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NOTE

EFFECTS OF AUXINS ON SIZE, QUALITY AND RIPENING OF 'SHAHANI' DATE

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ABSTRACT

An experiment was conducted to investigate the effects of naphthalene acetic acid (NAA), naphthaleneacetamide (NAD) and 2,4-dichlorophenoxyacetic acid (2,4-D) on quantity and quality of 'Shahani' date. Twenty four 15-year-old 'Shahani' date palms were selected for the experiment in a commercial orchard in Jahrom, Fars province. Fruit bunches on the selected trees were treated with NAA (0, 40, 60 mg l^{-1}), NAD (0, 80, 120 mg l^{-1}) and 2,4-D (0, 10, 20 mg l^{-1}). NAD at 80, 120 mg l^{-1} significantly increased weight, length, diameter and pulp weight of fruit during khalal and tamer stages. NAA at 40 and 60 mg l^{-1} and 2,4-D at 10 and 20 mg l^{-1} also increased length and diameter of fruits at khalal and tamer stages, but NAA was more effective than 2,4-D in improving fruit characteristics. In general, NAA, NAD and 2,4-D delayed fruit ripening up to 17 d and reduced total soluble solids (TSS) particularly at higher concentrations.

Key words: Auxins, Dates, Fruit growth, Ripening.

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اثرهای اکسین ها بر اندازه، کیفیت و رسیدن خرمای شاهانی

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به ترتیب، دانشیار بخش باغبانی دانشکده کشاورزی دانشگاه شیراز و مربی پژوهش ایستگاه تحقیقات کشاورزی حاجی آباد، هرمزگان، جمهوری اسلامی ایران.

چکیده

آزمایشی به منظور بررسی اثر نفتالین استیک اسید، نفتالین استامید و ۲، ۴ - دی کلروفنوکسی استیک اسید بر کمیت و کیفیت خرمای شاهانی انجام شد. برای این آزمایش، ۲۴ درخت ۱۵ ساله خرمای شاهانی در یک باغ تجارتی در شهرستان جهرم، استان فارس انتخاب شدند. خوشه های میوه روی هر درخت با محلول های نفتالین استیک اسید (۰، ۴۰ و ۶۰ میلی گرم در لیتر)، نفتالین استامید (۸۰ و ۱۲۰ میلی گرم در لیتر) و ۲، ۴- دی (۰، ۱۰ و ۲۰ میلی گرم در لیتر) تیمار شدند. نفتالین استامید در غلظت های ۸۰ و ۱۲۰ میلی گرم در لیتر به طور معنی داری سبب افزایش وزن، طول و قطر میوه ها و وزن گوشت در مراحل خلال و تمر شد. هم چنین، نفتالین استیک اسید در غلظت های ۴۰ و ۶۰ میلی گرم در لیتر و ۲، ۴-دی در غلظت های ۱۰ و ۲۰ میلی گرم در لیتر سبب افزایش طول، قطر میوه در مراحل خلال و تمر شد ولی نفتالین استامید بهتر از ۲، ۴-دی سبب بهبود خصوصیات شد. به طور کلی، نفتالین استیک اسید، نفتالین استامید و ۲، ۴-دی، به ویژه در غلظت های بالا سبب تاخیر در رسیدن میوه به مدت ۱۷ روز شدند و میزان مواد جامد محلول را کاهش دادند.

INTRODUCTION

'Shahani' date palms are extensively grown in Fars province of Iran. Although this cultivar has excellent fruit quality, it ripens very late and is severely damaged by early autumn rains. It is a semi-dry date and can be stored for a relatively long time.

The effect of plant growth regulators on date fruit development has been studied only to a small extent. Early studies examined the effects of application of different synthetic auxin-type substances at pollination time or 1 or 2 weeks after pollination (4, 5). A concentration of 10 mg l^{-1} indoleacetic acid (IAA), gibberellic acid (GA_3) and 6-furylaminopurine plus gibberellic acid ($BA+GA_3$) significantly increased the weight of fruit, length of fruit and formation of seedless fruit (3). Application of naphthalene acetic acid (NAA) at 10, 20, 40 and 60 mg l^{-1} 15 to 16 weeks after pollination to immature 'Zahedi' date palm fruits caused an increase in fruit size and weight. NAA at 40 and 60 mg l^{-1} increased fruit size, weight, volume and pulp to seed ratio (10). Treating fruits at the same stage with gibberellic acid (GA_3) at 100 to 500 mg l^{-1} induced the same effects on fruit size, pulp-to seed weight ratio and delay in ripening (7, 8, 10).

Several studies have been conducted to determine physiological stage of fruit development responsive to the application of growth regulators. A physiologically active stage known as the 'depressed period' during the early second sub-stage of chimri stage was found in 'Zahedi' and 'Sayer' date palm (1, 2).

The purpose of this study was to evaluate the effects of synthetic auxins on various important fruit characteristics (size, weight, quality and ripening) of 'Shahani' date palm.

MATERIALS AND METHODS

Experiments were conducted on 'Shahani' date *(Pheonix datylifera* L.) in a commercial orchard in Jahrom, Fars province (198 km south of Shiraz).

Twenty four 15 year-old uniform trees were selected and fruit bunches on selected trees sprayed with NAA (0, 40, 60 mg l^{-1}), NAD (0, 80, 120 mg l^{-1}) and isopropyl ester of 2,4-D (0, 10, 20 mg l^{-1}) 4 and 8 wk after pollination in 1996 and 1997. Growth regulator solutions were applied to the fruits in the morning with a one-liter plastic sprayer. The control fruit bunches were sprayed with distilled water. A factorial experiment in a randomized block design was used in this experiment. Each growth regulator was applied in three concentrations to three fruit bunches on each tree and replicated 4 times. Four blocks were used in this experiment and each block consisted of three trees.

At harvest time, fruit were sampled at khalal and tamer stages and length (L), dimater (D), length/diameter ratio, pulp weight and total soluble solids (TSS) of fruit at both stages were measured for 10 fruits. Also L/D ratio of seeds of 10 treated fruits were measured.

Analysis of variance was conducted by using MSTATC statistical software and treatment means were compared using Duncan's multiple range test (DMRT).

RESULTS

Effects on Fruit Characteristics at Khalal Stage 1996 and 1997

In both years of the experiment, application of growth regulators significantly increased fruit weight. Weight of 10 non-treated fruits was 127.6 and 128.20 g in 1996 and 1997, respectively. Treated fruits with NAA at 40 and 60 mg l^{-1} had significantly greater fruit weight and the difference was highly significant at 1% level. 2,4-D at both concentrations also significantly increased fruit weight, although less effective than NAA. NAD at 80 and 120 mg l^{-1} significantly increased fruit weight at khalal stage in 1997 (Table 1 and 2).

The results of 1996 showed that the best treatment was NAD at 120 mg/l which increased fruit length 11.11% during khalal stage (Table 1). Only in 1997, NAD increased fruit length significantly at both concentrations (Table 2). NAA at 40 and 60 mg l^{-1} effected fruit length more than 10 and 20 mg l^{-1} of 2,4-D treatments (Table 1 and 2). NAA at 60 mg l^{-1} significantly increased fruit length in both years of study (Table 1 and 2). 2,4-D at both concentrations affected fruit length, but less than NAD and NAA (Table 1 and 2).

Table 1. Effects of growth regulators on fruit characteristics measured for 10 fruits of 'Shahani' date at khalal stage, 1996.

Treatment (mg l^{-1})	Fruit			Pulp		Seed
	Weight (g)	Length (cm)	Diameter (cm)	Weight (g)	Pulp/seed ratio	L/D ratio
Control	127.6 e†	47.5 e	19.5 d	117.0 e	11.0 e	3.63 b
NAA 40	145.6 c	50.21 c	20.01 c	135.5 c	13.4 e	3.67 ab
NAA 60	152.1 bc	51.4 b	21.65 b	142.1 b	14.31 b	3.8 a
NAD 80	153.1 ab	51.3 b	21.72 b	143.0 b	14.2 b	3.7 ab
NAD 120	1590 a	52.7 a	22.7 a	149.4 a	15.6 a	3.81 a
2,4-D 10	138.9 d	48.7 d	20.44 c	128.7 d	12.6 d	3.7 ab
2,4-D 20	147.0 bc	49.8 c	20.99 c	136.8 c	13.4 c	3.8 a

† Mean separation within columns by DMRT, 1% level.

Table 2. Effects of growth regulators on fruit characteristics measured for 10 fruits of 'Shahani' date at khalal stages, 1997.

Treatments (mg l^{-1})	Fruit			Pulp		TSS (%)	Seed L/D ratio
	Weight (g)	Length (cm)	Diameter (cm)	Weight (g)	Pulp/seed ratio		
Control	128.2 f†	45.4 e	19.6 d	117.9 f	11.4 e	33.76 a	3.63 b
NAA 40	146.1 d	50.15 c	21.34 bc	136.4 d	14.1 c	32.44 b	3.9 ab
NAA 60	150.8 e	51.31 b	21.6 bc	141.3 bc	14.8 b	32.2 bc	3.99 a
NAD 80	154.9 b	51.74 b	22.2 b	154.0 b	14.3 c	31.81 bc	3.77 ab
NAD 120	159.9 a	52.84 a	24.0 a	150.4 a	15.89 a	31.44 c	3.76 ab
2,4-D 10	138.3 e	48.8 d	2.4 cd	129.5 e	12.79 d	32.44 b	3.76 ab
2,4-D 20	147.8 cd	50.15 c	21.3 bc	137.8 cd	13.97 c	32.13 bc	3.76 ab

† Mean separation within columns by DMRT, 1% level.

The results of 1996 showed that fruits treat went with NAD at 120 mg l^{-1} increased fruit diameter 16.2% (Table 1). Lowest fruit diameter was obtained by application of 2,4-D with only 4.7 % increase compared to control. NAD at 80 mg l^{-1} and NAA at 60 mg l^{-1} improved fruit diameter at khalal stage by 11.2% and 10.9%, respectively (Table 1). The results of 1997 experiment were similar to those of 1996 experiment. Fruit treated with NAD at 120 mg l^{-1} produced highest fruit diameter at khalal stage (24 mm) and the lowest was in the 2,4-D treatments (20.41 cm) (Table 2). Similarly, time of application generally influenced fruit diameter.

An increase in pulp weight in treated fruits was observed in 1996 and 1997. NAD at 120 mg l^{-1} significantly increased pulp fruit weight (Table 1 and 2). 2,4-D had the lowest effect on increasing pulp weight of fruit at khalal stage, but still it was significant at 1% level (Table 1 and 2).

Treatments had different effects on pulp: Seed ratio. The best treatments were NAD at 80 and 120 mg l^{-1} which significantly increased pulp: Seed ratio in 1996 (Table 1 and 2). NAD at 120 mg l^{-1} resulted in 41.12% increase in pulp: Seed ratio during the khalal stage (Table 1).

Total soluble solids (TSS) content of the treated fruits was lower than untreated fruits at khalal stage (Table 1 and 2). A significant reduction in TSS occurred at khalal stage in fruits treated with NAD at 120 mg l^{-1} (Table 2).

Effects on Fruit Characteristics at Tamer Stage. 1996 and 1997

Fruit weight at tamer stage significantly increased by the application of treatments in both years of study. The differences between treatment means were significant at the 1% level. NAD at 80 and 120 mg l^{-1} resulted in 25.9% and 31.4% increases in fruit weight during the tamer stage (Table 3). NAA at 60 mg l^{-1} increased fruit weight up to 22.2% (Table 3). NAA at 40 mg l^{-1} and 2,4-D at 20 mg l^{-1} were also effective in improving fruit weight at tamer stage (Table 3). The same results were obtained in 1997 (Table 4). The effects of treatments on fruit length and diameter at tamer stage had the same trend as khalal stage. NAD at 80 and 120 mg l^{-1} increased fruit length at tamer stage up to 13.2% and 17%, respectively (Table 3). 2,4-D at 10 or 20 mg l^{-1} had the lowest effect on fruit length (Table 3). The results of 1997 were similar to 1996 (Table 4).

Treated fruits with NAD at 80 and 120 mg l^{-1} and NAA at 60 mg l^{-1} in comparison to control increased pulp weight at tamer stage up to 45.5%, 52.6% and 40.5%, respectively (Table 3). The lowest increase of pulp weight was in the 2,4-D at 10 mg l^{-1} treatment. The results of the experiment in 1997 were the same as 1996 (Table 4). In both years of study the effects of treatments on pulp weight at tamer stage were the same and NAD and NAA significantly increased pulp weight at 1% level (Table 3 and 4).

Treatment effects in both years had a significant effect on pulp: Seed ratio. NAD at 120 mg l^{-1} in both years of study increased pulp: Seed ratio at tamer stage (Table 3 and 4).

Total soluble solids content of treated fruits at tamer stage were generally lower than control and the results were the same in both years of study (Table 4). The lowest TSS was found in fruits treated with NAD at 120 mg l^{-1} (Table 4).

Length: Diameter ratio (L/D) of seeds were increased with NAD at 120 mg/l (Table 3 and 4). Generally, all synthetic auxin compounds delayed .fruit ripening and the longest delay in ripening of fruits occurred in fruits treated with NAD (17 days) and the shortest belonged to the NAA and 2,4.D treatments (12 days) (Table 3 and 4).

DISCUSSION

It is shown that the enhancement of fruit size and weight by synthetic auxin-type substances may be due to the increase in cell size and/or cell number of treated fruits (1). As a result of the increase in cell size more water and mineral compounds can enter the cells of the date fruits, thus reducing total soluble solids (6). In this study, significant reduction in total soluble solids occurred at the tamer stage in fruits treated with NAD at 120 mg l^{-1}. The reduction of total soluble solids was probably due to increasing in moisture content of fruits at tamer stage (10). Treatments that significantly increased pulp weight and pulp: Seed ratio particularly during the tamer stage were useful because they are producing edible portion of fruits (10). Our results also indicated that an increase in length of fruits at all stages of maturation was accompanied by a corresponding increase in diameter. Application of synthetic auxin was found to delay ripening of 'Shahani' date at least by 20 days.

Table 3. Effects of growth regulators on fruit characteristics and ripening measured for 10 fruits of 'Shahani' date at tamar stage, 1996.

Treatments (mg l^{-1})	Fruit			Pulp		Seed L/D ratio	Ripening date (d)
	Weight (g)	Length (cm)	Diameter (cm)	Weight (g)	Pulp/seed ratio		
Control	97.1 f†	41.8 e	17.1 e	77.98 d	8.99 f	3.5 c	(10/10/96) 0.0 d
NAA 40	115.1 d	46.42 c	19.46 bc	105.7 bc	11.28 d	3.75 abc	(21/10/96) 11 c
NAA 60	118.7 c	47.46 b	19.85 ab	109.6 ab	12.03 c	3.76 abc	(21/10/96) 11 c
NAD 80	122.2 b	47.3 b	19.4 bc	113.4 ab	12.85 b	3.58 bc	(27/10/96) 17.0 a
NAD 120	127.6 a	48.9 a	20.2 a	119.0 a	14.1 a	3.89 a	(27/10/96) 17.0 a
2,4-D 10	107.6 e	45.3 d	18.55 d	98.1 c	10.35 e	3.77 abc	(22/10/96) 12.0 b
2,4-D 20	114.5 d	45.7 d	18.97 cd	105.2 bc	11.4 d	3.83 ab	(22/10/96) 12.0 b

† Mean separation within columns by DMRT, 1% level.

Table 4. Effects of growth regulators on fruit characteristics and ripening measured for 10 fruits of 'Shahani' date at tamar stage, 1997.

Treatments (mg l^{-1})	Fruit			Pulp		Seed L/D ratio	TSS (%)	Ripening date (d)
	Weight (g)	Length (cm)	Diameter (cm)	Weight (g)	Pulp/seed ratio			
Control	96.1 g†	42.3 f	17.1 e	86.4 g	8.9 f	3.5 b	69.2 a	(12/10/97) 0.0 d
NAA 40	114.0 d	46.7 c	19.4 bc	105.1 d	11.95 c	3.64 b	66.9 bc	(25/10/97) 13 b
NAA 60	116.6 c	47.4 c	19.8 ab	107.9 c	12.4 c	3.67 b	66.3 d	(25/10/97) 13 b
NAD 80	124.5 b	48.11 b	19.7 ab	116.4 b	14.2 b	3.86 a	66.7 cd	(29/10/97) 17.0 a
NAD 120	127.9 a	49.1 a	20.2 a	119.9 a	15.3 a	3.97 a	66.4 d	(29/10/97) 17.0 a
2,4-D 10	105.5 f	45.13 e	18.6 d	96.4 f	10.7 e	3.6 b	67.2 b	(24/10/97) 12 c
2,4-D 20	108.2 e	45.9 d	18.99 cd	96.4 e	11.3 d	3.7 b	67.1 b	(24/10/97) 12 c

† Mean separation within columns by DMRT, 1% level.

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