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Effect of GA_3 on Fruit Yield and Quality of Date Palm (*Phoenix dactylifera* L.)

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A B S T R A C T

The present investigation aimed to determine the effect of GA_3 on fruit yield and quality in different date palm (Phoenix dactylifera L.) cv. Barhee, Halawy, Khadrawy and Zahidi in carried out at Date palm Research Centre, Swami Keshwanand Rajasthan Agricultural University, Bikaner during 2015. The experiment consisted of four date palm cv. Barhee, Halawy, Khadrawy and Zahidi and five level of GA_3 concentration (control, 50 ppm, 100 ppm, 150 ppm and 200 ppm), arranged in split plot design with three replications. GA_3 (control, 50, 100, 150 and 200 ppm) applications were sprayed on fruits of Barhee, Halawy, Khadrawy and Zahidi cvs. At late *kimri* stage. The results showed that GA_3 treatments significantly increased physical properties (fruit weight, fruit length, fruit diameter, fruit volume and pulp:stone ratio) and highest fruit weight, fruit length, fruit diameter, fruit volume and pulp:stone ratio has been observed @ 200 ppm GA_3. However, the high fruit quality characters *viz.* total soluble solid, ascorbic acid, total, reducing and non reducing sugars was recorded by the application of Gibberellic acid (GA_3) at 150 ppm concentration. Results of this work suggest that 150 ppm GA_3 could be used to increase the yield and improve fruit quality of Barhee, Halawy, Khadrawy and Zahidi cultivars.

Introduction

Date palm (*Phoenix dactylifera* L.), a monoctyledonous and dioecious species belonging to Arecaceae (Palmaceae) family, is one of the world's oldest cultivated fruit trees. It is widely cultivated the Middle East and North Africa in hot arid regions of the world.

In India, a mostly exist in the western part such as *Kachchh* region of Gujarat state (Johnson *et al.*, 2013), Rajasthan (Jaisalmer, Barmer, Bikaner, Jodhpur and some parts of Churu, Sri Ganganagar, Hanumangarh, Nagaur districts), Haryana and some parts of Tamil Nadu.

Date palm plays an important role in the economic and social life of the people of these regions. Fruits of date palm are eaten as fresh fruits (hard ripe stage), dry dates (*Chhuhara*) and soft dates (*pind khajoor*) and used in different processed products like, sugar, starch, vinegar, juice, toffees, wine, chutney, jam, pickles etc. and date fruits are

highly nutritious and contain high calorific value (3150 calories / kilogram of fresh fruits), 60-65% sugar, fair amount of fibre (2.5%), protein (2%), less than 2 per cent fat, minerals up to 2 per cent i.e. iron, potassium, calcium, copper, magnesium, chloride, sulphur and phosphorus etc. (Gopalan *et al*., 1985). Date seed oil is also suggested for use in nutritional and edible purpose (Abdul Afiq *et al*., 2013). Date palm requires high temperature (25^0C - 40^0C), fertile deep (at least 2 meter) sandy loam soil with good water holding capacity. The date fruit goes four distinct ripening stages derived from Iraqui Arabic language as *Kimri*, *Khalal*, *Rutab* and *Tamar*. In India, these stages are called as *Gandora*, *Doka*, *Dang* and *Pind*, respectively. In India, maximum fruits are harvested at hard ripen *khalal* or *doka* stage because, if kept on trees for longer duration fruits are spoiled due to rains and high humidity. Internationally, there is an increasing demand for excellent quality dates (Glasner *et al*., 1999; Awad, 2007). Fruit weight and size are critical quality parameters that affect dates marketing because larger size is generally preferred over small ones (Botes and Zaid, 1999; Al-Qurashi and Awad, 2011). The aim of this work of the study were assessed the effect of GA_3 on fruit yield and quality of date palm and to evaluate the optimum concentration of GA_3 that could increase the size of fruit, yield and fruit quality of date palm under hot arid conditions of western Rajasthan.

Materials and Methods

The experiment was conducted at Date Palm Research Centre and Plant Biotechnology Centre and Department of Horticulture, College of Agriculture of SKRAU, Beechwal, Bikaner during rainy season (June to November, 2015). Twelve date palm trees were selected similar in growth, vigour, height, age (28 years old) and moderate pruning 10: 1 leaf/bunch ratio (Hussein et al., 1993). Only 5 bunches were left on each experimental tree. Normal cultural practices were carried out as usual used for date palm trees. Pollination was done at second week of March and GA_3 (control, 50, 100, 150 and 200 ppm) was sprayed at late *kimri* stage (15 - 16 weeks after pollination) in early morning with a plastic hand sprayer. A non-ionic wetting agent (APSA-80 surfactant) at 0.01% was added to all treatments. Control bunches were sprayed with distilled water and APSA-80. Bunches were isolated against contamination during spraying by polyethylene bags. The yield of fruits for this experiment was harvested at the last week of July and the following characters were determined.

A. Fruit physical characters samples of three replicates, each of 10 fruits were taken randomly from each bunch to determine fruit weight (g), length (cm), diameter (cm), volume (cc), stone weight (g), length (cm), diameter (cm) and pulp:stone ratio. Statistical analysis was performed (analyzed) with HAU, Hisar software (HAU Institute, 1997) and mean separation was carried out at 5% probability level.

Results and Discussion

Weight of fruit (g)

Data presented in table 1 shows that fruit weight was non-significant in the different varieties of date palm and the respective value recorded in Khadrawy (11.81 g) followed by Barhee (11.33 g), Halawy (9.93 g) and Zahidi (9.22 g).

Data given in table 1 further indicated that all different concentration of gibberellic acid significantly increased the average fruit weight of date palm. The highest fruit weight was recorded with GA_3 concentration 200

ppm (11.69 g) which was statistically at par with GA_3 concentration 150 ppm (10.91 g). The lowest fruit weight (9.57 g) was recorded under control. These results were reported by EL-Kosary (2009), Awad and AL-Qurashi (2012), Ghazzawy (2013) and Abo-El-Ez *et al.,* (2002) and El-Hodairi (1991).

Length of fruit (cm)

Data presented in table 1 indicate that the fruit length of date palm varieties varied significantly to each other. The highest fruit length was observed in Khadrawy (3.94 cm) followed by Halawy (3.89 cm), Zahidi (3.49 cm) and Barhee (3.05 cm). Meligi *et al.,* (1982), Surial *et al.,* (1982), Meena (2005) and EL-Kosary (2009) was reported as same result.

The data presented in table 1 further indicate that increasing concentration of GA_3 from 0 to 200 ppm significantly increased the length of fruit in date palm over control. The highest concentration of GA_3 200 ppm (3.91 cm) remained statistically at par with GA_3 150 ppm (3.69 cm) in term of length of fruit. The minimum fruit length was observed under the control (3.39 cm). These results are in agreement with the trend reported by El-Hodairi (1991).

Diameter of fruit (cm)

Data presented in table 1 revealed that fruit diameter significantly differed among the different date palm varieties under the present study. The highest value of fruit diameter was recorded in Barhee (2.55 cm) followed by Zahidi (2.38 cm), Khadrawy (2.37 cm) and Halawy (2.20 cm). Similar results have been reported by Meligi *et al.,* (1982), Surial *et al.,* (1982), Meena (2005) and EL-Kosary (2009).

Data given in table 1 further revealed that spray of GA_3 on date palm fruits significantly increased the fruit diameter with the increasing concentration of GA_3 from 0 to 200 ppm. The GA_3 200 ppm (2.57 cm) was significantly higher over GA_3 150 ppm (2.42 cm). GA_3 at concentration 200 ppm gave the highest (2.57 cm) fruit diameter followed by the 150 ppm (2.42 cm), 100 ppm (2.35 cm) and 50 ppm (2.30 cm). El-Hodairi (1991) reported as same results.

Volume of fruit (cc)

Data presented in table 1 showed that the fruit volume was non-significant in the different varieties of date palm under the present investigation. The value of fruit volume recorded in different varieties was; Khadrawy (11.32 cc) followed by Zahidi (10.32 cc), Barhee (10.27 cc) and Halawy (9.89 cc). Similar results have been reported by Meena (2005).

Table 1 further showed that GA_3 spray at late *kimri* of fruit has significant effect on the fruit volume. The highest fruit volume was recorded with GA_3 200 ppm (11.75 cc) followed by GA_3 150 ppm (10.83 cc). The minimum fruit volume was recorded in control (9.49 cc).

Yield of fruit per plant (kg)

Data presented in table 1 shows that fruit yield per plant was maximum in date palm variety Barhee (38.29 kg) which was significantly higher over Halawy (31.51 kg), Khadrawy (26.92 kg) and Zahidi (18.59 kg). In different date palm varieties have also been reported by Meligi *et al.,* (1982), Surial *et al.,* (1982), Meena (2005) and EL-Kosary (2009).

Further, data presented in table 1 revealed that GA_3 spray on fruit at late *kimri* stage has significant effect on fruit yield. The highest fruit yield per plant was recorded with GA_3 spray at concentration 200 ppm (31.86 kg)

which was statistically at par with GA_3 concentration 150 ppm (29.78 kg). The minimum fruit yield per plant was recorded in control (26.03 kg).

Weight of stone (g)

Data presented in table 1 showed that difference in weight of stone in the different varieties of date palm was found non – significant under the present investigation.

The stone weight was recorded different varieties was; Zahidi (1.25 g), Halawy (1.18 g), Khadrawy (1.10 g) and Barhee (0.91 g). Similar result was reported in different date palm by Meena (2005) and EL-Kosary (2009).

The GA_3 spray on fruits at late *kimri* stage has significant effect on stone weight (Table 1).

The highest stone weight was recorded with GA_3 spray at concentration of 100 ppm (1.20 g) which was at par with 50 ppm (1.12 g). The minimum stone weight was recorded in 200 ppm GA_3 (1.03 g).

Length of stone (cm)

Data on length of stone was presented in table 1. The data revealed that length of stone was significantly higher in Halawy (2.59 cm) as compared to Zahidi (2.31 cm) and Khadrawy (2.37 cm). The minimum value of stone length was recorded in Barhee (1.91 cm).

The data further revealed that GA_3 has significant effect on length of stone. The highest value (2.34 cm) of length of stone was recorded in GA_3 at concentration of 100 ppm and 150 ppm followed by 200 ppm (2.30 cm) and 50 ppm (2.27 cm). Whereas minimum length of stone was observed in control (2.21 cm).

Diameter of stone (cm)

Diameter of stone in the different varieties of date palm was found non–significant under the present investigation (Table 1). The stone diameter in different varieties was; Zahidi (0.95 cm), Halawy (0.93 cm), Barhee (0.93 cm) and Khadrawy (0.92 cm).

The data given in table 1 further revealed that increasing concentration of GA_3 has significant effect on diameter of stone. The highest value of stone diameter of 0.95 cm was recorded in 100 ppm and 150 ppm GA_3. The minimum stone diameter was observed in control (0.91 cm).

Pulp : stone ratio

Data presented in table 1 revealed that pulp : stone ratio varied significantly in different date palm cultivars. Pulp: stone ratio was highest in Barhee (11.70) and minimum in Zahidi (6.48).

Data given in table 1 further indicate that GA_3 has significant effect on the pulp : stone ratio. The pulp: stone ratio was recorded highest in GA_3 at the concentration of 200 ppm (10.75) which was statistically at par with 150 ppm (9.41). The lowest pulp : stone ratio was recorded in control (7.91). Similar results were reported by El-Hodairi (1991) and El-Kosary (2009).

Fruit quality characters

Total soluble solids (T.S.S.) (^{o}Brix)

Data on T.S.S. was given in table 2. The data revealed that there was no significant difference in TSS of different varieties of date palm. The TSS values recorded for different varieties was; Khadrawy (39.31°Brix), Zahidi (37.97 °Brix), Halawy (35.79 °Brix) and Barhee (35.04 °Brix).

Data presented in table 2 showed that GA_3 indicated that increasing concentrations of GA_3 up to 150 ppm significantly increased the total soluble solids in date palm fruits. The concentration i.e. 150 ppm GA_3 gave highest value of TSS (41.29 °Brix) which was at par with 200 ppm GA_3 (39.79 °Brix). However, it was 37.20, 34.81 and 32.04 °Brix in 100 ppm, 50 ppm and control, respectively. Efficacy of GA_3 in improving fruit quality has been reported by EL-Kosary (2009), Awad and AL-Qurashi (2012), Ghazzawy (2013) and Abo-El-Ez *et al.*, (2002).

Titratable acidity (%)

Data on acidity given in table 2 indicate that the difference in acidity in the fruits of different varieties of date palm was found non – significant. Further, the values on titratable acidity in different was Halawy (0.27 %), Khadrawy (0.28 %), Barhee (0.28 %) and Zahidi (0.29 %).

GA_3 spray on fruit at colour turning stage has significant effect on titratable fruit acidity of date palm fruits (Table 2). The titratable acidity was recorded highest in control and lowest in 200 ppm GA_3 (0.22 %) which was at par with 150 ppm GA_3 (0.25). Efficacy of GA_3 in improving fruit quality have been reported by EL-Kosary (2009), Awad and AL-Qurashi (2012), Ghazzawy (2013).

Ascorbic acid (mg/100g fruit)

Significant difference was observed in ascorbic acid content in fruits of different varieties of date palm (Table 2). The highest ascorbic acid content was recorded in variety Halawy (6.61 mg/100g fruit) which was at par with Khadrawy (6.16 mg/100g fruit). The ascorbic acid content in varieties Barhee and Zahidi was 4.56 mg/100g fruit and 5.31 mg/100g fruit, respectively.

Data in table 2 further revealed that GA_3 spray on fruits at *late kimri* stage has significant effect on ascorbic acid content of date palm fruits. The maximum ascorbic acid content (6.57 mg/100g fruit) was recorded when fruits were sprayed with 150 ppm GA_3 which was followed by 200 ppm GA_3 (5.98 mg/100g fruit). The minimum ascorbic acid content (4.75 mg/100g fruit) was recorded in control. Commbe and Hale (1973) reported that increased in ascorbic acid may due to translocation rate from the leaves and stem as a result of increased sink potency which increased ascorbic acid content of fruits.

Total sugars (%)

An examination of data in table 2 revealed the difference in total sugar content in fruits of different date palm varieties was non-significant. Individual values of total sugar % in different varieties were Halawy (33.33 %), Khadrawy (33.20 %), Zahidi (32.89 %) and Barhee (30.95 %). Further examination of data in table 2 indicated that application of 150 ppm GA_3 gave highest (36.30 %) total sugar content in fruits, which was followed by 200 ppm (34.64 %), 100 ppm (33.17 %) and 50 ppm (30.40 %) and minimum total sugar was recorded in control (28.45 %). Similar result have also been reported by Abo-El-Ez *et al.*, (2002), Ackermann *et al.*, (1992), Yamaki *et al.*, (1993) and Abo-Aziz *et al.*, (1982).

Reducing sugars (%)

The data on reducing sugar content in fruits of different date palm varieties was mentioned in table 2. The data revealed that there was no significant difference in reducing sugar content of four varieties viz., Halawy (30.01%), Khadrawy (29.61 %), Zahidi (28.48%) and Barhee (28.36%). similar results were reported by El-Kassas *et al.*, (1995) and Baccha and Shaheen (1986).

Table.1 Performance of date palm varieties and effect of GA_3 concentrations on physiological characteristics

Treatments	Weight of fruit (g)	Length of fruit (cm)	Diameter of fruit (cm)	Volume of fruit (cc)	Yield of fruit per plant (kg)	Weight of stone (g)	Length of stone (cm)	Diameter of stone (cm)	Pulp:stone ratio
A. Varieties									
Barhee	11.33	3.05	2.55	10.27	38.29	0.91	1.91	0.93	11.70
Halawy	9.93	3.89	2.20	9.89	31.51	1.18	2.59	0.93	7.55
Khadrawy	11.81	3.94	2.37	11.32	26.92	1.10	2.37	0.92	9.88
Zahidi	9.22	3.49	2.38	10.32	18.59	1.25	2.31	0.95	6.48
SEm±	**0.610**	**0.118**	**0.044**	**0.773**	**1.823**	**0.081**	**0.067**	**0.015**	**0.809**
CD at 5 %	**NS**	**0.415**	**0.155**	**NS**	**6.432**	**NS**	**0.235**	**NS**	**2.855**
B. GA_3 (ppm)									
0 ppm (control)	9.57	3.39	2.23	9.49	26.032	1.11	2.21	0.91	7.91
50 ppm	10.16	3.44	2.30	9.86	27.676	1.12	2.27	0.93	8.43
100 ppm	10.53	3.54	2.35	10.32	28.791	1.20	2.34	0.95	8.02
150 ppm	10.91	3.69	2.42	10.83	29.777	1.09	2.34	0.95	9.41
200 ppm	11.69	3.91	2.58	11.75	31.859	1.03	2.30	0.94	10.75
SEm±	**0.280**	**0.066**	**0.048**	**0.148**	**0.865**	**0.030**	**0.029**	**0.004**	**0.388**
CD at 5 %	**0.811**	**0.192**	**0.139**	**0.430**	**2.503**	**0.085**	**0.084**	**0.010**	**1.222**

Interaction of varieties x gibberellic acid was found non-significant

Table.2 Performance of date palm varieties and effect of GA_3 concentrations on biochemical characteristics

Treatments	Total soluble solids (TSS%)	Acidity (%)	Ascorbic acid (mg/100 g fruit)	Total Sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
Treatments						
A. Varieties						
Barhee	35.04	0.28	4.56	30.95	28.36	2.60
Halawy	35.79	0.27	6.61	33.33	30.01	3.32
Khadrawy	39.31	0.28	6.16	33.20	29.61	3.59
Zahidi	37.97	0.29	5.31	32.89	28.48	4.41
SEm±	**1.455**	**0.005**	**0.212**	**0.517**	**0.505**	**0.228**
CD at 5 %	**NS**	**NS**	**0.748**	**NS**	**NS**	**0.806**
B. GA_3 (ppm)						
0 ppm (control)	32.04	0.33	4.75	28.45	25.65	2.80
50 ppm	34.81	0.31	5.16	30.40	27.23	3.18
100 ppm	37.20	0.28	5.85	33.17	29.49	3.68
150 ppm	41.29	0.25	6.57	36.30	32.27	4.03
200 ppm	39.78	0.22	5.98	34.64	30.94	3.70
SEm±	**0.628**	**0.006**	**0.162**	**0.310**	**0.249**	**0.623**
CD at 5 %	**1.818**	**0.016**	**0.469**	**0.896**	**0.720**	**0.215**

Interaction of varieties x gibberellic acid was found non-significant

Further examination of data in table 2 indicated that spray of 150 ppm of GA3 on fruits resulted in maximum reducing sugar content (32.27 %) in fruits, which was significantly superior over rest of the treatments. The minimum reducing sugar content was recorded in control (25.65 %). similar results were reported by authors such as Ackermann *et al.*, (1992) and Yamaki *et al.*, (1993).

Non-reducing sugar (%)

Data given in table 2 showed that non-reducing sugar content varied significantly in fruits of different date palm varieties. Non-reducing sugar content in fruits of Zahidi was maximum (4.41 %) which was significantly higher over the non-reducing sugar content in fruits of varieties viz; Khadrawy (3.59 %), Halawy (3.32 %) and Barhee (2.60 %).

The data further showed that spray of 150 ppm concentration of GA_3 on fruits gave highest non-reducing sugar content (4.03 %) in date palm fruits. This was followed by non-reducing sugar content by spray of 200 ppm (3.70 %) and 100 ppm (3.68 %). The non-reducing sugar in fruit content was recorded minimum (2.80 %) when fruits.

On the basis of results of one year experimentation, above findings could be concluded as under

1. Out of the four varieties, the variety Barhee was found best in order to have statistically better yield and net profit.

2. In the present study it was found that GA_3 spray on fruits at concentration of 150 ppm and 200 ppm increased the fruit weight by 14.00 % and 22.15 %, respectively, over the control.

3. The GA_3 spray @ 150 ppm increase fruit quality characters viz. TSS, ascorbic acid, total sugars, reducing sugars and non reducing sugars over the control.

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