



Effect of Some Growth Regulators on Yield and Fruit Quality of Sewy and Hayany Date Palm Cultivars

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Abstract

This study was carried out during two successive seasons 2018 and 2019 at the orchard of Faculty Agriculture, Assiut University. The aim of this study was to investigate the effect of spraying with GA₃ at 100 ppm, combined with BA at 50 ppm and/or IAA at 100 ppm on some physical and chemical characteristics and yield parameters of Sewy and Hayany date palm cultivars. The obtained results showed that all combinations of the used growth regulators decreased the fruit set and fruit retention percentages of both tested cultivars, while the average bunch weight (kg) and average yield weight (kg/palm) increased by these treatments during both studied seasons. Moreover, the fruit weight (g), flesh weight (g), fruit volume (cm³) and flesh volume (cm³) significantly increased as affected by all growth regulators applications for Sewy and Hayany cultivars during 2018 and 2019. All applied treatments of GA₃, BA and IAA combinations decreased total soluble solids percentage (T.S.S%), reducing and total sugar content of Sewy and Hayany fruits, while it increased acidity content for both cultivars.

Keywords: *Date palm, growth regulators, IAA, BA, Sewy cv and Hayany cv.*

Introduction

Dates (*Phoenix dactylifera* L.) belong to the family Palmaceae and fall among the oldest mankind's food crop and has been used for 6000 years (Kwaasi, 2003). The date palm has an economic importance because of its fruit, which is the most nutritive providing food. Dates provide a wide range of essential nutrients, and are a very good source of dietary potassium. Date flesh contains carbohydrates (73.5%), ash (1.5%), fat (0.2%), protein (2.3%), also contain unsaturated fatty acids include palmitoleic, oleic, linoleic and linolenic acids and vitamins A, C, B1, B2, folic acid and nicotinic acid. Moreover, dates are rich source of several minerals including calcium, magnesium, iron, phosphorus, potassium, sodium, zinc, copper, manganese and selenium (Al-Shahib and Marshall, 2003).

A report by the Food and Agriculture Organization of the United Nations (FAO) showcases that Egypt's annual production of dates surpasses 1.7 million tons contributing in global production standing at eight million tons by 21 percent.

In Egypt, the distribution of date palms covers a large area extending from Aswan to north Delta, beside the oasis of Siwa, Bahrya, Farafra, Kharga and Dakhla. Saigy date palm is considered the national date palm cultivar in New Valley Governorate. It is the most important cultivar of semi-dry dates that is largely required in the local and foreign markets. It is required to ensure good fruit production through understanding some horticultural practices that affect tree growth and productivity (Elmahdy *et al.*, 2017; Ahmed *et al.*, 2019).

Plant growth regulators may be defined as substances capable of controlling key points in a living plant system so that the natural course of development is modified. Cell elongation, Apical dominance, Parthenocarpy, Abscission, Respiration, Bolting and Flowering are some of the physiological effects of the growth regulators. IAA (Indoleacetic acid) was found to increase fruit size, weight and delayed ripening of dates. Also, Gibberellin A₃ (GA₃) increased fruit weight, and delayed fruit ripening. Benzyl adenine (BA) increased fruit size and delayed chlorophyll break down and fruit aging. (El-Hamady *et al.*, 2014; and Merwad *et al.*, 2015).

The plant growth regulators act as a messenger and are needed in small amount at low concentration. In fact, their site of action and biosynthesis are different. GA₃ increased the fruit weight, diameter, length, volume and pulp weight, while it decreased fruit set and fruit number as well as bunch and yield weight (El-kosary, 2009; Hesami and Abdi, 2010; Kassem *et al.*, 2011).

Cytokinin stimulates protein synthesis and participates in cell cycle control in a cell division, it increased fruit and flesh weight, fruit length. Also, Cytokinin is proved to be very effective in improving fruiting of various crops through its benefit in enhancing cell enlargement, morphogenesis, development of plastids and stomata aperture and in delaying the breakdown of chlorophyll, proteins and RNA (Aljuburi *et al.*, 2001; George *et al.*, 2008; Al-Qurashi and Awad, 2011; Ashour *et al.*, 2018).

NAA and IAA increase fruit length, fruit diameter, fruit weight, flesh weight, bunch and yield weight (Aljuburi *et al.*, 2001; Bakr *et al.*, 2007 and Al-Qurash *et al.*, 2012). IAA is predominantly produced in cells of the apex (bud) and very young leaves of a plant. IAA is an auxin plant hormone and it is the most active auxin (Ahmed *et al.*, 2013).

The aim of this work was to study the effect of growth regulators: gibberellic acid, indole acetic acid and benzyle adenine on some physical and chemical properties of Sewy and Hayany date palm cultivars.

Material and Methods

This investigation was conducted during two consecutive seasons of 2018 and 2019 at the orchard of Pomology Department, Faculty of Agriculture, Assiut University. Two cultivars were used for this study where 3 palms of Sewy, 25 years old (each for one replicate) and 3 palms of Hayany, 35 years old (each for one replicate) were selected during two successive growing seasons. Healthy and vigorous palms were chosen and divided for achieving this study. All palms received the standard agricultural practices that are used in the orchard including soil fertilization, irrigation and pest control. Treatments were conducted at depressed period of fruit growth and one week after fruit set during two consecutive growing seasons. Clusters were protected from contamination by special practice.

Three palms (replicates) each contained 8 spathes for each cultivar (2 spathes for each treatment) were selected for the following treatments:

- 1- control
- 2- spraying GA₃ at 100 ppm +BA at 50 ppm
- 3- spraying IAA at 100 ppm+ BA at 50 ppm
- 4- spraying GA₃ at 100 ppm+ IAA at 100 ppm +BA at 50 ppm

Two spathes were used for each treatment which replicated three times.

The following measurements were carried out:

Yield parameters

Initial fruit set percentage

During the first week of April in each season fruit set percentage was determined by

$$\text{Initial fruit set \%} = \frac{\text{No. of setting fruits on the strand}}{\text{No. of retained fruits} + \text{No. of flowers scars on the same strand}} \times 100$$

Fruit retained percentage

$$\text{Fruit retention \%} = \frac{\text{Number of retained fruit}}{\text{Number of retained of fruit} + \text{number of flowers scars}} \times 100$$

Bunch weight and yield/palm (Kg)

In the two seasons, bunches were harvested in mid-September and have been counted and weighted (Kg) were recorded. Then, the average yield (Kg)/palm was calculated.

Fruit physical properties

Samples of 10 fruits were randomly taken from each bunch on the experimental palms. The fruit weight (g), flesh weight (g), fruit volume (cm³) and fresh volume (cm³) index were determined.

Fruit chemical properties

Preparation of sample for chemical analysis: Ten fruits from each treatment were divided into pieces and seeds were omitted. Fifty grams of pieces were mixed with 150 ml distilled water using a special electric mixer for extraction, then filtered and the filtrate was used for the determinations the following parameters:

Total soluble solids (TSS)

Total soluble solids percentage (TSS%) was determined by using hand refractometer in the squeezed past of dates according to A.O.A.C.(2000).

Total acidity

Total acidity percentage (TA%) was measured as malic acid and determined by titrating 10 ml of dates extracting against 0.1 N NaOH using phenolphthalein as indicator according to A.O.A.C.(2000).

$$\text{Acidity (\%)} = \frac{\text{standard solution (N)} \times \text{base solution (mL)} \times 0.67}{\text{Total juice 5 (ml)}} \times 100$$

Sugars %

Total sugars, reducing and non-reducing sugars percentages were determined according to Lane and Eynon (1965) that outlined in A.O.A.C. (2000).

Statistical analysis

The obtained data were tabulated and subjected to the proper statistical analysis of variance according to the complete randomized block design using new L.S.D test for recognizing the significance differences among the various treatment means according to the method outlined by Snedecor and Cochram (1980).

Results and Discussion

The results obtained during this study will be explained as follow:

1. Yield parameters: fruit set (%), fruit retention (%), bunch weight (kg) and yield per palm (kg).
2. Fruit physical characteristics: fruit weight (g), flesh weight (g), fruit volume (cm³), flesh volume (cm³).
3. Fruit chemical characteristics: TSS (%), acidity (%), TSS/acid ratio (%), non-reducing sugar (%), reducing sugar (%) and total sugar (%).

Yield parameters

Fruit set%

Data in Tables 1 and 2 show the effect of spraying with combinations of GA₃, BA, IAA on fruit set percentage of Sewy and Hayany date palm cvs. during 2018 and 2019 seasons.

It is clear from such Tables to notice that the application of all treatments slightly or significantly decreased the fruit set % compared with the control for both tested cultivars. The lowest percentages of fruit set were obtained in Hayany palms treated with GA₃+BA in 2018 (50.27) and those treated with the combination of three growth regulators in 2019 season (54.14%).

The untreated palms had the highest fruit set % for both cultivars (62.14 and 64.16 %) for Hayany cv and (68.43 and 65.79%) for Sewy cv during the two studied seasons, respectively.

Table 1. Effect of growth regulators on fruit set %, fruit retention %, bunch weight (kg) and yield (kg) of “Sewy” date palm cv during (2018, 2019)

Treatments	Fruit set %		Fruit retention %		Bunch weight kg		Yield kg	
	2018	2019	2018	2019	2018	2019	2018	2019
	Control	68.43	65.79	57.64	55.90	7.10	9.16	56.80
GA ₃ 100ppm+BA 50ppm	64.48	60.81	55.64	53.66	8.06	12.73	64.48	101.84
IAA 100ppm+BA 50ppm	64.88	61.17	55.16	52.62	8.33	10.13	66.64	81.04
GA ₃ +IAA+BA	66.94	58.27	56.15	51.23	9.03	13.53	72.24	108.24
New L.S.D	1.48	1.35	3.79	3.29	2.47	2.98	27.67	29.79

Table 2. Effect of growth on fruit set %, fruit retention % bunch weight (kg) and yield (kg) of “Hayany” date palm cv during (2018, 2019)

Treatments	Fruit set %		Fruit retention %		Bunch weight kg		Yield kg	
	2018	2019	2018	2019	2018	2019	2018	2019
	Control	62.14	64.16	50.04	55.10	5.56	8.03	44.48
GA ₃ 100ppm+BA 50 ppm	50.27	54.14	41.76	54.65	7.06	9.50	56.48	76.00
IAA 100 ppm +BA 50 ppm	54.84	58.90	43.17	50.69	6.96	8.13	55.68	65.04
GA ₃ +IAA+BA	60.63	55.50	48.25	48.92	8.06	10.66	64.48	85.28
New L.S.D	1.31	1.84	3.49	5.70	1.53	15.28	15.28	18.62

Fruit retention %

Data in Tables 1 and 2 clearly indicated that, the highest fruit retention percentages were recorded in the untreated palms (control) in Sewy and Hayany cvs during both seasons. In addition GA₃+BA as well as IAA+BA treatments gave the lowest fruit retention % (41.76 and 43.17) in Hayany cv during 2018 season. Moreover, it could be observe that the fruit retention percentages were slightly higher in Sewy cv. than those in Hayany cv. during both studied seasons.

The average of bunch weight (kg)

The effect of the treatments with GA₃, BA and IAA combination on bunch weight of Sewy and Hayany palms are represented in Tables 1 and 2. The obtained results indicated that all used treatments of GA₃, BA increased the bunch weight of Sewy and Hayany cvs. during the both investigated seasons of 2018 and 2019. The highest bunch weight was recorded by GA₃+BA+IAA treatment (13.53kg) during 2019 followed by GA₃+BA treatment (12.73kg) during 2019 in Sewy cultivar.

The average of yield weight (kg)

Changes in yield weight of Sewy and Hayany date cultivars as affected by GA₃, BA and IAA combinations are presented in Tables 1 and 2. It is clear to notice that, all applied treatments increased the average yield weight of the two investigated cultivars during 2018 and 2019 seasons. The untreated palms (control) produced the lowest values of yield weight (56.80 and 73.28 kg/palm) for Sewy cv and (44.48 and 64.44 kg/palm) for Hayany during 2018 and 2019 seasons, respectively.

In addition, the highest values of yield weight were obtained from the palms treated with GA₃+IAA+BA (165 kg /palm) followed by those sprayed by GA₃+BA (157.33 kg/palm) in Sewy cv during 2019 season. It could be also observed that the yield weight per palm of Sewy were higher than those of Hayany cv, especially in 2019 season.

The obtained results concerning the yield parameters are in accordance with those found by (Al-Wasfy, 2005; Abd El-Kader *et al.*, 2008; Choudhary *et al.*, 2018).

Fruit physical characteristics

Data in Tables 3 and 4 show the effect of growth regulators GA₃, BA and IAA (as combinations) spray on some physical characteristics of Sewy and Hayany date palm cvs. during 2018 and 2019 seasons.

Table 3. Effect of growth regulators on fruit weight, flesh weight, flesh volume and flesh volume of “Sewy” date palm during (2018, 2019)

Treatments	Fruit weight (g)		Flesh weight (g)		Fruit volume (cm ³)		Flesh volume (cm ³)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	183.60	193.20	174.36	181.26	180.57	188.05	170.87	178.81
GA ₃ 100ppm+BA 50 ppm	205.58	208.66	187.33	194.77	196.60	207.79	175.70	194.79
IAA 100 ppm +BA 50 ppm	204.42	205.96	185.26	196.48	197.50	204.77	186.76	194.14
GA ₃ +IAA+BA	210.45	214.89	194.15	202.01	205.13	210.77	183.36	201.14
New L.S.D	8.68	12.02	7.08	12.46	9.05	11.72	6.05	9.09

Table 4. Effect of growth regulators on fruit weight, flesh weight, flesh volume and flesh volume of “Hayany” date palm during (2018, 2019)

Treatments	Fruit weight (g)		Flesh weight (g)		Fruit volume (cm ³)		Flesh volume (cm ³)	
	2018	2019	2018	2019	2018	2019	2018	2019
Control	182.40	186.32	173.33	175.59	192.74	189.61	182.37	184.08
GA ₃ 100ppm+BA 50ppm	195.23	206.44	184.29	194.09	195.26	201.35	176.06	186.30
IAA 100ppm+BA50ppm	194.11	202.08	185.21	192.19	199.10	201.90	185.50	188.99
GA ₃ +IAA+BA	208.43	208.78	196.55	199.77	205.56	207.28	195.23	198.15
New L.S.D	10.48	12.10	10.35	12.14	7.78	9.50	8.50	10.25

Fruit weight (g)

It could be deduced from the results obtained in Tables 3 and 4 that all applied combination of GA₃, BA and IAA significantly increased the fruit of both Sewy and Hayany cvs. during the two tested seasons. The highest values of fruit

weight (g) were recorded in Sewy cv. treated with GA₃+BA+IAA (210.45 and 214.89g) during 2018 and 2019, respectively. While the lowest values were found in untreated (control) Hayany and Sewy palms (182.40 and 183.60 g) during 2018 season.

Flesh weight (g)

Data in Tables 3 and 4 indicated that all combinations of growth regulators GA₃, BA and IAA sprays significantly increased flesh weight of Sewy and Hayany dates during both studied seasons, (except GA₃+BA and IAA+ BA sprays for Hayany cv. in 2018 season which the increase were not significant). Moreover, the lowest values of flesh weight were recorded in untreated palms (control) of both studied cultivars (174.36 and 181.26) in Sewy and 173.33 and 175.59 in Hayany date during 2018 and 2019 seasons, respectively. On the other hand, the highest flesh weight values were found in Hayany dates treated with GA₃+BA+IAA (196.55 g/fruit) during 2018 seasons and in Sewy dates treated by GA₃+BA+ IAA (202.01 g/fruit) during 2019 season.

Fruit volume (cm³)

The obtained results of fruit volume as shown in Tables 3 and 4 as affected by growth regulators sprays took approximately similar trend of fruit weight of both Sewy and Hayany cvs. during 2018 and 2019 seasons. It is clearly noticed from the previous Tables that all investigated treatments increased fruit volume of both Sewy and Hayany cvs. during 2018 and 2019 seasons. The increment of fruit volume were significant for both tested cvs. in 2018. The highest values of fruit volume were found by GA₃+IAA+BA treatments for Sewy cv. (205.13 and 210.77 cm³) as compared to control and other treatment during 2018 and 2019 seasons, respectively.

Flesh volume (cm³)

The obtained results shown in Tables 3 and 4 indicated that all applied treatments of GA₃, IAA, BA combinations increased the flesh volume of Sewy and Hayany dates in 2018 and 2019. The lowest values of flesh volume were found in untreated (control) dates of Sewy (170.87 and 178.81 cm³) and Hayany (182.37 and 181.08 cm³) in 2018 and 2019 seasons, respectively. In addition, GA₃ +IAA+BA treatments produced the highest values of flesh volume in Sewy cv. (201.14 cm³) and Hayany cv. (198.15 cm³) in 2019 season compared to control and other treatments. The results are in agreement of those reported by (Ahmed, 2013; Aubied and Hamzah, 2019).

It could be concluded that application of growth regulators GA₃, BA and IAA combinations lead to decrease of fruit set and fruit retention percentages of both Sewy and Hayany date palm cultivar. On the other hand, these treatments increased on other hand the fruit weight and volume as well as bunch weight and yield of both studied cultivars Sewy and Hayany cv. during the two studied seasons 2018 and 2019.

Fruit chemical characteristics

The obtained results in Tables (5 and 6) show the effect of spraying GA₃, BA and IAA combination on the characteristics of Sewy and Hayany fruits during 2018 and 2019 seasons.

Table 5. Effect of growth regulators on T.S.S %, acidity %, TSS/acidity %, reducing sugars %, no- reducing sugar % and total sugar % “Sewy” date palm during (2018, 2019)

Treatments	TSS %		Acidity %		TSS/Acidity		Non-reducing sugars %		Reducing sugars %		Total sugars %	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Control	61.74	60.85	0.21	0.13	294.46	448.82	8.70	7.32	49.10	51.08	57.81	58.41
GA ₃ 100 ppm+ BA 50 ppm	58.38	57.55	0.23	0.16	264.55	346.74	9.41	6.55	45.84	48.89	54.40	55.44
IAA 100 ppm+ BA 50 ppm	58.08	65.41	0.23	0.18	249.01	308.05	9.41	7.30	45.17	48.10	54.59	55.41
GA ₃ +IAA+BA	56.16	55.41	0.28	0.18	200.58	308.43	8.66	7.32	43.10	45.76	51.77	53.09
New L.S.D	1.59	1.35	0.01	0.02	21.34	37.36	2.28	1.94	0.87	1.80	1.82	2.32

Table 6. Effect of growth regulators on T.S.S %, acidity%, TSS/acidity%, reducing sugars %, no- reducing sugar % and total sugar % “Hayany” date palm during (2018, 2019)

Treatments	TSS %		Acidity %		TSS/Acidity		Non-reducing sugars %		Reducing sugars %		Total sugar %	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Control	60.38	61.72	0.21	0.21	283.41	288.23	8.58	7.28	46.46	49.09	55.04	56.37
GA ₃ 100 ppm + BA 50 ppm	55.61	56.52	0.24	0.24	224.86	228.62	9.45	6.62	41.80	46.46	51.05	53.08
IAA 100 ppm + BA 50 ppm	55.70	57.46	0.25	0.27	201.01	219.96	8.54	7.32	42.28	45.10	50.82	52.42
GA ₃ +IAA+BA	54.76	58.18	0.24	0.25	220.84	228.04	9.11	7.23	42.71	44.51	51.82	51.74
New L.S.D	1.50	2.23	0.03	0.04	29.92	36.93	3.47	2.32	0.98	1.46	3.07	3.58

Total soluble solids %

As shown in Table (5 and 6) data revealed that the untreated dates (control) contained significantly higher T.S.S percentages on both tested cultivars during 2018 and 2019 seasons than those treated by all combinations of growth regulators. The results took approximately the same trend in both studied season. The lowest values of T.S.S were found in the fruit treated with GA₃+IAA+BA combination compared with other treatments (56.16, 55.41%) in Sewy cv and (54.76, 58.18%) in Hayany cv during both investigated seasons 2018 and 2019 seasons, respectively.

Acidity content %

The obtained data showed that the treatments of all combinations of GA₃, BA and IAA significantly increased the acidity content % in the dates of Sewy and Hayany cvs. during 2018 and 2019 seasons. The lowest values of acidity% were increased in untreated fruits of Sewy cv. (0.21, 0.13%) and Hayany in (0.21, 0.21%) in the two seasons, respectively.

Total soluble solids/acidity ratio

Data in Tables 5 and 6 clearly explained that T.S.S / acidity ratios of Sewy and Hayany cvs. were significantly higher in the untreated fruits (control) as

compared with those treated by all combinations of GA₃, BA and IAA during both studied seasons.

Reducing sugar content %

It is clear to notice from data in Tables 5 and 6 that the results of reducing sugars % took similar trend of T.S.S in both seasons. So, the highest values of reducing sugar % were recorded in the untreated date (control) of Sewy (49.10, 51.08%) and Hayany (46.46, 49.09%) cvs. during (2018, 2019) seasons, respectively.

Non-reducing sugar content

From data in Tables 5 and 6, it could be observed that the differences of between the applied treatments were not significant concerning the non-reducing sugar content in both Sewy and Hayany fruits during 2018 and 2019 seasons. Moreover, the content of non-reducing sugar ranged from 9.41% to 6.55% in Sewy fruits and 9.45% to 6.62% in Hayany fruits. In general, the non-reducing sugar percentages were higher during 2018 season than 2019 for both Sewy and Hayany fruits.

Total sugar content%

The obtained results in Table 5 and 6 showed that total sugar content took approximately similar tendency as T.S.S and reducing sugar content for both tested cultivars during 2018 and 2019 seasons. In addition, all combinations of the applied growth regulators GA₃, BA and IAA combinations significantly reduced the total sugar content comparing with untreated fruits of Sewy and Hayany cvs. during both studied seasons. The highest values of total sugar % were measured in untreated fruits of Sewy (57.81, 58.41%) and Hayany (55.04, 56.37%) compared with other treatments during (2018, 2019) seasons, respectively.

On the other hand, GA₃+BA+ IAA treatment produced the lowest values of total sugar % in Hayany fruit (51.74%) during 2019 and in Sewy fruits (51.77, 53.09%) during 2018 and 2019 seasons, respectively as compared with other treatments.

The obtained results are in harmony with those reported by (Davies, 2010; Al-Temimi, 2016; Jabbar and Hassan, 2020).

It could be concluded that the decrease of T.S.S and sugar content as affected by GA₃, BA and IAA treatments may be attributed to the increase of fruit weight and volume as well as delaying the ripe stage of fruits as a result of these treatments (Al-Samaraie and Al-Falahy, 2020).

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تأثير الرش ببعض منظمات النمو على المحصول و جوده الثمار فى صنفى نخيل البلح السيوى والحيانى

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المخلص

اجريت هذه التجربة خلال موسمي 2018، 2019 بمزرعة ومعامل قسم الفاكهة بكلية الزراعة جامعة أسيوط. الهدف هو دراسة تأثير الرش بـ GA_3 عند 100 جزء في المليون مع BA عند 50 جزء في المليون و / أو IAA عند 100 جزء في المليون على بعض الصفات الفيزيائية والكيميائية وخصائص المحصول لصنفين سيوى وحيانى. أظهرت النتائج أن جميع المعاملات المستخدمة قللت من نسبة العقد ونسبة الثمار المتبقية في كلا الصنفين ، بينما زاد متوسط وزن السباطه (كجم) ومتوسط وزن المحصول (كجم / نخيل) نتيجة للزيادة في وزن الثمرة (جم) ووزن اللحم (جم) وحجم الثمرة ($سم^3$) وحجم اللب ($سم^3$) بشكل معنوي فى الثمار المعاملة مقارنة بالثمار الغير معاملة (الكنترول) وذلك لكلا الصنفين وخلال موسمي الدراسة موسمي 2018 و 2019.

من ناحية أخرى أدى استخدام جميع المعاملات الى نقص فى نسبة المواد الصلبة الذائبة الكلية والسكريات المختزلة والكلية وزيادة في نسبة الحموضة لثمار كلا الصنفين السيوى والحيانى مقارنة بالثمار الغير معاملة خلال موسمي الدراسة.