

Fruit Characteristics and Productivity of Date Palm as Affected by Growth Regulators

Hameed J. Aljuburi, Hasan H. Al-Masry and M. Al-Banna

College of Science, Agricultural Science Unit, University of Qatar, P.O. Box 2713, Doha, Qatar.

Abstract: Relative effectiveness of GA₃, NAA, ethephon and a mixture of growth regulators on some fruit characteristics and fruit yield of date palm cultivar "Fardh" was studied. Five uniform female date palm trees were pollinated between 5 and 15 March during 1994, 1995 and 1996 by placing eight fresh male strands on female spadix center (flower cluster). Ten female flower clusters were used on each tree, and every two flower clusters were subjected to one of the following treatments: control (water), 150 mg L⁻¹ GA₃, 100 mg L⁻¹ NAA, 1000 mg L⁻¹ ethephon and a mixture of growth regulators. Application of ethephon on flower clusters had no significant effect on fruit characteristics and productivity of trees. Naphthalene acetic acid, mixture of growth regulators or GA₃ application on "Fardh" flower clusters, reduced fruit dry matter percentage, total soluble solid (°B), fruit ripening percentage, and increased the fruit weight per bunch and per tree. Spraying Fardh date palm flower clusters with NAA or mixture of growth regulators, 20 days after pollination, were more effective in reduction of fruit total soluble solids, dry matter percentage, fruit ripening and increasing the fruit yield. Therefore, these treatments could be recommended.

Key words: Date palm, NAA, GA₃, ethephon, growth regulators, Fardh, yield.

Synthetic and natural plant growth regulators are extensively used for the improvement of performance of fruit crops like citrus (Agusti *et al.*, 1994), apple (Elfving and Cline, 1993a and 1993b), blackberry (Rom, 1999), and sweet cherry (Facteau *et al.*, 1992). Application of gibberellic acid (GA₃), along with hand pollination in date palm, increased fruit set, fruit weight and size, and pulp:seed ratio (Ibrahim and Simbel, 1991). However, in some studies application of GA₃ decreased the seed weight, fruit weight, pulp weight, and total soluble solids (TSS), and delayed fruit maturation slightly (Benjamin *et al.*, 1975) or significantly

(El-Kassas, 1993; Moustafa and Seif, 1993; Hussein *et al.*, 1993a). Naphthalene acetic acid (NAA) application on date palm trees reduced fruit yield per bunch, but increased fruit weight, dimensions, flesh weight percentage and total soluble solid percentage, and reduced the fruit ripening percentage (Aljuburi *et al.*, 2000; Shabana *et al.*, 1998). 2,4-DP is reported to slightly increase "Satsuma" mandarin yield, but had no effect on fruit soluble solid contents (SSCs) (Agusti *et al.*, 1994). Ethephon application reduced fruit set of apple trees (Elfving and Cline, 1993a; Ansari *et al.*, 1999), but increased fruit ripening, total soluble solid (TSS), fruit pulp weight.

Ethephon had no effect on bunch weight, and yield of date palm trees (Benjamin *et al.*, 1975; Hussein *et al.*, 1993b; El-Hamady *et al.*, 1993).

The objectives of this study were to assess relative effectiveness of GA₃, NAA, ethephon and mixture of growth regulators (MGR) on fruit set, fruit flesh, fruit dry matter, total soluble solids, fruit ripening, fruit weight and yield of date palm cv. Fardh.

Materials and Methods

The experimental site, having fine sand, was at Kuawaytate Experiment and Research Station, Department of Agriculture and Livestock, Al-Ain, the UAE. Date palm cv. "Fardh" trees were planted at 10 x 10 m spacing (100 trees ha⁻¹). Trees of uniform size, age (25 years), and growth were selected. Date palm trees were pollinated between 5 and 15 March during 1994, 1995 and 1996, by placing eight fresh male strands on the center of female spadix (flower cluster). Ten flower clusters were used on each tree and every two flower clusters were subjected to one of the following treatments: control (Water); 150 mg L⁻¹ GA₃; 100 mg L⁻¹ NAA; 1000 mg L⁻¹ ethephon; MGR (150 mg L⁻¹ GA₃ + 100 mg L⁻¹ NAA + 1000 mg L⁻¹ ethephon). These growth regulators were sprayed with a hand gun once in 20 days after pollination (DAP) during each of the three consecutive growing seasons (1994-1996). Clusters were protected from contamination by polyethylene bags. The bags were removed after 10 days. Solution of growth regulators were prepared in a mixture of ethanol:water 8:92 v/v. Wetting agent (Tween 20 surfactant) 0.01% was added in all solutions. The experiment was arranged in randomized complete block design with

5 replications, each replicate with two clusters.

All fruit bunches were covered at the Khalal stage (mature stage) by permeable bags to prevent bird damage and fruit shattering. Ten strands were randomly selected from each replicate (5 strands for each bunch), from 40 to 50 strands that composed a bunch, to determine percentage of fruit set at 45, 90 and 135 days after pollination (DAP: first, second and third stages of fruit development, respectively). Each bunch was tagged and labelled and the respective percentage of fruit set per selected strand was determined by counting the number of fruit and dividing it by the total number of twigs on the respective strand. From each replicate 50 fruits were randomly selected to determine fruit flesh (pulp) percentage, fruit dry matter percentage and total soluble solids, at 90, 135 and 180 DAP (second, third and fourth stages of fruit development) (Aljuburi, 1995a). Bunches were harvested 180 days after pollination, weighed and fruits separated into ripened and non-ripened ones. The data were subjected to Duncan's multiple range test (DMR) using a MASTAT program analysis.

Results and Discussion

Application of GA₃, NAA, ethephon or MGR, compared to control, did not affect fruit set percentage of date palm trees at all the three stages of fruit development (45, 90 and 135 DAP) during three successive growing seasons 1994-96. MGR significantly increased the fruit set at third stage of fruit development during third growing season, as compared to application of GA₃ (Table 1). The fruit set tended to be high in the first stage of fruit development, then

progressively decreased with fruit growth during second and third developmental stages. The results are in agreement with those of Elfving and Cline (1993a and 1993b), who did not find any effect of ethephon on fruit set in apple trees.

Application of GA₃ or ethephon on flowers had no significant effect on fruit flesh percentage at second, third and fourth stages of fruit development during three successive growing seasons, but its application on flower clusters increased fruit flesh at the second stage during second growing season. NAA and MGR significantly increased fruit flesh percentage at the second stage, or decreased it at fourth stage of fruit development during second or first growing season, respectively, as compared with the control (Table 1).

Fruit dry matter was reduced significantly, when treated with GA₃, NAA, or MGR at the second stage of fruit development during first and second or first growing season, respectively, as compared with the control (Table 2). Ethephon treatment did not influence fruit development during three seasons. Fruit dry matter significantly decreased when treated with GA₃ at fourth stage of fruit development during second growing season. NAA or MGR significantly reduced fruit dry matter percentage at the third and fourth stages of fruit development during second and third growing seasons, respectively, as compared to control.

Spraying GA₃ on flower clusters of "Fardh" trees decreased total soluble solids at fourth stage of fruit development during first growing season, compared with control. NAA or MGR significantly influenced total soluble solids at the third, or third and fourth stages of fruit development during

second and third, or second third and first growing seasons, respectively, as compared to the control. Ethephon had no significant effect on total soluble solids (Table 2).

Ansari *et al.* (1999) also did not observe significant effect of ethephon on total soluble solids. The results of GA₃ treatment are similar to those obtained by Rom (1999) and Facticeau *et al.* (1992), who also recorded decreased SSC accumulation in sweet cherry fruit in one of the two years, or had no effect on SSC of blackberry fruits. Aljuburi *et al.* (2000) also found that the application of NAA or mixture significantly reduced fruit total soluble solids.

Ethephon treatment had no significant effect on fruit ripening percentage during three successive growing seasons, whereas GA₃ treatment significantly reduced fruit ripening percentage during third growing season as compared with control (Table 3). Application of NAA and MGR on date palm flower clusters significantly reduced the fruit ripening during three consecutive growing seasons as compared to the control. The results are similar to those recorded by Benjamin *et al.* (1975) and Aljuburi *et al.* (2000). Similar results of GA₃ were obtained by Moustafa and Seif (1993) and Hussein *et al.* (1993a), who found that the fruit ripening percentage of date palm decreased with the application of GA₃. The results of NAA are also in agreement with the work of Shabana *et al.* (1998), who reported that the NAA application to date palm flower clusters delayed fruit ripening.

Application of GA₃ on Fardh date palm flower clusters significantly increased fruit weight (kg/bunch) during third growing season, whereas application of ethephon on flower clusters had no significant effect

Table 1. Effect of GA₃, NAA, ethephon and MGR on fruit set of Fardh date palm tree during 1994, 1995 and 1996^{ZY}

Treatment	Fruit set (%)			Fruit flesh (%)		
	Days after pollination			Days after pollination		
	45	90	135	90	135	180
Control						
1994	90.88a	71.78a	63.91a	87.47a	—	92.46a
1995	75.67a	71.80a	68.01a	85.11b	89.22a	91.17a
1996	81.80a	71.36a	69.33ab	86.58a	90.07a	92.23a
GA₃						
1994	89.71a	69.69a	65.41a	87.31a	—	92.32a
1995	72.97a	70.79a	66.60a	86.87a	89.86a	92.08a
1996	80.21a	66.07a	55.97b	86.71a	90.55a	91.21a
NAA						
1994	90.64a	74.55a	71.26a	87.28a	—	90.16c
1995	71.21a	70.33a	69.27a	86.96a	89.17a	92.29a
1996	79.79a	72.13a	69.36ab	86.37a	90.61a	91.74a
Ethephon						
1994	87.08a	70.43a	59.77a	87.28a	—	91.95ab
1995	71.10a	61.12a	58.72a	86.60ab	90.10a	92.29a
1996	84.34a	72.22a	68.96ab	86.90a	90.46a	91.67a
MGR						
1994	91.38a	70.26a	67.24a	87.63a	—	91.31b
1995	74.90a	71.95a	71.95a	87.22a	89.72	91.04a
1996	80.13a	71.52a	77.75a	87.34a	90.57a	91.97a

Z: Values are mean of 5 replications (each replication represents 2 bunches).

Y: Means within columns followed by the same letter do not differ significantly (P = 5%); Duncan's multiple range test.

during three growing seasons. The results of ethephon application on Fardh date palm flower clusters are in agreement with the work of Benjamin *et al.* (1975), Ansari *et al.* (1999) and El-Hamady *et al.* (1993), who reported no significant effect on bunch weight and fruit yield, and also with Ibrahim and Simbel (1991) and El-Kassas (1993), who reported that the application of GA₃ increased bunch weight of date palm trees.

The NAA treatment significantly increased fruit weight during three successive growing seasons vis-a-vis

control. Agusti *et al.* (1994) also observed increase in crop load due to application of 2,4-DP on Satsuma mandarine. Aljuburi *et al.* (2000) found that application of NAA on date palm flower clusters increased bunch weight of date palm trees. Application of MGR on flower clusters significantly increased fruit weight during three consecutive growing seasons vis-a-vis control. Spraying GA₃ on Fardh flower clusters significantly increased fruit yield of each tree by 31.3% during third growing season relative to the control, but ethephon

Table 2. Effect of ethephon and MGR on fruit dry matter and total soluble solids of Fardh date palm trees during 1994, 1995, 1996^{ZY}

Treatment	Days after pollination								
	90			135			180		
	1994	1995	1996	1995	1996	1994	1995	1996	
Fruit dry matter (%)									
Control	16.68a	17.01a	13.85a	42.98a	26.60a	84.98ab	79.09	79.85a	
GA ₃	15.89c	16.54b	13.77a	41.97a	25.76a	83.10bc	77.28b	77.86a	
NAA	15.89c	16.50b	13.93a	28.26b	18.92b	80.48d	72.14c	80.06a	
Ethephon	16.59ab	16.74ab	13.67a	40.91a	25.06a	85.75a	78.49ab	83.14a	
MGR	16.00	16.69ab	13.78a	26.69b	17.55b	81.39cd	73.10c	79.66a	
Total soluble solids (°Bx)									
Control	15.93a	16.93ab	11.60a	47.10a	32.60a	80.76a	75.07a	72.87a	
GA ₃	15.70a	18.03a	11.77a	45.63a	27.77a	74.67c	74.21a	72.93a	
NAA	14.97a	17.20ab	11.80a	29.40b	22.40b	77.86abc	72.93a	73.46a	
Ethephon	15.17a	17.27ab	11.50a	51.80a	29.50a	78.89ab	78.20a	73.40a	
MGR	15.00a	16.39b	11.50a	27.28b	18.73b	75.55bc	74.33a	72.67a	

Z: Values are mean of 5 replications (each replication represents 2 bunches).

Y: Means within columns followed by the same letter do not differ significantly ($P = 5\%$);

Duncan's multiple range test.

treatment had no significant effect on yield of "Fardh" date palm trees during three consecutive growing seasons.

MGR significantly increased fruit yield by 26.0, 38.2 or 60.6%, during first, second and third growing seasons relative to the control. NAA treatment increased fruit yield by 27.0, 28.0 or 29.3% during first, second or third growing seasons, respectively, as compared with the control. The results of MGR or NAA, treatments are similar to those obtained by Aljuburi *et al.* (2000) who found that the MGR or NAA treatment increased significantly the average yield of date palm trees.

The results also showed that the yield of Fardh date palm trees increased gradually from first to third growing season. The data suggest that MGR or NAA may be more effective in increasing Fardh date palm fruit yield than other treatments under Al-Ain conditions of the United Arab Emirates.

The results revealed that one application of MGR or NAA at 20 DAP on flower clusters of "Fardh" date palm reduced dry matter percentage of fruit, fruit ripening and increased the fruit flesh percentage, fruit production per bunch and per tree. Thus, these treatments could be recommended to

Table 3. Effect of GA₃, NAA, ethephon and MGR on fruit ripening (%), fruit weight (kg/bunch) and yield (kg/tree) of Fardh date palm trees during 1994, 1995, 1996^{ZY}

Treatment	Fruit ripening (%)			Fruit weight (kg/bunch)			Yield (kg/tree)		
	1994	1995	1996	1994	1995	1996	1994	1995	1996
Control	91.3a	84.61a	81.83a	7.66bc	8.84cd	10.38c	78.64bc	88.44cd	103.8c
GA ₃	89.1a	81.54a	66.87b	8.67ab	9.75bc	13.63b	86.72ab	97.51bc	136.3b
NAA	4.9c	31.93b	25.03c	9.99a	11.32ab	13.42b	99.86a	113.2ab	134.2b
Ethephon	91.1a	81.25a	74.58a	7.13c	7.91d	12.03bc	71.30c	79.05d	120.3bc
MGR	21.2b	8.56c	16.71d	9.91a	12.22a	16.67a	99.12a	122.2a	166.7a

Z: Values are mean of 5 replications (each replication represents 2 bunches).

Y: Means within columns followed by the same letter do not differ significantly (P = 5%); Duncan's multiple range test.

improve date palm yield under Al-Ain conditions.

Acknowledgements

The authors wish to thank Mr. R. Al-Kasab and Mr. A. Azab, Department of Agriculture and Animal Livestock, for facilities, help and encouragement during the course of this work.

References

- Agusti, M., Almela, V., Azna, M., El-Otmani, M. and Pons, J. 1994. Satsuma mandarin fruit size increased by 2,4-DP. *HortScience* 29: 279-281.
- Ansari, E.M., Matta, F.B., Baqir, M. and Abbas, T. 1999. Accel, ethephon and wilthin decreased fruit set and increased fruit quality of apple. *HortScience* 34: 826.
- Aljuburi, H.J. 1995a. Analysis of mineral in date palm fruit under different nitrogen fertilization. *Fruits* 50: 153-158.
- Aljuburi, H.J. 1995b. Effect of mechanical and hand pollination on some fruit characteristics and productivity of date palm trees (*Phoenix dactylifera* L.) Faradh cultivar. *Journal of King Saud University* 7: 97-116.
- Aljuburi, H.J., Al-Masry, H.H. and Al-Muhanna, S.A. 2000. Fruit characteristics and productivity of date palm trees (*Phoenix dactylifera* L.) as affected by some growth regulators. *HortScience* 35: 476.
- Benjamin, N.D., Shabana, H.A., Al-Ani, B.A., Clor, M.A., Jawad, K.S. and Shaibani, A.M.H. 1975. Effects of some growth regulators on the depressed period of development, and physico-chemical changes during different stages of ripening in date fruit. Palms and Dates Research Center, Scientific Research Foundation Board of Planning, Baghdad, Iraq. *Technical Bulletin* No. 1/75: 1-23.
- Elfving, D.C. and Cline, R.A. 1993a. Cytokinin and ethephon affect crop load, shoot growth and nutrient concentration of 'Empire' apple trees. *HortScience* 28: 1011-1014.
- Elfving, D.C. and Cline, R.A. 1993b. Benzyladenine and other chemicals for thinning 'Empire' apple tree. *Journal of the American Society for Horticultural Science* 118: 593-598.
- El-Hamady, M.M., Al-Mughrabi, M.A., Bacha, M.A. and Abdelrahman, A.O. 1993. Effect of ethephon treatment on fruit thinning and quality of "Seleg" and "Meneify" date palm cultivars. *Third Symposium on Date Palm*, Vol. 1, pp. 405-413. Date Palm Center, King Faisal Univ., Saudi Arabia 17-20 Jan. 1993.
- El-Kassas, S.E. 1993. Effect of some growth regulators on the yield and fruit quality of Zaghloul date palm: *Third Symposium on Date Palm*, Vol. 1, pp. 179-186. Date Palm Research Center, King Faisal University, Saudi Arabia 17-20 Jan. 1993.

- Facteau, T.J., Chestnut, N.E., Rowe, K.E. and Payne, C. 1992. Brine quality of gibberellic acid treated 'Napoleon' sweet cherries. *HortScience* 27: 118-122.
- Hussein, M.A., El-Agamy, S.Z., Amin, K.I.A. and Galal, S. 1993a. Physiological studies for prolonging harvest date of Samany dates under Assiut Governorate conditions. A- Effect of GA₃ and fruit thinning. *Third Symposium on Date Palm*, Vol. 1, pp. 423-433. Date Palm Research Center, King Faisal University, Saudi Arabia, 17-20 Jan. 1993.
- Hussein, M.A., El-Agamy, S.Z., Amin, K.I.A. and Galal, S. 1993b. Physiological studies for prolonging harvest date of Samany dates under Assiut Governorate conditions. B- Effect of ethephon and fruit thinning. *Third Symposium on Date Palm*, Vol. 1, pp. 435-444. Date Palm Research Center, King Faisal University, Saudi Arabia 17-20 Jan. 1993.
- Ibrahim, A.M.F. and Simbel, H.M. 1991. Effect of GA₃ and/or hand pollination on fruit set and fruit quality of Shakra date cultivar grown in Gassim. *Journal of Agriculture Mansoura University* 16: 141-148.
- Moustafa, A.A. and Seif, S.A. 1993. Effect of ethrel and GA₃ treatments on yield and fruit quality of "Seewy" date palms grown in Al-Fayoum Governorate. *Third Symposium on Date Palm*, Vol. 1, pp. 379-388. Date Palm Research Center, King Faisal University Saudi Arabia, 17-20 Jan. 1993.
- Rom, C.R. 1999. Effect of GA application on blackberry, *HortScience* 34: 833.
- Shabana, H., Al Shereqi, R.K., Ibrahim, M. and Al Safadi, W. 1998. Effect of naphthalene acetic acid on fruit ripening and quality of cv. Khanaizy. *The First International Conference on Date Palms*, pp. 72-77. March 8-10 Al-Ain, United Arab Emirates.