Assiut J. Agric. Sci., (47) No. (6-1) 2016 (181-190) *ISSN: 1110-0486*
Website: http://www.aun.edu.eg/faculty_agriculture *E-mail: ajas@aun.edu.eg*

Effect of GA_3, Calcium Chloride and Vapor guard Spraying on Yield and Fruit Quality of Manfalouty Pomegranate Trees

El-Akkad, M.M.; Fatma El-Zahraa M. Gouda and R.A. Ibrahim

Pomology Department, Fac. Agric, Assiut University

Received on: 1/1/2017 **Accepted for publication on:**18/1/2017

Abstract

This study was carried out at the Experimental Orchard, Faculty of Agriculture, Assiut University, Egypt, to study the effect of GA_3, calcium chloride and vapor guard spraying on fruiting of Manfalouty pomegranate during 2014 and 2015 seasons. The experiment was set up in a complete randomized block design with three replicates, one tree per each.

GA_3, calcium chloride and vapor guard spraying significantly increased the yield/tree compared to unsprayed ones. GA_3 spraying gave the highest yield followed by calcium chloride. On the other hand, all treatments significantly decreased the fruit cracking percentage compared to unsprayed ones. The least fruit cracking was recorded due to calcium chloride spraying.

All treatments significantly increased fruit weight and fruit dimensions as well as aril percentage and juice contents compared to unsprayed ones. Moreover, calcium chloride and vapor guard significantly improved the fruit chemical constituents, whereas, GA_3 spraying decreased the chemical fruit constituents compared to unsprayed ones.

It could be concluded that spraying Manfalouty pomegranate trees with calcium chloride at 40 or 80 ml/L at 1st July was necessary to get high yield, reduce the fruit cracking percentage and improve fruit quality.

Keywords: GA_3, Calcium, Vapor guard, Fruit cracking, Yield, Fruit quality, Manfalouty pomegranate.

Introduction

Pomegranate (*Punica granatum*) is one of the oldest known edible fruits. It mentioned in the holy Quran and in the ancient Egyptian mythology. It is native of Iran and is extensively cultivated in Mediterranean regions. Pomegranate is one of the most suitable fruits for tropical and subtropical regions (El-Sese, 1988; Sheikh and Manjula, 2012 and Bakeer, 2016).

Pomegranate fruits are rich in sugars, vitamins, polyphenols and mineral (Bakeer, 2016).

Manfalouty is considered one of the most important pomegranate cultivars grown successfully in upper Egypt (Hegazi *et al*., 2014).

Cracking damage is one of the most serious problem faces pomegranate growers. It causes loss about 50% of the marketable fruits. This problem is due to the improper water management and deficiency of micronutrients and Ca (Sheikh and Manjula, 2012).

Calcium plays an important role in reducing fruit cracking, it improves fruit growth and creates a state of water balance between epicarp and inside fruit tissues, as well as maintains fruit cell wall elasticity and firmness (Mitra, 1997). Applying calcium before harvest im-

proves various fruits quality (Pooviah, 1979 and Cheour *et al*, 1990).

Gibberellic acid was widely used in various horticultural crops for improving fruit set, fruit weight and dimensions, aril %, firmness, peel thickness, yield and its components, total sugars, vitamin C, total anthocyanins and total soluble solids percentage (Khalil and Aly, 2013 and Merwad *et al*., 2016). Spraying pomegranate with various concentrations of GA_3 reduced the percentage of fruit cracking (Sepahi, 1986; El-Salhy, 1996; El-Mahdy *et al*., 2009 and Hegazi *et al*., 2014).

Vapor guard is an anti-transpirant and frost protectant and forms a thin film covering the plant, thereby reducing water loss. It is believed that silicon precipitates beneath the top layer of cell to improve the natural resistance of plants against unfavourable climatic and other conditions (Verreynne and Der Merwe, 2011).

This investigation aimed to study the effect of spraying with GA_3, calcium chloride, and vapor guard on controlling cracking damage and improving the fruiting of Manfalouty pomegranate cultivar.

Materials and Methods

This experiment was carried out during two successive seasons of 2014 and 2015 at the Fruit Orchard of Faculty of Agriculture, Assiut University, Egypt. Eighteen (18) healthy, nearly uniformed in shape, size and productivity pomegranate trees of Manfalouty cultivar fourty years old were chosen for this study. Trees are grown on clay soil and spaced 5x5 m apart, subjected to surface irrigation system, and received the same horticultural practices.

This investigation included the following six treatments.

1- Control (spraying water).
2- Spraying with gibberellic acid at 50 ppm
3- Spraying with gibberellic acid at 100 ppm
4- Spraying with calcium chloride at 40 mL/L.
5- Spraying with calcium chloride at 80 mL/L.
6- Spraying with vapor guard at 20 mL/L.

GA_3, calcium chloride and vapor guard solution were prepared by dissolving the assigned amount in the required water. The fruits received solutions with triton B as a wetting agent, using a hand held spray wand at the 1st week of July (two months of fruit set) during the two seasons of study.

The experiment was arranged in a complete randomized block design with six treatments each treatment replicated three times, one tree per each.

At commercial maturity stage the response of Manfalouty pomegranate to gibberellic acid, calcium chloride and vapor guard was evaluated through the following determinations:

1- Yield):

At harvest time the fruits per each tree was harvested and weighed then yield/tree was recorded.

2- Fruit cracking percentage:

The percentage of cracked fruits was calculated as follows:

$$\text{Cracking (\%)} = \frac{\text{Number of cracked fruits/tree}}{\text{Total number of fruits/tree}} \text{ x } 100$$

3- Fruit physical properties:

a) Fruit weight (g): At mature stage a sample of ten fruits per replicate was weighed.

b) Fruit height and diameter (cm) were measured by using vernier caliper.

c) Fruit peel and aril were weighed by digital balance.

d) Aril/fruit ratio was calculated as follows:

$$\text{Aril/fruit ratio} = \frac{\text{Aril weight (g)}}{\text{Fruit weight (g)}} \times 100$$

e) Fruit juice volume (cm^2) was measured using graduated cylinder and juice percentage to whole the fruit was calculated.

4- Fruit chemical properties:

a) Total soluble solids percentage (TSS%) was determined in fruit juice using a hand refractometer.

b) Total acidity" using titration by NaOH at 0.1 N and phenolphthalene as an indicator then expressed as citric acid, according to A.O.A.C. (1985) and then TSS/acid ratio was calculated.

c) Percentage of reducing sugars in juice was determined, according to Land and Eynon procedure which outlined in A.O.A.C. (1985).

d) Vitamin C content (mg ascorbic acid/100 mL juice): It was determined by titration against 2,6 dichlorophenol indophenol dye according to A.O.A.C. (1985).

e) Total anthocyanin content of juice was calculated according to Rabino and Mancinelli (1986).

Statistical analysis:

Data were tabulated and statistically analyzed according to Snedecor and Cochran (1972). Means were compared using the least significant differences (LSD) values at 5% levels of the probability.

Results and Discussion

1- Yield and fruit cracking:

Data presented in Table (1) showed the effect of GA_3, calcium chloride and vapor guard on yield/tree and fruit cracking percentage of Manfalouty pomegranate trees during 2014 and 2015. It is obvious from the data that the results took similar trend during the two studied seasons.

In general view, data showed that all treatments significantly increased the yield/tree compared to untreated ones. The highest values of yield/tree were recorded on the trees that sprayed by GA_3 at 100 ppm, (96.45 & 106.45 kg). On other hand, the lowest values were recorded on untreated trees, (75.91 & 84.40 kg) during the two studied seasons, rsepectively. The obtained yield/tree were (89.74, 96.45, 90.55, 88.18, 80.70 & 75.91) and (103.50, 106.45, 100.28, 96.38, 88.50 & 84.40 kg/tree) due to spray with GA_3 at 50 ppm, GA_3 at 100 ppm, calcium chloride at 40 ml/L, calcium chloride at 80 ml/L, vapor guard at 20 ml/L and unsprayed one during the two studied seasons, respectively.

Hence, the corresponding increment percentage over unsprayed ones were (18.22, 27.06, 19.29, 16.16 & 6.31%) and (22.63, 26.13,

18.82, 14.19 & 4.86%) during the two studied seasons, respectively.

Contrarly, all treatments significantly decreased the fruit cracking percentage compared to unsprayed ones. The least values was recoded on the trees that sprayed by calcium chloride at 80 ml/L (5.67 & 6.17%), whereas, the highest ones were obtained on unsprayed ones (11.80 & 13.65%) during the two studied seasons, rsepectively. The recorded fruit cracking percentage was (7.39, 7.60, 6.09, 5.67, 7.21 & 11.80%) and (8.32, 8.65, 6.82, 6.17, 8.62 & 13.65%) due to spray with GA_3 at 50 ppm, GA_3 at 100 ppm, calcium chloride at 50 ml/L, calcium chloride, calcium chloride at 80 ml/L, vapor guard at 20 ml/L and unsprayed one during the two studied seasons, respectively. Hence, the corresponding decrement percentage of fruit cracking percentage under unsprayed ones was attained (37.37, 35.59, 48.39, 51.95 & 38.90%) and (39.05, 36.63, 50.04, 54.80 & 36.85%) during the two studied seasons, respectively.

The effect of $CaCl_2$ and GA_3 on reducing the fruit cracking percentage may be attributed to that calcium enhanced fruit growth and cause maintaining of water balance between exocarp and inside fruit tissues and keep fruits cell walls flexibility and strength. GA_3 can influence fruit cracking indirectly by influencing of permeability or elasticity of the fruit cuticle (El-Salhy, 1996; Hegazi *et al.,* 2014 and Bakeer, 2016).

These results are agree with those reported by El-Salhy (1996), Mohamed (2004), Ali (2006), El-Mahdy *et al*. (2009), Sheikh and Manjula (2012), Ahmed *et al*. (2014), Bakeer (2016) and Digrase *et al*. (2016).

2- Fruit properties:

A- Physical fruit properties:

These include fruit weight, fruit dimension, aril percentage and juice percentage. As shown in Tables (1 & 2), fruit weight and its dimension took similar trend in response to different treatments. Generally, the results reported that all treatments significantly increased all the studied physical fruit properties compared to untreated ones. GA_3 at 100 ppm gave the highest values of these traits, where the fruit weight reached (434.33 & 456.18 g), aril percentage (68.11 & 66.29%) and juice percentage (39.80 & 40.61%) during the two studied seasons, respectively.

Table 1. Effect of GA_3, calcium chloride and vapor guard spraying on yield/tree, fruit cracking and fruit weight of Manfalouty pomegranate during 2014 and 2015 seasons.

Treatment		Yield/tree (kg)		Fruit cracking %		Fruit weight (g)	
		2014	2015	2014	2015	2014	2015
Control		75.91	84.40	11.80	13.65	328.33	359.17
GA_3	50 ppm	89.74	103.50	7.39	8.32	405.83	418.50
	100 ppm	96.45	106.45	7.60	8.65	434.33	456.18
Calcium chloride	40 (ml/L)	90.55	100.28	6.09	6.82	396.50	412.50
	80 (ml/L)	88.18	96.38	5.67	6.17	385.00	403.33
Vapor guard 20 (ml/L)		80.70	88.50	7.21	8.62	365.80	381.50
L.S.D. 5%		2.86	3.31	0.58	0.42	12.64	15.17

Table 2. Effect of GA_3, calcium chloride and vapor guard spraying on some physical fruit properties of Manfalouty pomegranate during 2014 and 2015 seasons.

Treatment		Juice %		Aril weight %		Fruit Height (cm)		Fruit diameter (cm)	
		2014	2015	2014	2015	2014	2015	2014	2015
Control		36.30	37.50	59.76	58.37	6.46	7.08	7.63	8.17
GA_3	50 ppm	39.26	40.11	67.12	65.90	7.25	7.80	8.27	8.85
	100 ppm	39.80	40.61	68.11	66.29	7.68	8.15	8.94	9.18
Calcium chloride	40 (ml/L)	37.70	38.93	65.87	63.13	7.01	7.67	8.18	8.67
	80 (ml/L)	37.85	38.66	65.27	62.82	6.93	7.55	7.98	8.48
Vapor guard 20 (ml/L)		32.18	38.06	62.82	60.16	6.84	7.43	7.91	8.40
L.S.D. 5%		1.83	1.56	1.23	1.47	0.32	0.28	0.26	0.21

The recorded fruit weight were (405.83, 434.33, 396.50, 385.00, 365.80 & 328.33 g) and (418.50, 456.18, 412.50, 403.33, 381.50 & 359.17 g) due to spray with GA_3 at 50 ppm, GA_3 at 100 ppm, calcium chloride at 40 ml/L calcium chloride at 80 ml/L, vapor guard at 20 ml/L and unsprayed one during the two studied seasons, respectively. Hence, corresponding the increment percentage of fruit weight over unsprayed ones were (23.60, 32.28, 20.76, 17.26 & 11.41%) and (16.52, 27.00, 14.85, 12.30 & 6.22%), respectively.

These results may be due to that gibberellins are involved in cell division and cell elongation, resulted in influence fruit weight and size. On

the other hand, calcium enhanced fruit growth and cause maintaining of water balance. These effects induce an obvious promotion increasing in fruit weights and their dimension and their juice contents.

The findings are in agreement with El-Salhy (1996), Mohamed (2004), Ali (2006), El-Mahdy *et al*. (2009), Abdi Reddy and Prasad (2012) and Digrase *et al*. (2016).

B- Chemical fruit constituents:

Data presented in Tables (3 & 4) indicated that calcium chloride and vapor guard spraying significantly improved the fruit chemical constituents in terms of increasing the total soluble solids and reducing sugars as well as TSS/acid ratio and anthoycanins contents and reducing total acidity percentage compared to GA_3 spraying or unsprayed ones. On the other hand, spraying GA_3 either at 50 or 100 ppm significantly decreased the total soluble solids, reducing sugars, TSS/acid ratio and anthocyanins content compared to unsprayed ones. All treatments significantly increased vitamin C content compared to unsprayed ones.

The highest values of TSS (16.83 & 17.20), (16.10 & 16.67%), reducing sugar (11.92 & 12.61%), (11.62 & 12.20%) and anthocyanin content (63.80 & 65.31), (62.91 & 64.25%) were recorded due to spray by calcium chloride at 40 ml/L or 80 ml/L during the two studied seasons, respectively. These values were (16.33 & 15.67%), (11.35 & 11.18%) and (58.90 & 57.82%) due unsprayed ones during the two studied seasons, respectively. Hence, the corresponding increment percentage of these traits due calcium chloride over unsprayed ones were attained (3.06 & 5.33%), (2.74 & 6.38%), (5.02 & 11.10%), (3.93 & 9.12%) and (8.32 & 10.88%), (8.80 & 11.12%) during the two studied seasons, respectively.

Table 3. Effect of GA_3, calcium chloride and vapor guard spraying on TSS, acidity and TSS/acid ratio of Manfalouty pomegranate during 2014 and 2015 seasons.

Treatment		TSS %		Acidity %		TSS/acid ratio	
		2014	2015	2014	2015	2014	2015
Control		16.33	15.67	1.305	1.237	12.51	12.67
GA_3	50 ppm	15.10	15.33	1.256	1.173	12.01	13.07
	100 ppm	15.00	15.00	1.263	1.195	11.88	12.55
Calcium chloride	40 (ml/L)	16.83	16.10	1.180	1.088	14.24	14.80
	80 (ml/L)	17.20	16.67	1.088	1.024	15.83	16.28
Vapor guard 20 (ml/L)		16.76	15.87	1.221	1.130	13.78	14.04
L.S.D. 5%		0.38	0.51	0.038	0.042	0.64	0.76

Table 4. Effect of GA_3, calcium chloride and vapor guard spraying on reducing sugar, anthocyanins and vitamin C of Manfalouty pomegranate during 2014 and 2015 seasons.

Treatment		Reducing sugar%		Anthocyanins mg/L		Vitamin C Mg/100ml	
		2014	2015	2014	2015	2014	2015
Control		11.35	11.18	58.90	57.82	23.38	23.85
GA_3	50 ppm	10.78	10.60	53.54	51.10	26.61	27.22
	100 ppm	10.30	10.11	50.36	49.88	25.88	26.95
Calcium chloride	40 (ml/L)	11.92	11.62	63.80	62.91	25.60	26.36
	80 (ml/L)	12.61	12.20	65.31	64.25	25.12	25.76
Vapor guard 20 (ml/L)		11.78	11.30	62.60	61.51	24.69	25.98
L.S.D. 5%		0.37	0.43	1.68	1.39	1.11	1.02

These finding might be due to calcium effects on improving the growth and nutrition uptake and consequently improved the food synthesized that translocated to fruits and enhanced their maturation and improved its contents of chemical constituents. On other hand, GA_3 might be delayed the fruit maturation. These results were supported by the results of El-Salhy (1996), Mohamed (2994), Ali (2006), El-Hamedawy *et al*. (2008), Verreynne and Der Merwe (2011) and Hegazi *et al*. (2014).

On the light at previously results, it could be concluded that sprayed the Manfalouty pomegranate trees with calcium chloride at 40 or 80 ml/L to get high yield and reduction fruit cracking percentage with good-fruit quality.

References

Abdi Reddy, P. and D.M. Prasad (2012). Effect of plant growth regulators on fruit characters and yield of pomegranate (*Punica granatum* L.) cv. Genesh. International Journal of Plant, Animal and Environmental Sciences, Vol. 2, Issue 2, p. 91-93

Ahmed, F.F.; M.M. Mohamed; A.M.A. Abou El-Kashab and S.H.A Aeed (2014). Controlling fruit splitting and improving productivity of Manfalouty pomegranate trees by using salicylic acid and some nutrients. World Rural Observ., 6 (1): 87-93.

Ali, M.A.A. (2006). Effect of some treatments on improving pomegranate fruit quality. Ph.D. Thesis, Agricultural Science (Pomology), Faculty of Agriculture, Cairo University.

Association of Official Agricultural Chemists (1985). Official Methods of Analysis. A.O.A.C. 14th Ed. Published by A.O.A.C. Washington, D.C., U.S.A..

Bakeer, S.M. (2016). Effect of ammonium nitrate fertilizer and calcium chloride foliar spray on fruit cracking and sunburn of Manfalouty pomegranate trees. Scientia Horticulturae, 209: 300-308.

Cheour, F.; C. Willemot; J. Arul; Y. Desjardins; J. Makhlouf; P.M. Charest and A. Gosselim (1990). Foliar application of calcium chloride delays postharvest ripening strawberry. J.A.M. Soc. Hortic. Sci., 115: 789-792.

Digrase, S.S.; T.B. Tambe; A.S. Kadam and B.M. Kalalband (2016). Effect of different plant growth regulators and chemicals on growth and yield of pomegranate (*Punica granatum* L.) cv. Bhagwa. Adv. Res. Crop Improv., 7 (1) June: 96-99, Hind Agr. Res. and Training Institute.

El-Hamedawy, A.M.S.; L.L.A. El-Hassnawy and S.K.H. Krof (2008). Effect of NNA and vapor guard spraying on infection percentage disease and quality characters of local pomegranate (*Punica granatum* L.) after storage. Scientifif Journal of Karbalaa University, 6 (1): 210-215.

El-Mahdy, T.K.R.; A.K.A. Mohamed and N.I.A. Mohamed (2009). Effect of flower thinning and spraying with gibberellic acid and ethephon on yield and fruit quality of Manfalouty pomegranate cultivar. Assiut J. of Agric. Sci., 40: 69-91.

El-Salhy, A.M. (1996). Performance of single and multiple Manfalouty pomegranate fruits in response to GA_3 application. 4th Arabic Conf. for Horti Crops, El-Minia, Egypt, 757-767.

El-Sese (1988). Effect of time of fruit setting on the quality of some pomegranate cultivars under Assiut conditions. Assiut J. of Agric. Sci., 19 (4): 320-336.

Hegazi, A.; N.R. Samra; E.E.T. El-Baz; Bahan M. Khalil and M.S. Gawish (2014). Improving fruit quality of Manfalouty and Wonderfull pomegranates by using bagging and some spray treatments with gibberellic acid, calcium chloride and kaolin. J. Plant Production, Mansoura Univ., 5 (5): 779-792.

Khalil, H.A. and H.S.H. Aly (2013). Cracking and fruit quality of

pomegranate (*Punica granatum* L.) as affected by pre-harvest sprays of some growth regulators and mineral nutrients. Journal of Horticultural Sciences and Ornamental Plants, 5 (2): 71-76.

Merwad, M.A.; R.A. Eisa and A.M.M. Merwad (2016). Effect of GA_3 and some nutrients on pomegranate under South Sinai Governorate conditions. International Journal of Chem. Tech. Research, 9 (8): 104-113.

Mitra, S.K. (1997). Post harvest physiology and storage of tropical and sub-tropical fruits. CAB, INT., Nadia, West Gengal, India, pp. 84-122.

Mohamed, A.K.A. (2004). Effect of gibberellic acid (GA_3) and benzyladinine (BA) on splitting and quality of Manfalouty pomegranate fruits. Assiut J. of Agric. Sci., 35 (3): 11-21.

Pooviah, B.W. (1979). Role of calcium in ripening and senescence. Commun. Soil Sci. Plant Anal., 10: 83-88.

Rabino, I. and A.L. Mancinelli (1986). Light, temperature and anthocyanin production. J. Plant Physiol., 81 (3): 922-924.

Sepahi, A. (1986). GA_3 concentration for controlling fruit cracking in pomegranate. Iran Agric. Res., 5: 93-99.

Sheikh, M.K. and N. Manjula (2012). Effect of chemicals on control of fruit cracking in pomegranate (*Punica granatum* L.) var. Ganesh. II- International symposium on the pomegranate, Zaragoza. CIHEAM/ Universidal Miguel Henández 2012, p. 133-135.

Snedecor, G.W. and W.G. Cochran (1972). Statistical Methods, 6th Ed. The Iowa State University Press, Ames, Iowa, U.S.A.

Verreynne and Der Merwe (2011). Sunburn reduction on (Miho Wase) Satsuma mandarin. SA Fruit Journal, April/May 2011: 52-55.

تأثير رش حمض الجبريليك وكلوريد الكالسيوم والفيبرجادر علي محصول وخصائص ثمار أشجار الرمان المنفلوطي

محمد مجدي العقاد، فاطمة الزهراء محمد عبد الله جودة، رشاد عبد الوهاب إبراهيم

قسم الفاكهة – كلية الزراعة – جامعة أسيوط

الملخص

تمت دراسة تأثير الرش بحمض الجبريليك وكلوريد الكالسيوم والفيبرجادر علي محصول وخصائص ثمار الرمان المنفلوطي المنزرعة بمزرعة كلية الزراعة – جامعة أسيوط – مصر، خلال موسمي ٢٠١٤ ، ٢٠١٥ حيث تم رش الأشجار بحمض الجبريليك بتركيزي ٥٠ ، ١٠٠ جزء في المليون وكذلك كلوريد الكالسيوم بتركيزي ٤٠ أو ٨٠ مل/لتر وكذلك الفيبرجادر بتركيز ٢٠ مل/لتر مقارنة بالرش بالماء فقط وقد اوضحت النتائج ما يلي:

–أدي الرش بحمض الجبريليك أو كلوريد الكالسيوم أو الفيبرجادر إلي زيادة معنوية في وزن المحصول/ شجرة مقارنة بمحصول الأشجار غير المرشوشة. كذلك أدت جميع المعاملات إلي نقص جوهري في نسبة تشقق الثمار مقارنة بالأشجار الغير مرشوشة.

–أظهرت المعاملات أن رش حمض الجبريليك أعطي أعلي وزناً للمحصول يليه رش كلوريد الكالسيوم بينما سبب رش كلوريد الكالسيوم أقل نسبة تشقق للثمار.

–سببت جميع المعاملات زيادة معنوية في صفات الثمار الطبيعية من حيث زيادة وزن وأبعاد الثمار وكذلك نسبة اللب وحجم العصير مقارنة بالثمار الغير معاملة.

–أدي رش كلوريد الكالسيوم إلي تحسين المكونات الكيميائية للثمار من حيث المواد الصلبة الكلية والسكريات وصبغة الأنثوسيانين وفيتامين C بينما أدي رش حمض الجبريليك إلي نقص معنوي في المكونات الكيميائية للثمار مقارنة بالثمار الغير مرشوشة.

من نتائج هذه الدراسة نوصي بضرورة رش كلوريد الكالسيوم بتركيز ٤٠ أو ٨٠ مل/لتر في أول يوليو (بعد العقد بشهرين) وذلك لإنتاج محصول عال ذو ثمار جيدة مع تقليل نسبة تشقق الثمار وهي من المشاكل الإنتاجية الهامة في بساتين الرمان.