AAB BIOFLUX
Advances in Agriculture & Botanics-
International Journal of the Bioflux Society

Extending harvest season and shelf life and improving quality characters of Barhee dates

H. A. Kassem, R. S. Al-Obeed, and M. A. Ahmed

Plant Production Dept., College of Food and Agricultural Sciences,
King Saud University, Saudi Arabia.
Corresponding author:
H. A. Kassem, Kassem60@yahoo.com

Abstract. The present study was conducted in order to extend harvest season and maintain fruit quality for better marketability of Barhee date palms growing in Riyadh in Saudi Arabia. Palms were by preharvest foliar sprayed at the hababouk stage and at the beginning of fruit color break with 10 ppm CPPU 'cytophex', 8Mm putrescine (PUT) and 50 ppm each of Gibberellin A3 (GA3), 1-Naphthaleneacetic acid (NAA), 6-Benzylaminopurine (BA) and salicylic acid (SA). Harvest date was delayed by one month with NAA and GA3, three weeks with putrescine and SA, and by two weeks with cytophex and BA from the commercial harvest date. All treatments decreased skin color intensity and carotenoids content and increased acidity as compared with control. The fruits turning to the postharvest rutab stage and the percent of total soluble solids (TSS) loss during storage at 0°C and 85-90% relative humidity were reduced by all treatments. The percentage of fruits reaching rutab stage during storage was 12.25, 16.25, 22.34, 12.4, 37.33, and 24.33, in the first season, for NAA, GA3, cytophex, putrescine, BA and SA, respectively. The corresponding value for the second season was 11.32, 18.46, 31.38, 19.45, 33.33 and 20.33%, respectively. The incidence of postharvest fruit decay during cold storage did not significantly differ among all sprayed growth regulators. The GA3, NAA and putrescine treatments had significant higher effect in extending shelf life and decreasing fruit weight loss percent than the other treatments. It is concluded that the sprayed growth regulators had positive influence on extending harvest season and shelf life of Barhee dates without any deterioration in fruit characteristics before and during cold storage.
Key Words: date palm, preharvest sprays, putrescine, GA3, NAA, salicylic acid, Cytophex, Benzyl adenine, harvest date, quality, rutab, shelf life, storage.

Introduction. The date palm fruits (*Phoenix dactylifera* L.) are highly demanded and consumed throughout the world, especially in the Middle East. According to FAO (2009), Saudi Arabia is considered the third country of the top ten date producers (982546 tones). A small quantity of certain date cultivars (such as Barhee) are harvested and consumed at the Khalal stage when they reach full maturity (partially-ripe) and are yellow, pink, or red in color (according to the cultivar), in this stage these cultivars are less astringent than other cultivars that are only harvested when they are fully ripen and are yellow, pink, or red in color. However, once ripened, these cultivars have a short shelf life (Hong et al 2006). In the mean time, dates consumers are looking for fruits with greater color and bigger size. The small fruit size of Barhee dates is another limiting factor that influences its marketing. Thus, it would be beneficial to improve quality characters and to prolong the Khalal stage of these cultivars in order to expand their shelf life and marketing ability.

Plant growth regulators play an important and major role in regulating fruit growth and development. Some of these substances were used in controlling ripening date (delayed ripening) as well as improving the fruit quality, which act for increasing the income and the revenues of farmers. NAA (1-Naphthaleneacetic acid) was found to increase fruit size, weight and delayed ripening of dates (Shabana et al 1998; Aljuburi et al 2000; Aljuburi et al 2001; Aboutalebi & Beharoznam 2006). Also, Gibberellin A3 (GA3) increased fruit weight, and delayed fruit ripening (Hussein et al 1996; Moustafa & Seif 1996; Moustafa et al 1996). Benzyl adenine (BA) and Cytophex (CPPU) increased fruit

size and delayed chlorophyll breakdown and fruit aging (Stern et al 2006). Polyamines such as putrescine (PUT) have been reported as anti-senescence agents (Ke & Romani 1988). They were found to retard color change, decrease firmness loss, delay ethylene production, decrease respiration rate and, induce mechanical resistance (Kramer et al 1991; Wang et al 1993; Martinez-Romero et al 1999; Valero et al 1999), which resulted in reducing senescence rate after harvest (Martınez-Romero et al 2002; Valero et al 1999). In addition, salicylic acid (SA) was reported to retard ethylene synthesis (Leslie & Romani 1988). Also, it has been recognized that SA is required in the signal transduction for inducing systemic acquired resistance against some pathogenic infections (Gaffney et al 1993; Vernooij et al 1994). Sayyari et al (2009) indicated that SA improved fruit quality during cold storage of pomegranate.

In accordance to the previous mentioned, the present study was conducted in order to investigate the effect of spraying NAA, GA3, CPPU, PUT, BA and SA on improving fruit quality Barhee dates before and during cold storage.

Material and Method. The present study was conducted during 2008 and 2009 seasons at the Research and Agricultural Experimental Station at Dirab, King Saud University, Saudi Arabia on Barhee date palms (*Phoenix dactylifera* L.). The palms were planted at 10x10 m apart and subjected to the same cultural practices usually done in the orchard. Organic manure, calcium superphosphate and potassium sulfate were applied in December of each season at the rate of 15 kg, 1kg and 1.5 kg per palm, respectively. Also, ammonium nitrate at the rate of 3 kg/palm was applied at three equal doses; mid-February, mid-April and mid-May of each season. Eleven palms were selected as uniform as possible and bunches were pollinated from the same male palm tree. Bunches were sprayed at both hababouk and the beginning of fruit color break stages with GA3, NAA, PUT, SA, N-(2-chloro-4-pyridinyl)-N'-phenyl urea (CPPU, 'Cytophex') and BA. Palms were subjected to seven foliage treatments with three replicates per treatment and three bunches for each replicate (i.e., 7 treatments x 3 replicates x 3 bunches = 63 bunches on 11 palm trees). Treatments arranged in a complete randomized design were as follow:

1- Water only (control); 2- NAA (50 ppm); 3- GA3 (50 ppm); 4- CPPU (10 ppm); 5- PUT (8 mM); 6- BA (50 ppm); 7- SA (50 ppm).

The surfactant Nourfilm (produced by Alam Chemica Co) at the rate of 40 cm/100 L water was added to all sprayed substances in order to obtain best penetrating results and bunches were sprayed once in the early morning. In order to determine the effect of the different treatments on fruit physical and chemical characteristics, a sample of ten strands were randomly collected from each bunch/ replicate during both seasons at the commercial harvest date where the control fruits reached full maturity and yellow color. To study the effect of the different treatments on fruit storage ability and shelf life, a second fruit sample of twenty five strands was randomly collected from each replicate when every treatment reached full maturity and yellow color and harvest date for each treatment in both seasons was recorded. Strands were kept at 0°C and 85-90% relative humidity for 45 days and the incidence percentages of fruit rutab, decay and weight loss were determined every fifteen day during the cold storage.

Physical properties. Fruit physical properties were determined at harvest; fruit and pulp weight (g), fruit diameter and length (mm), fruit volume (cm^3). Also, ground fruit color was estimated by giving five degrees of color stage as follow; (1) = 100 % green, (2) = 25% yellow (3) = 50% yellow, (4) = 75% yellow and (5) = 100% yellow.

Chemical properties. Fruit chemical properties were determined at harvest; the percentage of total soluble solids was measured by a hand refractometer, acidity (%) was determined by titration according to AOAC (1995), carotenoids and total chlorophyll contents (mg/100 g peel fresh weight) were achieved by the method of Moran & Porath (1980), as 80% acetone extract was colorimetrically assayed at 650nm, for total chlorophyll and 440 nm for carotene using Spectrophotometer and the percent of reducing, non-reducing and total sugars were determined according to the method of Malik & Singh (1980).

Statistical analysis. Data obtained were subjected to analysis of variance (ANOVA) to detect treatment effect. Mean separation were performed by using least

significant difference (LSD) at the p≤ 0.05 level. The data were analyzed using statistical analysis system (SAS 2000) version 8.02.

Results and Discussion

Fruit physical characteristics. Data obtained in both seasons are presented in Table 1. All sprayed substances (SA) significantly increased fruit weight, diameter, length and volume and pulp weight when compared with the control. GA3 and PUT sprays resulted in a significant higher effect in increasing fruit weight, length and volume and pulp weight than NAA in the first season with no significant difference between them. However, in the second season no significant differences were obtained among the NAA, GA3, CPPU, PUT and BA treatments. In the mean time, fruit diameter did not significantly differ among the previously mentioned compounds in both seasons. In addition, data of both seasons showed a remarked delay in the fruit green color break by all sprayed compounds as compared with the control. Fruit green color break was significantly lower by NAA than BA and CPPU sprays in the first season. Moreover, no significant difference between BA and CPPU on one hand and between NAA, GA3, PUT and SA treatments on other hand was found. In the second season, the NAA and SA had a significant higher effect on retarding fruit green color break than BA, PUT and CPPU with no significant differences between BA, putrescine and cytophex on one hand and between NAA, GA3 and SA on the other hand was obtained.

In general, the data obtained in our study showed that all sprayed growth regulators had positive influences in increasing fruit weight, diameter, length and volume and pulp weight and retarded fruit green color break of Barhee dates. This increment in fruit physical characteristics was also reported by numerous investigations working on different fruit trees (Bagni & Torrigiani 1992; Shabana et al 1998; Aljuburi et al 2000, 2001; Stern et al 2006; Aboutalebi & Beharoznam 2006). The improvement in fruit physical properties as a result of the different growth regulators treatments might be due to their influence in enlarging the cells size and enhancing the strength of carbohydrate sink, thus increasing fruit size and weight. Similarly, Valero et al (2002) reported that polyamines are essential for cell growth and differentiation and their intracellular concentrations increase during periods of rapid cell proliferation. Also, the role of putrescine in delaying fruit color break was reported by Serrano et al (2003), Martinez-Romero et al (2002) and Valero et al (1999). BA and CPPU sprays were found to delay chlorophyll breakdown and fruit aging (Stern et al 2006).

Fruit chemical characteristics. The effect of the various treatments on fruit chemical parameters at harvest are presented in Table 2. The data obtained showed that fruit acidity was significantly increased by spraying NAA and SA (in both seasons), PUT (in the first season) and GA3 (in the second season) when compared with the unsprayed control. No significant difference was obtained among the previously mentioned treatments during both seasons. In addition, fruit chlorophyll was increased significantly with all treatments during both seasons. Spraying SA had a significant higher effect in increasing the fruit chlorophyll content than BA and cytophex in the first season only, whereas, no significant difference was obtained among the SA, NAA, GA3 and PUT. In the second the SA and NAA had similar and higher effect in increasing peel chlorophyll content than BA, cytophex and PUT with no significant differences were obtained among the BA, cytophex and PUT treatments. A significant increase in the fruit non-reducing sugars was obtained by NAA, GA3, SA and PUT sprays (in both seasons) and CPPU (in the first season), with no significant differences found among the previously mentioned treatments during both seasons.

Total soluble solids content was decreased by NAA, SA and putrescine sprays (in both seasons) and GA3 (in the second season) as compared with the control, with no significant difference was obtained among the previously mentioned treatments during both seasons. Moreover, the fruit reducing sugars were also decreased with all treatments (except BA) during both seasons with no significant differences obtained among them in the first season. However, in the second season the highest decrease of reducing sugars content was obtained by salicylic acid sprays. In addition the NAA, PUT,

GA3 and CPPU treatments showed no significant difference among them in the second season. Fruit total sugars were decreased by spraying NAA, SA, CPPU and PUT in both seasons and by GA3 in the first season. In the mean time, all sprayed substances decreased the fruit carotene content in both seasons as compared with the water sprayed control.

Table 1

Effect of different growth regulators sprays on the physical characteristics of Barhee fruits during 2008 and 2009 seasons

Treatments	Fruit weight (g)	Fruit volume (cm^3)	Fruit length (mm)	Fruit diameter (mm)	Pulp weight (g)	Ground color
2008 year						
Control	9.21	8.80	2.48	2.04	8.54	5.00
NAA	12.68	12.17	3.07	2.60	11.38	3.60
GA3	14.86	14.63	3.53	2.65	13.75	4.00
CPPU	13.90	13.50	3.42	2.72	12.67	4.22
PUT	14.47	14.00	3.48	2.63	13.83	4.04
BA	13.84	13.33	3.18	2.47	12.70	4.40
SA	10.80	10.45	2.80	2.45	9.81	4.00
L.S.D 0.05	1.61	1.74	0.37	0.48	1.76	0.46
2009 year						
Control	9.97	9.87	2.93	2.30	8.98	5.00
NAA	13.60	13.17	3.37	2.60	12.61	4.02
GA3	13.86	13.83	3.33	2.65	12.84	4.12
CPPU	14.90	14.50	3.42	2.72	13.67	4.24
PUT	14.17	14.00	3.60	2.63	12.83	4.24
BA	15.34	14.83	3.38	2.67	14.03	4.36
SA	10.85	10.85	2.98	2.45	9.81	4.06
L.S.D. 0.05	2.16	1.80	0.30	0.26	1.46	0.18

The high increase in fruit acidity, non-reducing sugars and total chlorophyll and the decrease in fruit acidity, TSS and carotene contents obtained in our study by NAA, GA3 and CPPU application might translate their influence in retarding fruit ripening process as mentioned before by (Hussein et al 1996; Moustafa et al 1996; Moustafa & Seif 1996; Aljuburi et al 2000) working on date palm fruit. Similarly, the role of PUT and SA in delaying fruit ripening was indicated. The main effect of PUT is lowering ethylene production and respiration rate as well as inducing mechanical resistance (Valero et al 1999; Martinez-Romero et al 2002). SA was reported to activate the metabolic consumption of soluble sugars to form new cell constituents as a mechanism for stimulating plant growth, and might also be assumed to inhibit polysaccharide-hydrolyzing enzyme system and/or accelerate the incorporation of soluble sugars into polysaccharides (Akhodary 2004). The previous mentioned might be leading factors to the role of SA in retarding fruit ripening.

Harvest date. The effect of different foliar sprays on fruit harvest date (ripe) in both seasons is presented in Table 3. Ripening period was prolonged by 38–30, 21 and 24 days for NAA and GA3, SA and PUT sprays, respectively as compared with the water sprayed control. Cytophex had a moderate effect on delaying fruit ripening, whereas, BA delayed fruit ripening by only 10 days in comparison with the control.

Table 2

Effect of different growth regulators sprays on the chemical characteristics of Barhee fruits during 2008 and 2009 seasons

Treatments	Acidity (%)	TSS (%)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)	Total Chlorophyll mg/100g	Carotene mg/100g
Control	0.31	33.4	21.64	8.53	30.17	2.94	8.47
NAA	0.49	30.3	18.38	9.97	28.35	5.74	4.04
GA3	0.43	31.8	18.47	9.68	28.15	4.86	3.75
CPPU	0.38	32.2	18.70	9.69	28.39	4.68	3.19
PUT	0.48	29.4	18.54	9.48	28.02	5.38	3.74
BA	0.38	33.6	19.89	8.67	28.56	4.28	4.23
SA	0.53	30.4	17.47	10.78	28.15	6.03	3.29
L.S.D 0.05	0.13	1.7	2.72	0.86	1.64	1.26	3.43
2009 year							
Control	0.39	32.8	20.28	9.23	29.43	2.18	7.83
NAA	0.58	30.0	17.63	10.83	27.46	7.37	4.76
GA3	0.61	27.6	17.57	10.93	28.40	6.15	3.28
CPPU	0.48	31.9	17.45	9.74	27.19	4.83	4.14
PUT	0.42	28.4	17.10	10.37	27.47	4.87	4.76
BA	0.42	31.6	18.17	9.93	28.10	4.43	5.48
SA	0.63	28.4	14.93	10.83	25.76	7.86	4.63
L.S.D 0.05	0.17	2.7	2.46	1.13	1.82	2.08	2.08

Table 3

Effect of different growth regulators sprays on the harvesting date of Barhee fruits during 2008 and 2009 seasons

Treatments	Harvest date	
	2008 year	2009 year
Control	1/8	27/7
NAA	8/9	4/9
GA3	30/8	2/9
CPPU	18/8	14/8
PUT	21/8	18/8
BA	10/8	12/8
SA	24/8	22/8

Fruit quality during storage. The effect of the different spray treatments on fruit storage ability determined as the percent of rutab incidence of fruits and weight loss in both seasons is presented in Tables 4 and 5. The data obtained showed that rutab percent during 45 days of storage at 0 °C and 85-90 % RH was significantly reduced by all treatments. NAA resulted in the lowest rutab percent, followed by GA3, PUT, SA, cytophex and BA sprays. The storage life of Barhee dates treated with NAA was extended by 30 day without incidence of any fruit rutab occurred, however, by 45 day the fruit reached rutab percentage of 12.76 and 11.32 in 2008 and 2009 seasons, respectively. Regarding the effect of the different treatments on fruit weight loss during storage, the data in table 5 revealed that the percentage of fruit weight loss tended to decrease with all sprayed substances when compared with the control. Weight loss is an important factor that limits postharvest storage life of fruit (Adato & Gazit 1974).

Table 4

Effect of different growth regulators sprays on the fruit rutab percentage during storage at 0 °C and 85% RH of Barhee fruits during 2008 and 2009 seasons

Treatments	Rutab percentage		
	After 15 days	After 30 days	After 45 days
2008 year			
Control	12.43	32.65	86.98
NAA	0.0	0.0	12.76
GA3	1.32	4.65	16.25
CPPU	4.34	13.54	22.34
PUT	1.23	5.87	12.43
BA	6.65	14.43	37.33
SA	2.67	5.33	24.33
2009 year			
Control	16.65	28.53	95.00
NAA	0.0	0.0	11.32
GA3	2.33	7.67	18.46
CPPU	5..67	12.76	31.38
PUT	1.67	6.72	19.45
BA	3.21	18.65	33.33
SA	4.67	4.42	20.33

Table 5

Effect of different growth regulators sprays on the fruit weight loss percentage during storage at 0°C and 85% RH of Barhee fruits during 2008 and 2009 seasons

Treatments	Fruit weight loss percentage		
	After 15 days	After 30 days	After 45 days
2008 year			
Control	3.63	6.76	13.24
NAA	2.00	3.42	9.45
GA3	2.23	4.06	8.21
CPPU	2.82	4.79	12.22
PUT	2.35	4.04	10.80
BA	2.76	5.32	12.55
SA	2.17	5.12	9.30
L.S.D 0.05	0.48	1.89	3.76
2009 year			
Control	3.84	8.5	13.46
NAA	2.21	4.42	8.45
GA3	2.33	5.07	9.21
CPPU	2.76	5.39	10.22
PUT	1.95	4.74	8.80
BA	2.75	5.08	10.55
SA	2.21	4.28	9.30
L.S.D0.05	0.82	2.74	4.27

Fruits going into ripening and senescence are mainly characterized by disintegration of organelle structures, intensive loss of chlorophyll and proteins, membrane leakage and breakdown of cell wall components leading to loss of tissue structure (Paliyath & Droillard

1992; Buchanan-Wollaston 1997). Ethylene is known to have primitive effect on ripening and senescence processes (Abeles et al 1992). From the results above, decreasing fruit deterioration (reduction of rutab incidence and weight loss) might be due the effect of the sprayed substances on regulating ethylene production or action, and thus, slowing down fruit senescence. Polyamines are well-known regulators of growth and differentiation and may compete directly with ethylene for their common precursor S-adenosylmethionine, thus reduce or even nullify ethylene emission in the final days of fruit growth (Bagni & Torrigiani 1992). Also, PUT application was found to reduce the activities of fruit softening enzymes in the skin and pulp tissues (Khana et al 2007). SA significantly maintained fruit firmness and lowered fruit decay during cold storage (Wanga et al 2006).

Conclusions. From the above results it might be concluded that, the GA3, NAA and putrescine treatments had significant higher effect in extending shelf life and decreasing fruit weight loss percent than the other treatments without any deterioration in fruit characteristics before and during cold storage.

Acknowledgements. Authors thank the Deanship of Scientific Research and Research Center, College of Food and Agricultural Sciences, King Saud University for funding this research.

References

A.O.A.C., 1995 Association of Official Agricultural Chemists, Official Methods of Analysis. 15th Ed, Washington, D.C., USA.

Abeles F. B., Morgan, P. Saltveit, M. E., 1992 Ethylene in Plant Biology, 2nd edition. Academic Press, San Diego.

Aboutalebi A., Beharoznam B., 2006 Study on the effects of plant growth regulators on date fruit characteristics. International conference on date palm production and processing technology, book of abstracts. 9-11 May 2006 – Muscat, Oman.

Adato I., Gazit S., 1974 Water-deficit stress, ethylene production, and ripening in avocado fruits. Plant Physiol **53**:45-46.

Akhodary S. E., 2004 Effect of salicylic acid on the growth, photosynthesis and carbohydrate metabolism in salt stressed maize plants. Int J Agr Biol **6**(1):1-8.

Aljuburi H. J., Al-Masry H., Al-Muhanna S. A., 2000 Fruit characteristics and productivity of date palm trees (*Phoenix dactylifera* L.) as affected by some growth regulators. HortScience **35**:476-477.

Aljuburi H. J., Al-Masry H. H., Al-Banna M., Al-Muhanna S. A., 2001 Effect of some growth regulators on some fruit characteristic and productivity of date palm trees (*Phoenix dactylifera* L). 2- Khaniezy cultivar. The second International Conference on Date Palms. March 25-27, Al- Ain, United Arabic Emirates. Pp.21.

Bagni N., Torrigiani P., 1992 Polyamines: a new class of growth substances. Progress in Plant Growth Regulation. Kluwer Academic Publishers, Dordrecht, Pp 264-275.

Buchanan–Wollaston V., 1997 The molecular biology of leaf senescence. J Exp Bot **48**:181-199.

F.A.O., 2009 FAOSTAT FAO Statistics Division. http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#anco

Gaffney T., Friedrich L., Vernooij B., Negrotto D., Nye G., Uknes S, Ward E,. Kessman H., Ryals J., 1993 Requirement of salicylic acid for the induction of systemic acquired resistance. Science **261**:754–756.

Hong Y. J., Tomas-Barberan F. A., Kader A. A., Mitchell A. E., 2006 The flavonoid glycosides and procyanidin composition of deglet noor dates (*Phoenix dactylifera*). J Agric Food Chem **54**:2405-2411.

Hussein M. A., Mahmoud H. M., Amen K. I. A., Mustafa M., 1996 Changes in the physical and chemical characteristics of Zaghloul dates during development and maturity as affected by GA3 and CCC under Assiut Governorate conditions. Proceedings of the Third Symposium on the Date Palm in Saudi Arabia. January, **17-20**:389-404.

Ke D., Romani R. J., 1988 Effects of spermidine on ethylene production and the senescence of suspension-cultured pear fruit cells. Plant Physiol Biochem **26**:109-116.
Khana A. S., Singh Z., Abbasi A. N., 2007 Pre-storage putrescine application suppresses ethylene biosynthesis and retards fruit softening during low temperature storage in „Angelino" plum. Postharvest Biology and Technology **46**(1):36-46.
Kramer G. F., Wang C. Y., Conway W. S., 1991 Inhibition of softening by polyamine application in "Golden Delicious" and "McIntosh" apples. J Amer Soc Hort Sci **116**:813–817.
Leslie C. A., Romani R. J, 1988 Inhibition of ethylene biosynthesis by salicylic acid. Plant Physiol **88**:833–837.
Malik C. P., Singh M. B., 1980 Plant enzymology and histoenzymology. A text manual, kalyani Publishing, New Delhi, India.
Martinez-Romero D., Serrano M., Carbonell A., Burgos L., Riquelme F., Valero D., 2002 Effects of postharvest putrescine treatment on extending shelf life and reducing mechanical damage in apricot. Journal of Food Science **67**:1706–1712.
Martinez-Romero D., Valero D., Serrano M., Riquelme F., 1999 Effects of postharvest putrescine and calcium treatments on reducing mechanical damage and polyamines and ABA levels during lemon storage. J Sci Food Agr **79**:1589–1595.
Moran R., Porath D., 1980 Carotenoids determination in intact tissues. Plant Physiol **65**:478-479.
Moustafa A. A., Seif S. A., Abou-El-Azayem A. I., 1996 Date fruit response to naphthalene acetic acid. Proceedings of the Third Symposium on the Date Palm in Saudi Arabia. January, **17-20**:369-378.
Moustafa A. A., Seif S. A., 1996 Effect of ethrel and GA treatments on yield and fruit quality of seewy date palms, grown in El-Fayoum Governorate. Proceedings of the Third Symposium on the Date Palm in Saudi Arabia. January, **17-20**:379-388.
Paliyath G., Droillard M. J., 1992 The mechanism of membrane deterioration and disassembly during senescence. Plant Physiol Biochem **30**:437-812.
S.A.S. Institute, 2000 Users Guide: Statistic Version 8.02 SAS Institute, Cary, NC, USA.
Sayyari M., Bablar M., Kalantari S., Serrano M., Valero D., 2009 Effect of salicylic acid treatment on reducing chilling injury in stored pomegranates. Postharvest Biology and Technology **53**:152-154.
Serrano M., D. Martinez-Romero, F. Guillen , Valero D., 2003 Effects of exogenous putrescine on improving shelf life of four plum cultivars. Postharvest Biology and Technology **30**:259-271.
Shabana H. R., Shereqi R. K. Ibrahim M., Al Safadi W., 1998 Effect of naphthalene acetic acid application on the time of ripening and quality of cv. Khaniezy. The First International Conference on Date Palms. March 8-10 Al-Ain, United Arabic Emirates, 72-77.
Stern R. A., Ben Arie R., Applebaum S., Flaishman M., 2006 Cytokinins increase fruit size of Delicious and Golden Delicious (*Malus domestica*) apple in warm climate. J Hort Sci Biotech **18**:51-56.
Valero D., Martinez-Romero D., Serrano M., Riquelme M. F., 1999 Polyamine response to external mechanical bruising in two mandarin cultivars. Hort Science **33**:1220–1223.
Valero D., Martinez-Romero D., Serrano M., 2002 The role of polyamines in the improvement of the shelf life of fruit. Trends Food Sci Technol **13**:228–234.
Vernooij B., Friedrich L., Morse A., Rest R., Kolditz–Jawahar R., Ward E., Uknef S., Kessmann Ryalf J., 1994 Salicylic acid is not the translocated signal responsible for inducing systemic acquired resistance but is required for signal transduction. Plant Cell **6**:959–965.
Wang C. Y., Conway W. S., Abbott J. A., Kramer G. F., Sams C. E., 1993 Postharvest infiltration of polyamines and calcium influences ethylene production and texture changes in "Golden Delicious" apples. J Amer Soc Hort Sci **118**:801–806.

Wanga L., Chena S., Kongb W., Li S., Archbold D., 2006 Salicylic acid pretreatment alleviates chilling injury and affects the antioxidant system and heat shock proteins of peaches during cold storage. Postharvest Biology and Technol **41**(3):244-251.

Received: 21 February 2011. Accepted: 05 March 2011. Published online: 04 June 2011.
Authors:
H. A. Kassem, Plant Production Dept., College of Food and Agricultural Sciences, King Saud University, Kingdom of Saudi Arabia, P.O. BOX 2460, Riyadh 11451, Kingdom of Saudi Arabia, e-mail: Kassem60@yahoo.com,
R. S. Al-Obeed, Plant Production Dept., College of Food and Agricultural Sciences, King Saud University, Kingdom of Saudi Arabia, P.O. BOX 2460, Riyadh 11451, Kingdom of Saudi Arabia, e-mail: robeed@hotmail.com,
M. A. Ahmed, Plant Production Dept., College of Food and Agricultural Sciences, King Saud University, Kingdom of Saudi Arabia, P.O. BOX 2460, Riyadh 11451, Kingdom of Saudi Arabia, e-mail: khider1968@yahoo.com.
How to cite this article:
Kassem H. A., Al-Obeed R. S., Ahmed M. A., 2011 Extending harvest season and shelf life and improving quality characters of barhee dates. AAB Bioflux **3**(1):67-75.