growth regulator TDZ on the nitrogen content in leaves, T_1 showed the highest (1.7074%), and did not differ significantly from T_2, which was superior over the comparison treatment (1.6807%). The increase in nitrogen content in olive leaves is due to the effectiveness of the growth regulator TDZ in stimulating the physiological activities of the plant, which was reflected in the improvement of the growth characteristics. Besides, the leaf area and the efficiency of photosynthesis was reflected in increasing nitrogen content of the leaves especially the, as the growth regulator itself is considered a source of nitrogen. These results are consistent with the findings of Aly et al (2017). There was significant

Table 2. Effect of spraying with growth regulators of salicylic, TDZ, and marine algae extract with nanotechnology on nitrogen and phosphorous content in leaves (%)

Factor N	Factor S	Nitrogen content (%)				Phosphorous content (%)			
		Factor T			N*S	Factor T			N*S
		T0	T1	T2		T0	T1	T2	
N_0	S_0	1.6400	1.6233	1.6633	1.6611	0.1233	0.1400	0.1400	0.1233
	S_1	1.6533	1.6867	1.7000	1.6656	0.1233	0.1400	0.1200	0.1400
	S_2	1.6900	1.6867	1.6967	1.6867	0.1233	0.1400	0.1467	0.1356
N_1	S_0	1.7000	1.7300	1.7400	1.7156	0.1333	0.1400	0.1533	0.1344
	S_1	1.7500	1.7033	1.7333	1.7144	0.1200	0.1267	0.1333	0.1422
	S_2	1.6967	1.7100	1.7267	1.7333	0.1500	0.1600	0.1767	0.1544
N_2	S_0	1.6833	1.6767	1.6700	1.6900	0.1300	0.1333	0.1467	0.1311
	S_1	1.6967	1.7000	1.7433	1.6911	0.1333	0.1433	0.1600	0.1400
	S_2	1.6900	1.6967	1.7700	1.7278	0.1300	0.1433	0.1567	0.1544
					Mean N				
N*T	N_0	1.6422	1.6800	1.6911	1.6711	0.1344	0.1278	0.1367	0.1330
	N_1	1.7233	1.7289	1.7111	1.7211	0.1422	0.1267	0.1622	0.1437
	N_2	1.6767	1.7133	1.7189	1.7030	0.1367	0.1456	0.1433	0.1419
					Mean S				
T*S	S_0	1.6744	1.6767	1.6911	1.6889	0.1289	0.1378	0.1467	0.1296
	S_1	1.7000	1.6967	1.7256	1.6904	0.1256	0.1367	0.1378	0.1407
	S_2	1.6922	1.6978	1.7311	1.7159	0.1344	0.1478	0.1600	0.1481
		1.6807	1.7074	1.7070		0.1378	0.1333	0.1474	
LSD 5%									
S		T	N	N*T		S	T	N	N*T
0.01187		0.01187	0.01187	0.02056		0.00618	0.00618	0.00618	0.01070
N*T*S		T*S	N*S			N*T*S	T*S	N*S	
0.03561		N.S	N.S			N.S	N.S	N.S	

effect of spraying with marine algae extract, as the treatment N_1 showed the highest nitrogen content in leaves (1.7211%), followed by the treatment N_2, which was superior over the comparison (1.6711%). The increase in the content of leaves treated with marine extract is due to the fact that the extract is a source of organic matter and is rich in nitrogen and amino acids, which is reflected in the increased nitrogen content. El-Sayed et al (2018) also obtained a significant increase in the leaves content from the elements, especially nitrogen.

Phosphorous content in leaves (%): Salicylic acid had a significant effect on the phosphorous content in leaves with an increase in added concentration (Table 2). Thus, the highest treatment S_2 achieved the highest value for phosphorus content, reached 0.1481%, followed by treatment S_1, which in turn significantly superior over the comparison treatment that recorded the lowest (0.1296%). The results observed that there is a significant effect of the growth regulator TDZ on the leaves content of phosphorus, as the treatment T_2 recorded the highest rate (0.1474%), followed by the treatment T_0, which in turn superior over the treatment T_1, that recorded the lowest (0.1333%). Furthermore, the treatment of spraying with marine algae extract showed a significant effect on the phosphorous content of leaves, as the treatment N_1 showed the highest rate (0.1437%), and it did not differ from the treatment N_2, which in turn superior over the comparison treatment, which recorded the lowest value of the trait by 0.1330%. The bilateral interaction between the growth regulator TDZ and the marine algae extract had a significant effect on this trait, as the treatment N_2T_2 recorded the highest rate (0.1600%).

The treatment N_1T_1 recorded the lowest average phosphorus content in leaves, which was 0.1267%. The results indicate that there was no significant effect of the combined interaction between salicylic acid and marine algae extract, as well as the interaction between salicylic acid and TDZ, as well as the triple interaction of study factors on the phosphorus content of leaves. The increase in the phosphorous content in leaves due to the addition of salicylic acid, the growth regulator TDZ and marine algae extract proved that all of these materials have significantly improved the growth characteristics such as the leaves content of chlorophyll. Coupled with the leaf area, which led to an increase in the efficiency of the plant in synthesis and accumulation of dry matter and the absorption of the elements from the soil. These results confirm the findings of Hussien (2017) and Ahmed et al (2018) that demonstrated there was an increase in phosphorous as a result of treating with salicylic acid. It also confirmed the findings of Aly et al (2017) that obtained a significant increase in the leaves content of phosphorous as a result of spraying plants with the growth regulator TDZ. Moreover, also consistent with the findings of Faissal et al (2018) that there was also an increase in the leaves content of phosphorous as a result of spraying them with the marine extract.

Potassium content in leaves (%): The spraying with salicylic acid had a significant effect on the potassium content in the leaves, as the salicylic S_2 achieved the highest rate of leaf content of potassium 0.7689%. Followed by treatment S_1, which in turn superior over the comparison treatment, which gave the lowest 0.7530% (Table 3). These results are consistent with the findings of Hussien (2017) and Ahmed et al 2018) that indicated there was an increase in the leaf content of potassium as a result of the salicylic acid addition. Instead, the results showed a significant effect of the growth regulator TDZ on the potassium content in leaves. The treatment T_2 showed maximum of potassium of 0.7630%, and it did not significantly differ from the treatment T_1, which in turn superior over the comparison treatment that recorded the lowest amount (0.7563%). These results are consistent with the findings of Aly et al (2017), which obtained a significant increase in leaf content of potassium as a result of spraying plants with the growth regulator TDZ. It is also noticed that there is a significant effect of spraying with marine algae extract for both the first and second seasons, as the N_2 showed the highest 0.7685%. Then, it was not significantly different from N_1, which in turn superior over the comparison treatment, and recorded the lowest value (0.7459%). These results confirm the findings of Faissal et al (2018) that demonstrated there was also an increase in the potassium content in leaves as a result of spraying them with the marine extract. The bilateral interaction between the growth regulator TDZ and the marine algae extract showed a significant effect on this trait, as the treatment N_2T_2 recorded the highest (0.7733%). There was showed that the bilateral interaction between salicylic acid and marine algae extract showed a significant effect on the same trait, as treatment N_2S_2 recorded the highest values reached 0.7800%, while treatment N_0S_0 recorded the lowest values of 0.7344%. The bilateral interaction of salicylic acid and TDZ showed a significant effect on the potassium content in leaves, as the treatment S_2T_2 was superior and showed the highest (0.7756%), while treatment S_0T_0 recorded the lowest (0.7456%). The triple interaction between the study factors showed the presence of significant differences, as the treatments $N_2S_2T_2$, $N_2S_0T_2$ and $N_1S_1T_1$ were superior and gave the highest potassium content in leaves. However, the triple interaction $N_0S_0T_0$ gave the lowest value (0.7200%).

Fruit length (mm): The spraying with salicylic acid S_2 gave the highest significant increase in the fruit length, reached 22.832 mm, followed by the treatment S_1, which in turn significantly superior over the comparison treatment and gave the lowest 20.803 mm (Table 3). The TDZ T_2 showed the highest rate (23.810 mm), followed by the treatment T_1, which in turn significantly superior over the comparison treatment, which recorded the lowest (20,560 mm). The treatment N_2 recorded the highest (24.167 mm), compared to the other treatments, followed by the treatment N_0, which in turn superior over the comparison treatment, and gave the lowest value (20.236 mm). The interaction treatment between spraying with salicylic acid and marine algae extract N_2S_2 achieved the highest value (25.319 mm), compared to the comparison treatment N_0S_0, which gave the lowest value (19.107 mm). The interaction N_2T_2 showed a significant effect and recorded the highest value (26.722 mm), while the bilateral interaction N_0T_0 showed the lowest (17.836 mm). Furthermore, the interaction treatment S_2T_2 was superior and showed the highest rate (24.773 mm), while the treatment S_0T_0 recorded the lowest value (19.473 mm). Similarly, the interaction between the study factors $N_2S_2T_2$ was superior and gave the highest (27.587 mm), while the treatment $N_0S_0T_0$ recorded the lowest value (17.133 mm).

The increase in the fruit's length as one of the fruit shape measures is due to the role of all study factors in improving the growth characteristics which were reflected in increasing the efficiency of photosynthesis and the dry matter accumulation and transfer to the fruits, which led to an increase in the dimensions and size of fruits, including the fruit length. These results are consistent with the findings Hussien (2017) about studies on salicylic acid, and with Assad (2014) about studies on growth regulator Thidiazuron. As well, with Mostafa et al (2019) about studies on marine algae extract, that there was a significant increase in fruit length as a result of treating with these substances.

Fruit diameter (mm): The spraying with salicylic acid S_2

Table 3. Effect of spraying with growth regulators of salicylic, TDZ, and marine algae extract with nanotechnology, in estimating the potassium content in leaves (%) and fruit length (mm)

Factor N	Factor S	Potassium content (%)				Fruit length (mm)			
		Factor T			N*S	Factor T			N*S
		T0	T1	T2		T0	T1	T2	
N_0	S_0	0.7200	0.7367	0.7400	0.7344	17.133	18.123	18.250	19.107
	S_1	0.7467	0.7567	0.7700	0.7456	19.000	20.037	22.660	20.271
	S_2	0.7367	0.7433	0.7633	0.7578	21.187	22.653	23.083	21.331
N_1	S_0	0.7567	0.7567	0.7833	0.7644	20.350	22.300	22.807	20.359
	S_1	0.7700	0.7867	0.7467	0.7667	19.683	22.750	19.080	22.520
	S_2	0.7667	0.7567	0.7767	0.7689	21.043	22.510	23.650	21.846
N_2	S_0	0.7600	0.7667	0.7867	0.7600	20.937	21.683	23.460	22.944
	S_1	0.7533	0.7600	0.7667	0.7656	21.910	24.437	24.910	24.238
	S_2	0.7667	0.7700	0.7867	0.7800	25.987	26.593	27.587	25.319
					Mean N				
N*T	N_0	0.7322	0.7578	0.7478	0.7459	17.836	20.566	22.308	20.236
	N_1	0.7656	0.7678	0.7667	0.7667	21.819	20.504	22.401	21.575
	N_2	0.7711	0.7600	0.7744	0.7685	22.027	23.752	26.722	24.167
					Mean S				
T*S	S_0	0.7456	0.7533	0.7700	0.7530	19.473	20.702	21.506	20.803
	S_1	0.7567	0.7678	0.7611	0.7593	20.198	22.408	22.217	22.343
	S_2	0.7567	0.7567	0.7756	0.7689	22.739	23.919	24.773	22.832
		0.7563	0.7619	0.7630		20.560	21.607	23.810	

LSD 5%							
S	T	N	N*T	S	T	N	N*T
0.00504	0.00504	0.00504	0.00874	0.3375	0.3375	0.3375	0.5846
N*T*S	T*S	N*S		N*T*S	T*S	N*S	
0.01513	0.00874	0.00874		1.0126	0.5846	0.5846	

gave the highest average fruit diameter of (18.757 mm) (Table 4). Followed by treatment S_1, which in turn superior over the comparison treatment S_0, which gave the lowest values (17.453 mm). Then, the effect of the TDZ treatment T_2 was superior (18.642 mm), followed by treatment T_1, which in turn superior over the comparison treatment T_0, and recorded the lowest average fruit diameter of 17.585 mm. The N_2 recorded the highest average (18.779 mm), and then followed by treatment N_1, which in turn superior over the comparison treatment. N_0 and gave the lowest average (17.333 mm). The treatment N_2S_2 was superior and showed the highest interaction value (19.618 mm) and treatment N_0S_0 recorded the lowest value (16.568 mm). The treatment, N2T2, achieved the highest (19.097 mm), compared to the lowest percentage at the comparison treatment N_0T_0, (16.874 mm). The increase in the fruit's diameter as one of the fruit shape measures is due to the role of all study factors in improving the growth characteristics which were reflected in increasing the efficiency of photosynthesis and the dry matter accumulation and its transfer to the fruits, which led to an increase in the dimensions and size of fruits, including the fruit length and diameter. These results are consistent with the findings Hussien (2017) about studies on salicylic acid, and with Assad (2014) about studies on growth regulator Thidiazuron, and with Mostafa et al (2019) about marine algae extract, that there was a significant increase in fruit diameter as a result of treating with these substances.

Percentage of dry matter in fruits (%): The highest rate of increase in the percentage of dry matter in fruits was 21.53% in S_2(Table 4), followed by treatment S_1, which in turn did not differ significantly from the comparison treatment, which gave the lowest percentage (20.06%). The spray treatment with TDZ at the T_2 gave the highest significant increase (21.57%), followed by the treatment T_1, which in turn superior

Table 4. Effect of spraying with growth regulators of salicylic, TDZ, and marine algae extract with nanotechnology on the average fruit diameter and dry matter content in the fruits (%)

Factor N	Factor S	Fruit diameter (mm)				Dry matter in fruit (%)			
		Factor T			N*S	Factor T			N*S
		T0	T1	T2		T0	T1	T2	
N_0	S_0	16.150	16.930	17.543	16.568	16.50	18.50	20.11	19.12
	S_1	16.193	17.530	18.120	17.312	19.99	20.25	21.00	19.88
	S_2	17.360	17.477	18.693	18.119	20.86	20.90	20.95	20.69
N_1	S_0	17.607	18.630	18.243	17.583	19.99	20.30	20.25	20.13
	S_1	17.737	18.747	19.043	18.726	20.19	18.30	22.10	19.57
	S_2	17.407	18.800	18.320	18.536	20.20	20.10	21.50	21.28
N_2	S_0	17.277	17.833	18.050	18.207	19.99	21.25	21.20	20.95
	S_1	18.330	18.130	19.673	18.513	21.05	21.35	22.10	21.97
	S_2	19.013	19.577	21.130	19.618	21.80	23.30	24.55	22.62
					Mean N				
N*T	N_0	16.874	17.281	17.843	17.333	18.37	20.41	20.90	19.90
	N_1	18.160	18.509	18.176	18.281	20.18	20.20	20.60	20.33
	N_2	17.720	18.711	19.907	18.779	20.81	21.50	23.22	21.84
					Mean S				
T*S	S_0	17.011	17.798	17.946	17.453	18.83	20.02	20.52	20.06
	S_1	17.420	18.136	18.946	18.184	20.41	19.97	21.73	20.47
	S_2	17.927	18.618	19.381	18.757	20.95	21.43	22.33	21.53
		17.585	18.167	18.642		19.79	20.70	21.57	

LSD 5%							
S	T	N	N*T	S	T	N	N*T
0.2463	0.2463	0.2463	0.4266	0.84**	0.84**	0.84**	N.S
N*T*S	T*S	N*S		N*T*S	T*S	N*S	
N.S	N.S	0.4266		N.S	N.S	N.S	

over the comparison treatment, which gave the lowest percentage (19.79%). The treatment N_2 was superior by giving the highest significant percentage (21.84%). This was followed by the treatment N_1, which in turn superior over the comparison treatment N_0, which gave the lowest (19.90%). The results also showed that the bilateral and triple interactions were not significant in this trait. This result is due to the role played by salicylic acid, growth regulator TDZ, and marine algae extract with nanoparticles in improving growth characteristics and increasing the accumulation of some nutrients (NPK) (Table 2 and 3), which subsequently accumulated in the fruits leading to an increase in the length and diameter of the fruits (Table 3 and 4), which reflected in increasing the percentage of dry matter in the fruits. These results are consistent with the findings of Aati (2012) about studies on salicylic acid, that there was a significant increase in the dry matter content in fruits as a result of treating trees with these substances.

CONCLUSION

Salicylic acid, TDZ growth regulator, and marine algae extract had a positive role in improving the growth characteristics and chemical content of some major minerals, which was reflected in increasing the fruit size and dry weight. The convergent performance of these materials is due to their direct or indirect role in the biological and physiological activities of the plant and increase the absorption and accumulation of dry matter in the vegetative and fruiting part.

Received 02 December, 2021; Accepted 28 January, 2022

REFERENCES

Ahmed MM, Akl AA and Elbakry ME 2019. Effect of spraying seaweed extract on fruiting of sakkoti date palms. *Stem Cell* **10**(2):127-132.

Aly MA, Harhash MM, Abd El-Megeed NA and Abo-Qumer KNA 2017. Effect of girdling and sitofex (CPPU) on vegetative growth, fruit set, yield, and fruit quality of Le - conte pear trees. *International Journal of Advance Agricultural Research* (IJAAR) **22**(3): 566- 578.

AOAC 1980. *Official Methods of Analysis.* 13th ed. Association of Official Analytical Chemists. Washington, D.C.

Assad SA 2014. The influence of spraying sitofex, iron, manganese, and zinc on "Anna" apple trees planted on new reclaimed calcareous land. *Life Science Journal* **11**(1s): 1-8.

Ati MA, Abbas MF and AL-Barak SHR 2012. Effect of spraying salicylic acid on certain fruit characteristic of Hillawi date palm (*Phoenix dactylifera* L.). *Basra Journal of Date Palm Research* **11**(1):16-38.

El-Sayed EM 2018. Effect of spraying some micronutrients via normal versus nano technology on fruiting of Sakkoti. *Date Palms* **10**(10):39-43.

Faissal F, Ahmed MK and Abdelaal AEA 2018. Physiological studies on fertilization of superior grapevines by nano technology system. *World Rural Observations* **10**(4):1-9.

Hussien MA 2017. Productive performance of sewy date palms in relation to spraying spirulina platensis algae, plant compost tea, salicylic acid and tocopherol. *New York Science Journal* **10**(7): 126-135.

Mostafa EAM, Merwad MA, Ashour NE and Saleh MMS 2019. Effect of boron, zinc, and seaweed sprays on yield and fruit quality and of barhee date palms. *Plant Archives* **19**(4):393-397.