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Evaluating the effects of 2,4-D, naphthalene acetic acid and potassium nitrate on yield and fruit quality of date palm (*Phoenix dactylifera*) cv. Zahedi

Abdolhossein Aboutalebi*, Abdohossein Mohammadi

Department of Horticulture, Islamic Azad University, Jahrom Branch, Jahroom, Iran

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Abstract

In order to induce the increase fruit size and yield of Zahedi date palm in the Farrashband region in Fars province an experiment was conducted to evaluate the effects of 2,4-D, NAA and potassium nitrate. This experiment was performed as a factorial arrangement in a complete randomized block design with 4 replications. 36 Zahedi date palm trees were selected. 2,4-D (20, 30 and 40 mg/L), NAA (30, 60 and 90 mg/L) and potassium nitrate (1% and 2%) were applied on fruit brunches at the beginning of Kimiri stage (6 weeks after pollination) followed by another application 4 weeks later. Four trees were untreated and left as controls. The results showed that 2,4-D (40 mg/L) and NAA (30 and 60 mg/L) at stages significantly increased fruit length, diameter and weight compared with untreated ones. These treatments resulted fruit ripening delayed and significantly decreased TSS as compared with control. Generally, NAA (30 and 60 mg/L) increased fruit size and delayed fruit ripening for 4 to 5 weeks.

* **Corresponding Author:** Abdolhossein Aboutalebi ✉ ab_aboutalebi@yahoo.com

Introduction

Date palm is one of the major agricultural crops of the Near East region, where about 90% of the world dates production take place (Ahmed 1999; Abdllah *et al*, 2012). About 400 date palm varieties are grown in Iran, among these with good taste and sweetness is Zahedi. Date fruit size therefore producing will be the economical importance in the marketing of this cultivar. Applications of plant growth regulators and fertilizers have been used to increase fruit traits both quantitatively and qualitatively. For this purpose, auxins, cytokinins, gibberellins, ethylene and macro and micro nutrient elements have been used. These substances are being used for increasing is one of the limiting factors in marketing the fruits, since consumers prefer large fruits and the weight and volume of fruit clusters, fruits thinning, early ripening, color development, and also increasing the yield and delaying fruit ripening. There is a high level of auxin at the initial stage of date fruit set. This hormone causes cell division and cell elongation (Tafazoli, 1991). Shaples and Hilgman (1950) reported that using auxin types at Kimiri or at the beginning of Khalal stages, does not have any effects on growth and development and also on the maturity of date fruit. 2,4-D, 2,4,5-T, NAA and IAA are the different auxin types that have been used on date palms (Hameed *et al*, 2001; Omaima *et al*, 2014). There are many reports on fruit thinning by using synthetic auxins at pollination stage or 1-2 weeks later. Shafaat and Shaban (1980) explained that the application of Naphthalene acetic acid 15-16 weeks after pollination on Zahedi cultivar was increased both fruit size and volume, flesh/stone ratio and fruit moisture content but had no effect on TSS and delayed ripening time for one month. Shabana *et al.* (1976) reported that application of 50-200 mg/L NAA in the second period of Kimiri stage on Zahedi and Sayer date palm cultivars was increased both fruit size and weight and also improved other fruit quality traits. They also explained that an application of 50-100 mg/L NAA, 12-13 weeks after pollination (end of Kimiri stage) on Khaniezy date palm cultivar was increased fruit weight, size and volume, stone and flesh weight and delayed ripening time for 1-2 months. There are reports indicating that synthetic auxins increase fruit size without fruit thinning. Hassaballa *et al.* (1984) was reported that non-pollinated clusters of Zaghloul cultivar treated with 20 mg/L BA at opening time of spath and 100 mg/L 2,4-D in early June and July had higher weight and fewer TSS than pollinate clusters. Tafazoli (1991) reported that spraying macro and micro nutrient elements (N, B, K and Zn) on Shahani date fruit increased yield and fruit quality but had no effects on TSS. The highest yields were related to 1500 mg/L H_3BO_3. Zahedi date cultivar (Ghasb) is the major date palm trees in Farrashband region, Fars Province, Iran. In general there is a little study on date palm fruit growth and development and the small size of fruit is one of the problems in this date palm cultivar, the aim of this study was in producing even and early ripening of date fruit, larger fruit size and yield and also saving time and expenses.

Materials and methods

Properties of experiment and treatments

In order to induce an increase in both fruit size and yield of Zahedi date palm in the Farrashband region in Fars Province, an experiment was conducted as a factorial arrangement in a complete randomized block design with 4 replications. The first factor was application times (6 and 10 weeks after pollination) and the second factor was 2,4-D (20, 30 and 40 mg/L), NAA (30, 60 and 90 mg/L) and potassium nitrate (1% and 2%).

Plant materials and treatment operation

36 Zahedi date palm trees were selected. Treatments were applied to fruit branches at the beginning of the Kimiri stage (6 weeks after pollination) and 4 weeks later (a total of 10 weeks after pollination). Four trees were not treated and left as controls. In each tree, 3 clusters were selected for spray at the first stage and another 3 clusters for the second stage.

Evaluated traits and statistical analysis

Evaluated traits were: Number of ripened fruits, length, diameter and weight of fruit and stone, flesh weight, flesh/stone ratio, TSS, pH and yield. Data

analyzed by MSTATC software and means compared with Duncan's Multiple Range test (DMRT).

Results

Fruits treated with 90 mg/L NAA were double in size and had brown lines on them. These fruits cracked from the tip at early ripening stage and then fermented and dropped. Therefore, this concentration of NAA was omitted and the experiment was carried out with 8 treatments.

Fruit length

The average fruit length of the first application stage (6 weeks after pollination) was 3.2 cm which was less than the second stage (10 weeks after pollination) (3.29 cm). The difference was significant at 0.05 levels (Table 1). The largest fruit length was observed in trees that treated with 60 mg/L NAA (3.5 cm) and the shortest in those treated with 20 mg/L 2,4-D (3.1 cm). The difference between 40 mg/L 2,4-D and two levels of NAA used were not significant. The increase in the concentrations of all substances used did not significantly increased fruit length. Except 20 mg/L 2,4-D, the application of other treatments as compared with control increased fruit length (Table 2). The evaluation of interaction between two factors showed that the largest fruit length was in the trees that treated with 60 mg/L NAA at the second stage application (3.7 cm) and the smallest in those treated with 20 mg/L 2,4-D at both application stages (3.1 cm). In control trees no difference was found in treatments applied at both application times. Increase in 2,4-D concentration at both application stages and in NAA at the second application time increased fruit length. Increase in KNO_3 concentrations in both application times had no effect on fruit length (Table 3).

Table 1. Comparison the effect of application time on evaluated traits.

Application time traits	First stage (6 weeks after pollination)	Second stage (10 weeks after pollination)	Statistical level
Ripening percentage	82.20[a]	75.08[b]	1%
Fruit length (cm)	3.24[b]	3.29[a]	5%
Fruit diameter (cm)	1.90[a]	1.93[a]	5%
Fruit weight (g)	6.55[b]	6.81[a]	1%
Flesh weight (g)	5.82[b]	6.05[a]	1%
Flesh/stone ratio	7.71[b]	8.02[a]	1%
Stone weight (g)	0.76[a]	0.75[a]	5%
Stone length (cm)	2.06[a]	2.07[a]	5%
Stone diameter (cm)	0.75[a]	0.74[a]	5%
TSS (%)	70.00[b]	70.94[a]	5%
pH	5.76[a]	5.84[a]	5%
Yield (kg/cluster)	10.81[a]	10.90[a]	5%

Means exist in each row with same letter have not significant different together in related statistical level of DMRT.

Fruit diameter

The average fruit diameter of the second application stage (1.93 cm) was more than the first stage application (1.9 cm) but the differences were not significant (Table 1). The highest fruit diameter was observed at 60 mg/L NAA and 40 mg/L 2,4-D (1.98 cm) treatments and the lowest in control (1.8 cm). Increase in concentrations of NAA and KNO_3 did not significantly increase fruit diameter. In 2,4-D treatments, this trait at first was decreased and then increased (Table 2). The comparison of interaction between two factors showed that the average largest fruit diameter was at 60 mg/L NAA at the second stage application (2.1 cm) and the lowest in control (1.8 cm). Increase in 2,4-D concentrations at both application stages at first decreased and then increased fruit diameter. In NAA treatments, this trait decreased at the first application stage and increased at the second application stage. In case of KNO_3 in both application times the fruit diameter increased (Table 3).

Table 2. Comparison the effect of treatments on evaluated traits.

Treatment / Traits	Control	KNO_3		NAA (mg/l)		2,4-D (mg/l)		
		2%	1%	60	30	40	30	20
Ripening percentage	65.4^{f}	75.7^{e}	75.5^{e}	58.8^{g}	83.2^{d}	87.8^{c}	89.2^{b}	93.5^{a}
Fruit length (cm)	3.15^{b}	3.21^{b}	3.20^{b}	3.50^{a}	3.40^{a}	3.40^{a}	3.16^{b}	3.10^{b}
Fruit diameter (cm)	1.80^{c}	1.94^{ab}	1.89^{ab}	1.98^{a}	1.93^{ab}	1.98^{a}	1.87^{bc}	1.93^{ab}
Fruit weight (g)	5.64^{e}	6.48^{c}	6.48^{c}	8.30^{a}	7.12^{b}	7.09^{b}	6.22^{cd}	6.13^{d}
Flesh weight (g)	4.95^{e}	5.73^{c}	5.75^{c}	7.46^{a}	6.43^{b}	6.32^{b}	5.49^{cd}	5.34^{d}
Flesh/stone ratio	7.07^{f}	7.56^{e}	8.10^{c}	9.02^{a}	8.14^{c}	8.44^{b}	7.76^{d}	6.84^{g}
Stone weight (g)	0.70^{e}	0.76^{cd}	0.71^{e}	0.83^{a}	0.79^{b}	0.75^{d}	0.71^{e}	0.78^{bc}
Stone length (cm)	2.00^{d}	2.08^{bc}	2.00^{d}	2.12^{ab}	2.16^{a}	2.12^{ab}	2.00^{d}	2.03^{cd}
Stone diameter (cm)	0.74^{bc}	0.75^{bc}	0.75^{bc}	0.77^{ab}	0.72^{c}	0.73^{c}	0.74^{bc}	0.79^{a}
TSS (%)	77.5^{a}	62.5^{d}	70.0^{bc}	68.8^{c}	71.2^{bc}	71.2^{bc}	72.5^{b}	70.0^{bc}
pH	5.65^{c}	5.78^{ab}	5.76^{b}	5.72^{bc}	5.70^{bc}	5.76^{b}	5.74^{bc}	5.86^{a}
Yield (kg/cluster)	9.46^{b}	10.54^{ab}	10.62^{ab}	11.75^{ab}	10.81^{ab}	9.86^{b}	12.99^{a}	10.83^{ab}

Means exist in each row with same letter have not significant different together in related statistical level of DMRT.

Fruit weight

The average fruit weight of the second application stage (6.81 g) was higher than the first stage (6.55 g). The difference was significant at 0.01 level (Table 1). The highest fruit weight was observed in 60 mg/L NAA (8.3 g) and the lowest in control (5.64 g). The differences between control and all other treatments were significant. As a result, their applications as compared with control increased fruit weight significantly. Increase in 2,4-D and NAA concentrations increased fruit weight. However, KNO_3 treatments did not have any effects on fruit weight (Table 2). The evaluation of interaction between two factors showed that the highest fruit weight was on 60 mg/L NAA at the second application stage (9 g) and the least was in control (5.64 g). Except of 20mg/L 2,4-D treatment at the second application stage, all treatments at both application stages had significant differences. Application of NAA and 2,4-D at both application stages increased fruit weight. This trend in KNO_3 at the first application stage increased and decreased at the second stage (Table 3).

Table 3. Comparison the effect of interaction between application time and treatment on evaluated traits.

Trait time×treatment		Ripening percentage	Fruit length	Fruit diameter	Fruit weight	Flesh weight	Flesh/stone ratio
6 weeks after pollination	2,4-D 20	92.0^{bc}	3.10^{c}	1.92^{bcd}	6.22^{efg}	5.42^{hi}	6.95^{hi}
	2,4-D 30	93.0^{b}	3.12^{c}	1.90^{bcd}	6.30^{efg}	5.54^{ghi}	7.29^{g}
	2,4-D 40	91.0^{c}	3.40^{b}	1.95^{bc}	7.04^{cd}	6.25^{de}	8.01^{de}
	NAA 30	90.5^{c}	3.40^{b}	1.90^{bcd}	6.68^{cde}	6.12^{def}	8.05^{de}
	NAA 60	80.8^{e}	3.30^{bc}	1.85^{cd}	7.60^{b}	6.86^{b}	9.27^{a}
	KNO_3 1%	76.0^{f}	3.20^{bc}	1.90^{bcd}	6.35^{efg}	5.60^{ghi}	7.78^{f}
	KNO_3 2%	68.8^{g}	3.22^{bc}	1.99^{ab}	6.60^{def}	5.80^{fgh}	7.25^{g}
	Control	65.4^{h}	3.15^{c}	1.80^{d}	5.64^{h}	4.95^{j}	7.07^{gh}
10 weeks after pollination	2,4-D 20	95.0^{a}	3.10^{c}	1.94^{bc}	6.04^{gh}	5.26^{ij}	6.74^{i}
	2,4-D 30	85.3^{d}	3.20^{bc}	1.84^{cd}	6.15^{fg}	5.44^{ghi}	8.24^{cd}
	2,4-D 40	84.6^{d}	3.40^{b}	2.00^{ab}	7.14^{bc}	6.38^{cd}	8.86^{b}
	NAA 30	76.0^{f}	3.40^{b}	1.96^{bc}	7.56^{b}	6.74^{bc}	8.22^{cd}
	NAA 60	36.7^{i}	3.70^{a}	2.10^{a}	9.00^{a}	8.06^{a}	8.76^{b}
	KNO_3 1%	75.0^{f}	3.20^{bc}	1.88^{bcd}	6.60^{def}	5.90^{efg}	8.43^{c}
	KNO_3 2%	82.6^{e}	3.20^{bc}	1.90^{bcd}	6.36^{efg}	5.66^{ghi}	7.86^{ef}
	Control	65.4^{h}	3.15^{c}	1.80^{d}	5.64^{h}	4.95^{j}	7.07^{gh}

Means exist in each column with same letter have not significant different together in 1% level of DMRT.

Flesh weight

Flesh weight (6.05 g) in the second application stage was higher than the first stage (5.82 g) and the difference was significant at 0.01 level (Table 1). The highest flesh weight was observed in 60 mg/L NAA (7.46 g) and the lowest in control (4.95 g). The differences between all treatments and control were statistically significant ($\alpha \leq 0.01$). In fact, utilization of these substances significantly increased flesh weight. Flesh weight increased with increase 2,4-D and NAA concentrations. However, increase KNO_3 concentration, the flesh weight remained unchanged (Table 2). Comparison of interaction between two factors showed that the highest flesh weight was on 60 mg/L NAA at the second stage application (8.06 g) and the lowest was in control (4.95 g). Except of 20 mg/L 2,4-D at the second application stage, the amount of flesh weight in all treatments at both application stages were significantly different from control. Increase in NAA and 2,4-D concentrations at both application stages increased flesh weight. However, in KNO_3 treatments, the flesh weight increased at the first application stage and decreased at the second application stage (Table 3).

Continuation of Table 3. Comparison the effect of interaction between application time and treatment on evaluated traits.

Trait time×treatment		Stone weight	Stone length	Stone diameter	TSS	pH	Yield
6 weeks after pollination	2,4-D 20	0.78^{bcd}	2.04^{de}	0.80^{a}	72.5^{bc}	6.00^{a}	11.37^{ab}
	2,4-D 30	0.76^{cde}	2.00^{e}	0.74^{bc}	72.5^{bc}	5.74^{cde}	13.55^{a}
	2,4-D 40	0.78^{bcd}	2.10^{bcde}	0.74^{bc}	70.0^{cd}	5.85^{bc}	9.65^{ab}
	NAA 30	0.76^{cde}	2.10^{bcde}	0.74^{bc}	72.5^{bc}	5.70^{de}	10.20^{ab}
	NAA 60	0.74^{def}	2.05^{cde}	0.74^{bc}	75.0^{ab}	5.73^{cde}	11.09^{ab}
	KNO_3 1%	0.72^{ef}	2.00^{e}	0.75^{abc}	62.5^{e}	5.70^{de}	10.69^{ab}
	KNO_3 2%	0.80^{bc}	2.16^{abc}	0.78^{ab}	57.5^{f}	5.69^{de}	10.50^{ab}
	Control	0.70^{fg}	2.00^{e}	0.74^{bc}	77.5^{a}	5.65^{e}	9.46^{b}
10 weeks after pollination	2,4-D 20	0.78^{bcd}	2.02^{e}	0.78^{ab}	67.5^{d}	5.73^{cde}	10.30^{ab}
	2,4-D 30	0.66^{g}	2.00^{e}	0.74^{bc}	72.5^{bc}	5.74^{cde}	12.43^{ab}
	2,4-D 40	0.72^{ef}	2.14^{abcd}	0.72^{c}	72.5^{bc}	5.68^{de}	10.07^{ab}
	NAA 30	0.82^{b}	2.22^{a}	0.70^{c}	70.0^{cd}	5.70^{de}	11.42^{ab}
	NAA 60	0.92^{a}	2.20^{ab}	0.80^{a}	62.5^{e}	5.72^{cde}	12.42^{ab}
	KNO_3 1%	0.70^{fg}	2.00^{e}	0.75^{abc}	77.5^{a}	5.81^{bcd}	10.54^{ab}
	KNO_3 2%	0.72^{ef}	2.00^{e}	0.72^{c}	67.5^{d}	5.87^{b}	10.58^{ab}
	Control	0.70^{fg}	2.00^{e}	0.74^{bc}	77.5^{a}	5.65^{e}	9.46^{b}

Means exist in each column with same letter have not significant different together in 1% level of DMRT.

Flesh/stone ratio

Flesh/stone ratio at the second application stage (8.02) was higher than the first stage (7.71). The differences were significant ($\alpha \leq 0.01$) (Table 1). The highest flesh/stone ratio was observed in60 mg/L NAA (9.02) and the lowest at 20 mg/l 2,4-D (6.84) treatments. The differences between all treatments and control were significant. Increase in NAA and KNO_3 concentrations was increased flesh/stone ratio (Table 2). The results of interactions between two factors indicated that the highest flesh/stone ratio was obtained in the treatment containing 60 mg/L NAA applied at the first stage (9.27) and the lowest was in 20 mg/L 2,4-D applied in both application stages (6.95 and 6.74 respectively). Increase in flesh/stone ratio corresponded with the increase in 2,4-D and NAA concentrations. This trend for KNO_3 treatments was reversed (Table 3).

Stone weight

Stone weight at the first application stage (0.76 g) was more than the second stage (0.75 g) but the differences were no significant (Table 1). The highest stone weight was found in treatments containing 60 mg/L NAA (0.83 g) and the lowest was in control (0.70 g). The differences observed between the results

obtained from either 30 mg/L 2,4-D or 1% KNO_3 treatments and control were not significant. Stone weight significantly decreased with an increase in 2,4-D concentrations and increased with the increase in NAA and KNO_3 concentrations (Table 2). The results of interaction between two factors demonstrated that the highest stone weight was observed at 60 mg/L NAA at the second application stage (0.92 g) and the lowest in 30 mg/L 2,4-D at the second application stage (0.66 g). Stone weight at the first application stage did not change with the increase in 2,4-D concentrations but increased at the second stage application. However, in NAA treatments, stone weight decreased at the first stage application but increased at the second stage application. Stone weight at both application stages increased with increased in KNO_3 concentration (Table 3).

Stone length

Stone length on the second stage application (2.07 cm) was more than the first stage application (2.06 cm) but the differences were not significant (Table 1). The highest stone length was observed in treatments containing 30 mg/L NAA (2.16 cm) and the lowest were in control, 30 mg/L 2,4-D and 1% KNO_3 (2.00 cm). The differences between 20 and 30 mg/L 2,4-D, 1% KNO_3 and control were no significant. The increase in the concentrations of these chemicals did not affect the stone length distinctly (Table 2). The interaction between two factors showed that the highest stone length was observed in treatments containing 30 mg/L NAA at the second stage application (2.22 cm) and the lowest were in control, 30 mg/L 2,4-D and 1% KNO_3 at both application stages and in 2% KNO_3 at the second stage application (2.00 cm). Stone length increased with an increase in 2,4-D concentration at both application stages. In the case of NAA treatments, this parameter did not decrease significantly. With regard to KNO_3 treatments, stone length increased at the first stage and did not change at the second stage (Table 3).

Stone diameter

There was not significant difference between two application stages (Table 1). The highest stone diameter was found in treatments containing 20 mg/L 2,4-D (0.79 cm) and the lowest was in both 40 mg/L 2,4-D (0.73 cm) and 30 mg/L NAA (0.72 cm). In this case, only the differences between 20 mg/L 2,4-D and control were significant. The increase in 2, 4-D concentration decreased stone diameter and the increase in NAA concentration, increased the stone diameter. Increase in KNO_3 concentration had not effect on stone diameter (Table 2). The interaction between the two factors indicated that the highest stone diameter was in treatments containing 20 mg/L 2,4-D at the first stage application and those containing 60 mg/L NAA at the second stage application (0.80 cm) and the lowest was in treatments containing 40 mg/L 2,4-D (0.72 cm), 30 mg/L and NAA (0.70 cm) and 2% KNO_3 (0.72 cm) at the second application stage. In this case, 20 mg/L 2,4-D at the first stage application and 60 mg/L NAA at the second stage application showed significant differences with the control. Stone diameter reduced with the increase in 2,4-D concentration at both application stages. In the case of NAA at the first application stage, the stone diameter did not change and was increased at the second stage application. In case of KNO_3, it was increased at the first stage application and decreased at the second stage (Table 3).

TSS

TSS at the second stage application (70.94 %) was more than the first stage (70.00 %) and the differences between two application stages were significant at 0.05 levels (Table 1). The highest TSS was observed in control (77.50%) and the lowest was at 2% KNO3 treatment (62.50%). The differences between all treatments and control were significant. In fact, utilization of these materials reduced TSS significantly. Increase in 2,4-D concentration at first increased TSS and then decreased it. Treatments containing NAA and KNO_3 reduced TSS (Table 2). Comparison of the interaction between the two factors showed that the highest TSS was in both control and 1% KNO_3 at the second stage application (77.50 %) and the lowest was at 2% KNO_3 (0.72 cm)

at first stage application (57.50 %). TSS reduced with the increase 2,4-D concentration at the first stage application and raised the second stage application. In the case of NAA, TSS increased at the first stage application and decreased in the second. However, KNO_3 treatments decreased the TSS at both stage applications (Table 3).

pH

Fruit flesh pH at the first stage application (5.76) was more than the second stage (5.74) but the differences were no significant (Table 1). The highest pH was in treatments containing 20 mg/L 2,4-D (5.86) and the lowest was in control (5.65). Increase in 2,4-D concentrations reduced pH. NAA and KNO_3 treatments did not increase significantly fruit flesh pH (Table 2). The interaction between the two factors showed that the highest pH was at 20 mg/L 2,4-D treatments at the first stage application (6.00) and the lowest in control (5.65). The pH reduced with the increase 2,4-D concentration at both application stages, but in the case of NAA treatments it was increased. In KNO_3 treatments, the pH did not change at the first stage application but increased at the second stage in the first (Table 3).

Yield

Yield in the second stage application (10.9 kg/cluster) was more than the first stage (10.81 kg/cluster) but the differences were no significant (Table 1). The highest yield was in treatment containing 30 mg/L 2,4-D (12.99 kg/cluster) and the lowest was in control (9.46 kg/cluster). The increase in the concentrations of used substances did not affect the amount of yield distinctly (Table 2). Interaction between the two factors showed that the highest yield was in 30 mg/l 2,4-D treatment at the first stage application (13.55 kg/cluster) and the lowest in control (9.46 kg/cluster). There was only significant difference between 30 mg/L 2,4-D treatment at the first stage application and control (Table 3).

Ripening percentage

Ripening percent of the first stage application (6 weeks after pollination) (82.20 %) was longer than the second stage (10 weeks after pollination) (75.08 %) and there was a significant difference between the two stages at 0.01 levels (Table 1). The highest ripening percentage was in treatments containing 20 mg/L 2,4-D (93.50 %) and the lowest was in 60 mg/L NAA (58.80 %). In this regard, there was not significant difference between 1% and 2% KNO_3 but in other treatments the differences were significant. Increase in 2,4-D and NAA concentrations reduced ripening percentage. However, ripening percentage increased by all treatments in this study as compared to control (Table 2). Interaction between the two factors showed that the highest ripening percentage was on 20 mg/L 2,4-D treatments at the second stage application (95.00 %) and the lowest was at 2% KNO_3 at the second stage (36.70 %). The differences between the control and other treatments were significant at both application stages. In all cases (except 1% KNO_3) there was a significant difference between treatments in both application stages. However, the increase in concentrations of the used substances did not have a distinct effect on ripening percentage and in fact the increase in KNO_3 concentrations at the first stage application reduced ripening percentage and was increased at the second stage (Table 3).

Discussion

Today the application of plant growth regulators has a very important in the control and improvement of both fruit quality and quantity such as fruit set, size, shape and maturity in agriculture. Moreover, growers can accelerate or delay the maturity, attract maximum demand for market and avoid unfavorable environmental conditions and expand the marketing period. Reactions of fruits to plant growth regulators (PGRs) are dependent on application time, concentration of PGRs, situation of fruits in clusters and cultivar. In our study utilization of 20 and 30 mg/L 2,4-D increased the fruit length and diameter, the flesh weight and finally increased clusters weight. Also the fruit length, diameter and weight and cluster weight increased and had significant differences with control plant, but ripening stage reduced to increase in concentrations of used substances. Application of

30, 60 and 90 mg/L NAA increased fruit length, diameter and weight, flesh and cluster weight and late ripening so that in 90 mg/L NAA fruit size increased very much and the fruits at early ripening stage cracked from tip and dropped. These results are similar to findings of other researchers such as Shanaba *et al* (1976). Maximum fruit size and weight was obtained in treatments containing 60 mg/L NAA. Some investigations have shown that auxins are used for improvement of fruit characteristics in the second stage of Kimiri that are named 'Depressed time'. Application of NAA increased fruit size caused by increasing carbohydrate absorption, cell development and elongation. Probably, auxin treatments by increasing cell wall elasticity are able to enhance the cell elongation and development (Harhash and Al-Obeed, 2005). A role of PGRs in increasing fruit size and weight is caused by increasing both the cell division and cell elongation. In many cases, these factors together affect fruit size. There are two factors affecting cell elongation: one increase in cell wall elasticity that probably is stimulated by auxins and the other increase in cell potassium content needed as an osmoticum for water absorption. Utilization of 1% and 2% KNO_3 increased ripening percent as compared with control. Also by increasing KNO_3 concentration from 1% to 2%, the length and the diameter of stones increased (Tafazoli, 1991).

Whereas PGRs and chemical materials are used for improvement of date fruit quantity and quality and fruits have a reaction to application time and concentration. Therefore, we suggest more studies be done on the effects of different concentrations these substances on Zahedi and other varieties. For increasing the fruit size and yield the following recommendations should be made to growers: 1) Use proper pollen for pollination, 2) Pollinate on time, 3) Thinning of cluster to increase the tree vigor, 4) Encourage trees to grow stronger by applying suitable nutrients and other horticultural practices.

References

Abdollah Doaigey R, Al-Whaibi MH, Siddiqui MH, Al sahli AA, El-Zaidy ME. 2012. Effect of GA_3 and 2,4-D foliar application on the anatomy of date palm (*Foenix dactylifera* L.) seedling leaf. Saudi Journal of Biology Science **20(2),** 141-147. http://dx.doi.org/10.1016/j.sjbs.2012.12.001

Ahmed AA. 1999. Date palm post harvest processing technology in Libia. Regional Workshop on Date Palm Postharvest Processing Technology, Iran.

Hameed Aljubury J, Hasan Al-Masry H, Saeed Al-Muhanna A. 2001. Effect of some growth regulators on some fruit characteristics and productivity of the Barhee date palm tree cultivar (*Foenix dactylifera* L.). Fruits **56(5),** 325-332. http://dx.doi.org/10.1051/Fruits.2001.133.

Harhash MM, Al-Obeed RS. 2005. Effect of Naphthalene acetic acid on yield and fruit quality of Barhee and Shal date palm cultivars. Date Growers Industrial Report **41,** 17-18.

Hassaballa IA, Yossef EY, Ibrahim MA, Khlifa SE. 1984. Effect of some growth regulators on yield and physical characteristics of Zaghloul date fruits. Annals Agriculture Science, Moshtohor **20,** 316-332.

Shabana HR, Javad KS, Benjamin ND, Al-Ani BA. 1976. Physio-chemical changes during different stages of ripening and determination of the depressed period of development in date fruit. I. Physical changes in Zahedi and Sayer cultivars. Baghdad Palm & Date Reaserch Center Technical Bultin **1,** 1974.

Shafaat M, Shabana HR. 1980. Effect of Naphthalene acetic acid on fruit size, quality and ripening of "Zahedi'" date palm. Horticultural Science **15(6),** 724-725.

Sharples GC, Hilgman RH. 1950. Progress report: Effects of hormones spray application upon the development and ripening of date fruit. Date Growers Industrial Report **24,** 14-16.

Omaima Hafez M, Malaka Saleh A, Mostafa EAM, El-Shamma MS, Maksoud MA. 2014.

Improving pollination efficiency, yield and fruit quality of two date palm cultivars using growth activator. International journal of Agricultural research **9(1),** 29-37.

http://dx.doi.org/10.3923/ijar.2014.29.37

Tafazoli E. 1991. Effect of growth regulators on Shahani date in relation to producing seedless fruits. Tropical Science **31,** 171-176.