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EFFECT OF NAPHTHALENE ACETIC ACID ON YIELD AND FRUIT QUALITY OF BARHEE AND SHAHL DATE PALM CULTIVARS

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Abstract: Effect of different concentrations of Naphthalene Acetic Acid (NAA) on Barhee and Shahl date palm cultivars was studied on the bunch weight and both physical and chemical properties during two successive seasons 2005 and 2006. NAA (0, 50, 100, 150 and 200 ppm) applications were sprayed on fruits of Barhee and Shahl cvs. 10 weeks after fruit set at depressed period. Results showed that NAA treatments significantly increased bunch weight, improved physical properties (fruit weight, height, diameter, and size and flesh weight percentage) and also increased the moisture percent of the fruit flesh of both Barhee and Shahl cvs. compared with untreated bunches. However, TSS, total and reducing sugars were decreased significantly by NAA treatments in fruit juice compared with the control in both seasons. Seed weight per fruit, acidity percentage and non-reducing sugars of both cultivars were not affected significantly by NAA treatments in both seasons.

Results of this work suggest that 150-ppm NAA application could be used to increase the yield and improve fruit quality of Barhee and Shahl date palm cultivars.

Key words: NAA, Fruit quality, Barhee, Shahl, Date palm *Phoenix dactylifera*

Introduction

Date palm (*Phoenix dactylifera* L.) is one of the most cultivated horticultural crops in the Saudi Arabia. The estimated number of cultivated date palm trees in the country was about 22.626 million producing 970,488 tons of fruit per year (Agric .Stat. Year Book, 2006). Small fruit size is one of the limiting factors in fruit marketing of many species such as date palm (Botes and Zaid, 1999), apple (Stern *et al.*, 2006), peach (Agusti et al., 1999), cherry (Whiting and Ophardt, 2005), citrus (Agusti *et al.*, 1995) and loquat (Agusti *et al.*, 2003). Consumers also prefer large fruits, making this a very important marketing consideration and the economic benefits from treatments capable of improving average fruit size are potentially very high.

Several techniques were used to improve fruit size of date palm; such as hand bloom and fruit thinning (Harhash, 2000; Al-Obeed *et al.*, 2004, Al-Obeed *et al.*, 2005a,b and Tavakkoli *et al.*, 2006). However, the cost of hand thinning and the low potential for chemical bloom or fruitlet thinning allow using that technique.

Synthetic auxins are effective on enhancing fruit growth (Faust, 1989 and Westwood, 1993). These auxins are known by their ability to increase the cell size (Arteca, 1996; Westwood, 1993 and Davis, 2004), which enhance fruit growth in several fruit species such as citrus (Agusti *et al.*, 1995), peach (Agusti *et al.*, 1999), loquat (Agusti *et al.*, 2003) and date palm (Shabana *et al.*, 1998; Aljuburi *et al.*, 2001a, b and 2003). The most studies mentioned that a synthetic auxin is effective in increasing fruit size without thinning.

Chemri is immature green colored stage of dates, which could differentiate in sub-stages. The first sub-stage is characterized by rapid increase in fruit size and weight, while fruit weight rate decreased in the second sub-stage "Depressed period" in comparison to the first sub stage (Shabana *et al.*, 1974). Application of naphthalene acetic acid (NAA) between 50 to 200 ppm concentrations during the depressed period of fruit growth caused an increase in fruit size and weight and improved fruit quality in Zahdi &Sayer cvs. (Shabana *et al.*, 1976); in Khenazi cv.(Shabana et al., 1998 and Aljuburi *et al.*, 2001b), in Barhee cv. (Aljuburi et al., 2001a) and in Khadrawy cv. (Aljuburi *et al.*, 2003) and Shahani cv. (Aboutalebi and Beharoznam, 2006).

The aim of this work was to study the improvement possibility of fruit quality in Barhee and Shahl date palm cultivars by treatments with naphthalene acetic acid (NAA) after fruit set.

2. Materials and methods

An experiment was carried out during two successive growing seasons of 2005 and 2006. Five selected female uniform date palmsw (*Phoenix dactylifera* L.) of Barhee and Shahl cultivars, grown in the Agricultural Experimental and Research Station (Deyrab), Faculty of Food and Agricultural Sciences – King Saud University, Riyadh were used. The trees are grown in sandy soil at 10 m apart. All palms were at similar age (15 years old), uniform in growth and subjected to the same management and cultural practices. The tree bunches were pollinated from one male tree by placing 10 fresh male strands on female flower clusters center in both seasons. After the complete fruit set, the number of bunches was adjusted to 10 bunches per tree for both cultivars. The leaf bunch ratio was maintained at 9: 1. Naphthaleene acetic acid treatments were arranged in a completely

randomized block design and each treatment was replicated ten times. For each treatment, two bunches per tree were used. The treatments were as follows: Control (water) and 50, 100, 150 and 200 ppm Naphthaleene acetic acid (NAA). Bunches at late chemri stage, which physiologically known as a depressed period, were sprayed once 10 weeks after pollination. Spraying was done in early morning with a plastic hand sprayer for each of the abovementioned treatments. A non-ionic wetting agent (Tween 20 surfactant) at 0.01% was added to all treatments. Control bunches were sprayed with distilled water and tween 20. Bunches were isolated against contamination during spraying by polyethylene bags.

At the end of Bisir stage (maturity stage), bunch weight was recorded and 50 fruits per bunch were randomly collected and immediately transported to the Fruit Laboratory of the College of Food and Agricultural Sciences for quality measurements. Fruit and seed weight (g), size (cm^3), height and diameter (cm) were recorded. The moisture percentage was determined in fruit flesh. The percentage of total soluble solids (TSS) was determined in fruit juice using BRX-242 digital refractometer. Titratable acidity was determined in juice by titrating with 0.1 N sodium hydroxide in the presence of phenolphthalein as an indicator and results were expressed as a percentage of maleic acid (A.O.A.C., 1985). Reducing, non – reducing and total sugars were determined according to A.O.A.C. (1985). Statistical analysis was performed with SAS software (SAS Institute, 1988).

Results and discussion

1- Bunch weight

Bunch weight of Barhee and Shahl date palm cvs. as affected by NAA treatments during 2005 and 2006 seasons is illustrated in Tables (1&2). Results indicated that NAA application significantly increased the bunch weight of both cultivars as compared with untreated control in both seasons. The highest bunch weight values were obtained with NAA at 150 and 200-ppm of Barhee and Shahl cvs. treatments in both seasons. Treatments of 150 and 200 pmm of NAA were not significantly different in their effects on the bunch weight. The increment in bunch weight may be attributed to the increase in fruit weight (Tables 1&2).These results are in agreement with those obtained by Shabana et al., 1976; Shabana et al., 1998, Aljuburi et al., 2001a&b, Aljuburi et al., 2003, Aboutalebi and Beharoznam, 2006) on several date palm cultivars.

2- Fruit physical properties:

Data presented in Tables (1&2) show that NAA treatments significantly increased the average of Barhee and Shahl cvs. fruit

weight over control in 2005 and 2006 seasons. These increases in fruit weight of Barhee cv. over the control were 13.14, 19.42, 27.91 and 26.96 % in the first season for 50, 100, 150, 200 ppm NAA treatments, respectively. The corresponding values for the second season were 13.43, 20.70, 27.47 and 25.80% respectively. Whereas the increment percentages in fruit weight of Shahl cv. over control were 13.87, 14.55, 39.08 and 31.72% in the first season for 50, 100, 150, 200 ppm NAA treatments, respectively. The corresponding values for the second season were 20.13, 35.46, 49.82 and 37.19% respectively. The highest fruit weight values were obtained with NAA at 150 and 200 ppm treatments for Barhee cv. and 150 ppm treatment for Shahl cv.

Naphthaleene acetic acid treatments significantly increased the fruit size of Barhee and Shahl cvs. compared to the control during 2005 and 2006 seasons (Tables 1&2). The trend was found to be the same as in fruit weight. Maximum increase in fruit size was obtained at concentration of 150 and 200 ppm NAA treatments of Barhee cv. and 150 ppm treatment of Shahl cv.

Significant increases in fruit height of Barhee and Shahl cvs. were recorded in all NAA treatments as compared to untreated control in both seasons (Tables 1&2). These increases were higher when 150 and 200 ppm of NAA treatments. A similar trend was noted with fruit diameter in both cultivars and seasons.

Regarding the seed weight per fruit of Barhee and Shahl cvs. itwas not significantly affected by NAA treatments during both seasons (Tables 1&2).

Values of flesh weight percentage of Barhee and Shahl cvs. followed a similar trend that seen in fruit weight in both seasons (Tables 1&2). It means that, NAA at 150 ppm significantly increased the flesh weight per fruit as compared with the control.

Results also indicated that the synthetic growth regulator NAA might be used for improvement of various important fruit characteristics, when the fruits treated at depressed period of growth. Application of NAA increased fruit size, due to the enhanced strength of the sink for carbohydrate (Stern et al., 2000).The increase in cell size following auxin application possibly indicates its ability to mobilize carbohydrate uptake and thus enlarge the cells considerably. Another possibility is that the auxins increase the elasticity of the cell wall, thereby enabling its enlargement (Arteca, 1996). As a result of cell enlargement the rate of fruit growth, eventually leading to an increased yield of large fruit. Our results emphasized the previous findings since the treatment of 150 ppm NAA applied to the Barhee and

Shahl cvs. significantly increased the yield of large fruit . These results are in harmony with the findings of many workers for several date cultivars (Shabana *et al.*, 1976; Shabana et al., 1998, Aljuburi et al., 2001a&b, Aljuburi et al., 2003, Aboutalebi and Beharoznam, 2006). They found that NAA increased date fruit growth and improved fruit physical properties. The same phenomenon was recently reported by Stern et al., (2007) in plum. They found that NAA stimulate cell enlargement in the fruit mesocarp, which in turn, caused improvement in fruit size and total yield.

Table(1): Effect of NAA application on bunch weight and fruit physical characteristics of Barhee and Shahl date palm cultivars during 2005 season.

Treatments	Bunch weight and fruit physical characteristics						
	Bunch weight (Kg)	Fruit weight (g)	Fruit Size (cm3)	Fruit height (mm)	Fruit diameter (mm)	Seed weight (g)	Flesh weight (%)
Barhee cv.							
Control	12.43	8.60	8.54	30.43	22.44	1.03	88.02
50 ppm NAA	13.87	9.73	9.70	31.80	23.92	1.12	88.49
100 ppm NAA	15.50	10.27	11.20	32.12	23.21	1.12	89.10
150 ppm NAA	17.70	11.00	11.90	33.45	24.67	1.02	90.73
200 ppm NAA	17.57	10.92	12.05	33.33	24.86	1.07	90.20
$LSD_{0.05}$	1.23	0.45	0.64	1.19	1.12	N.S	0.96
Shahl cv.							
Control	8.00	10.31	10.62	30.24	23.98	0.99	90.40
50 ppm NAA	10.63	11.74	12.08	34.30	24.29	0.94	91.99
100 ppm NAA	13.71	11.81	12.53	34.95	25.30	1.01	91.45
150 ppm NAA	16.50	14.34	15.76	37.33	25.74	0.96	93.31
200 ppm NAA	16.10	13.58	14.70	37.37	26.50	0.95	93.00
$LSD_{0.05}$	1.63	0.61	0.78	1.24	0.80	N.S	0.86

Table(2): Effect of NAA application on bunch weight and fruit physical characteristics of Barhee and Shahl date palm cultivars during 2005 season.

Treatments	Bunch weight and fruit physical characteristics						
	Bunch weight (Kg	Fruit weight (g)	Fruit Size (cm3)	Fruit height (mm)	Fruit diameter (mm)	Seed weight (g)	Flesh weight (%)
Barhee cv.							
Control	13.15	9.90	9.63	29.68	23.33	1.08	89.10
50 ppm NAA	14.55	11.23	12.04	31.96	24.02	1.10	90.20
100 ppm NAA	16.25	11.95	11.75	32.26	24.38	1.09	90.88
150 ppm NAA	18.12	12.62	13.20	33.40	25.56	1.09	91.36
200 ppm NAA	17.80	12.46	12.88	34.30	25.12	1.08	91.33
$LSD_{0.05}$	1.42	0.55	0.96	1.31	1.08	N.S	0.99
Shahl cv.							
Control	7.86	11.08	11.74	33.34	24.92	1.00	90.97
50 ppm NAA	10.45	13.31	13.54	35.84	26.76	1.03	92.26
100 ppm NAA	12.97	15.01	15.04	37.03	28.77	1.08	92.80
150 ppm NAA	16.61	16.60	17.84	38.63	28.48	1.12	93.25
200 ppm NAA	16.15	15.20	16.42	37.83	27.29	1.03	93.22
$LSD_{0.05}$	1.72	0.83	1.29	1.42	1.04	N.S	1.17

3- Fruit chemical properties:

It is obvious from Tables (3&4) that the moisture percentage in the fruit flesh of Barhee and Shahl cvs. was significantly affected by NAA treatments in both seasons. The untreated control gave the lowest percentage of moisture percentage compared to NAA treatments of Barhee and Shahl cvs. in both seasons

Results shown in Tables (3&4) illustrate that the total soluble solids (TSS) in fruit juice of Barhee and Shahl cvs. were significantly decreased by NAA treatments in both seasons (Tables 3&4). Naphthaleene acetic acid at 150 and 200 ppm treatments decreased TSS in fruit juice of Barhee and Shahl cvs. as compared to the control in both seasons.

The acidity percentage of Barhee fruit was not significantly affected by NAA treatments in both seasons (Tables 3&4). However, a significant decrease was recoded in Shahl fruit by NAA treatments in both seasons. The highest fruit acidity percentage in fruit juice was recorded in the control of Shahl cv. in both seasons as compared with NAA treatments.

Percentages of total and reducing sugars in fruit juice decreased significantly by NAA treatments of Barhee and Shahl cvs. compared with the control in both seasons. The highest contents of total and reducing sugars in fruit juice were in the control. On the other hand, the concentrations of 150 and /or 200 ppm NAA decreased the total and reducing sugars in fruit juice of Barhee and Shahl cvs. in both seasons. However, the non-reducing sugars percentage in fruit juice of Barhee and Shahl cvs. were not affected significantly in fruit juice of Barhee and Shahl cvs. in both seasons (Tables 3&4). The lowest contents of TSS, total and reducing sugars in fruit juice of Barhee and Shahl cvs., which has been treated by NAA application. This could attribute to the dilution effect of increase in fruit weight and size and high yield per bunch (Table 1&2). In addition, an increase in the moisture percentage occurred(Tables 3&4). These results are in agreement with those obtained by Aljuburi *et al.* (2001a&b), Aljuburi *et al.* (2003) and Aboutalebi and Beharoznam (2006).

Regarding the effect of NAA treatments, data of both seasons indicated that the highest values of fruit yield and quality were obtained with NAA at 150 and 200-ppm concentrations. Thus, it is recommended to spraying the bunches during depressed period of fruit growth with 150 ppm NAA to obtain best yield with high fruit physical characteristics (weight, volume, height, diameter and flesh %) which affected TSS and sugars contents of Barhee and Shahl date palm cultivars .

Table(3): Effect of NAA application on fruit chemical characteristics of Barhee and Shahl date palm cultivars during 2005 season.

Treatment	Fruit chemical characteristics					
	Flesh moisture (%)	TSS (%)	Acidity (%)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)
Barhee cv.						
Control	65.37	30.72	0.44	19.04	8.20	27.24
50 ppm NAA	66.37	30.16	0.45	18.86	8.17	27.03
100 ppm NAA	70.67	30.40	0.39	18.78	7.73	26.74
150 ppm NAA	69.29	27.44	0.40	16.64	7.53	24.17
200 ppm NAA	71.61	27.84	0.41	16.86	7.80	24.66
$LSD_{0.05}$	1.90	1.63	N.S	1.18	N.S	2.02
Shahl cv.						
Control	63.69	23.32	0.53	14.60	6.30	20.90
50 ppm NAA	72.71	22.48	0.44	14.34	6.10	20.44
100 ppm NAA	73.98	21.56	0.39	14.10	5.98	20.08
150 ppm NAA	74.43	19.65	0.39	11.27	6.07	17.34
200 ppm NAA	74.72	19.40	0.34	11.31	5.72	17.03
$LSD_{0.05}$	2.28	1.70	0.08	1.32	N.S	1.86

Table(4): Effect of NAA application on fruit chemical physical characteristics of Barhee and Shahl date palm cultivars during 2006 season.

Treatment	Fruit chemical characteristics					
	Flesh moisture (%)	TSS (%)	Acidity (%)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)
Barhee cv.						
Control	67.12	28.52	0.45	17.89	8.38	26.27
50 ppm NAA	68.53	28.30	0.38	17.74	7.88	25.62
100 ppm NAA	70.67	27.24	0.37	17.79	7.73	25.52
150 ppm NAA	7185	25.52	0.40	15.30	7.62	22.92
200 ppm NAA	71.87	25.84	0.43	15.56	7.72	23.28
$LSD_{0.05}$	2.02	1.69	N.S	1.28	N.S	1.96
Shahl cv.						
Control	65.44	24.12	0.52	13.90	7.66	21.56
50 ppm NAA	73.21	23.46	0.47	13.84	7.11	20.95
100 ppm NAA	73.85	21.55	0.37	13.10	7.15	20.25
150 ppm NAA	75.54	20.59	0.38	10.47	7.39	17.86
200 ppm NAA	74.92	20.28	0.33	10.51	7.54	18.05
$LSD_{0.05}$	2.18	1.46	0.05	1.22	N.S	1.77

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تأثير نفثالين حامض الخليك علي المحصول و جودة الثمار في صنفي نخيل التمر البرحي و الشهل

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ص .ب ٢٤٦٠ الرياض ١١٤٥١– المملكة العربية السعودية

اجـــري هـــذا البحث في محطة البحوث و التجارب الزراعية بديراب التابعة إلي كلية علوم الأغذيـــة و الـــزراعة– جامعـــة الملك سعود بالرياض لدراسة تأثير نفثالين حامض الخليك علي المحصول وجودة ثمار نخيل التمر صنفي البرحي و شهل خلال موسمي النمو ٢٠٠٥و ٢٠٠٦م و تـــم رش الثمار بتركيز صفر و ٥٠ و١٠٠و١٥٠و ٢٠٠ جزء في المليون بعد ١٠ أسابيع من التلقـــيح خلال فترة النمو البطيئة للثمار. أوضحت أهم النتائج أن وزن العذق قد زاد معنويا عند معاملـــة الـــثمار بنفثالين حامض الخليك (NAA) مقارنة بالمعاملة القياسية(الشاهد) .وأعطت معاملـــة الـــثمار بتركـــيز ١٥٠و ٢٠٠ جـــزء في المليون أعلي قيمة من وزن العذق . كما أدي اســـتخدام NAA بتركـــيز ١٥٠و ٢٠٠ جـــزء فـــي المليون إلي زيادة معنوية في صفات الثمار الطبيعـــية (وزن– حجم– طول– قطر– النسبة المئوية للحم)و نسبة الرطوبة في كلا الموسمين . بينما أنخفض محتوي الثمر من نسبة المواد الصلبة الكلية TSS و السكريات الكلية و المختزلة و لم يتأثر معنويا وزن البذرة و محتوي الثمار من السكريات غير المختزلة و نسبة الحموضة.

و ينصح تحت ظروف الدراسة باستخدام نفثالين حامض الخليك(NAA) بتركيز ١٥٠ جزء في المليون لزيادة المحصول و تحسين صفات ثمار الطبيعية مثل وزن، حجم ، إرتفاع ، قطر الثمار و نســـبة اللحـــم فـــي صنفي التمر البرحي و الشهل و إن قللت إلي حد ما نسبة السكريات و المواد الصلبة الذائبة الكلية و إن كان يمكن تدارك ذلك بتأخير الجمع أسبوعان.

الكلمات الدالة: نخيل التمر– برحي– شهل – نفثالين حامض الخليك– المحصول و جودة الثمار