

## **IMPROVING FRUIT QUALITY OF MANFALOTY AND WONDERFULL POMEGRANATES BY USING BAGGING AND SOME SPRAY TREATMENTS WITH GIBBERELIC ACID, CALCIUM CHLORIDE AND KAOLIN.**

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### **ABSTRACT**

This study was carried out during the two successive seasons of 2012 and 2013 on Manfaloty and Wonderful pomegranate trees at 5 and 3-years old respectively, the trees were spaced at 4x4 m. grown in a sandy soil. The highest values of yield and its components i.e., fruit weight, fruit number /tree and yield /tree were recorded when Manfaloty and Wonderful pomegranate trees treated with GA<sub>3</sub> at 50 or 100ppm, CaCl<sub>2</sub> 4 %, kaolin 2.5 or 5 % and bagging treatment. The lowest percentage of fruit cracking and sunburn were obtained with bagging treatment followed by kaolin 5% and spraying by CaCl<sub>2</sub> and GA<sub>3</sub> treatments compared with the control treatment .All treatments caused a highly significant increase in Marketable fruits %. Bagging treatment gave the highest Marketable fruits percentage compared with the control and other treatments. The highest fruit length and diameter obtained by GA<sub>3</sub> 50 or 100ppm and CaCl<sub>2</sub> 2 or 4% treatment. Furthermore,GA<sub>3</sub>, kaolin and bagging treatments improved SSC, total acidity and SSC/acid ratio ,meanwhile the highest anthocyanin content in juice and peel was obtained by bagging and spraying kaolin 5% treatments in both cultivars. Therefore, these treatments could be recommended for improving Manfaloty and Wonderful pomegranate cvs performance under similar conditions of this study.

**Keywords:** Pomegranate, bagging, foliar spray, GA<sub>3</sub>, kaolin, CaCl<sub>2</sub>, fruit cracking, sunburn, fruit quality.

### **INTRODUCTION**

Pomegranate (*Punica granatum* L.) is one of the oldest known edible fruits, among the fruit kinds mentioned in the Holy Quran and an important in human medicine and its components have a wide range of clinical applications (Lansky & Newman, 2007). The cultivated area nowadays, acreage is rapidly increasing especially with Wonderful cultivar under the new reclaimed lands. The total cultivated area is about 26351 feddans. From this area, the fruiting area was about 9746 feddans which produced about 89035 tons (Ministry of Agriculture statistics, 2012). Manfaloty and Wonderful pomegranate are the most important cultivars in Egypt.

Fruit cracking is a serious problem in pomegranate which hinders its cultivation to a large extent. Cracking varies from 10 to 70% depending upon the prevailing environmental conditions. Various factors are responsible for fruit cracking which include fluctuation in soil moisture regimes, climate, tree nutrition and cultivars (Kumar *et al.*, 2010).It may also occur due to micronutrient deficiency in young fruits, while in mature fruits it might be due

to moisture imbalance or due to extreme variations in day and night temperatures (Abd El-Rhman, 2010). Cracked fruits lose their value for the fresh market and are used for processing only as fruit juice if not affected by fungi. Cracked fruits are susceptible to storage disease and have a shorter storage as well as shelf-life.

Pomegranates are especially sensitive to sunburn because they are terminal-bearing plants, with generally thin branches that bend with the increase in fruit weight as the season progresses (Melgarejo *et al.*, 2004 and Samra & Shalan, 2013). This exposes fruit parts that had developed previously in the shade, and are extremely sensitive to sunburn. Pomegranates are picked in early autumn, therefore the fruits exposed to high temperatures throughout the summer. As a result, the incidence of sunburn damage can be high causing grower losses that may exceed 30% of the harvested fruits (Melgarejo & Martinez, 1992) Controlling irrigation, bagging and spraying pomegranate with GA<sub>3</sub> or kaolin reduced the percentage of fruit cracking, sunburn (Talaat *et al.*, 2009 and Abd El-Rhman, 2010) Gibberellic acid is used widely in various horticultural crops for improving fruit set and also to control cracking of pomegranate fruit (Sepahi, 1986) and litchi (Sharma & Dhillon, 1986) In addition, GA<sub>3</sub> may be influencing cell wall strength or elasticity (Byers *et al.* 1990) The beneficial role of Ca in reducing fruit splitting might be attributed to owing as a cement material plays a vital role in increasing firmness of fruit which reduces water evaporation and increases withstand of the trees to water and drought stresses (Tuckey, 1986).

Kaolin has recently been utilized in the development of hydrophilic particle film technology. This technology uses chemically inert, non-toxic mineral particles coat to plant surfaces (Glenn *et al.* 1999). Kaolin application showed significantly positive effect on protection of fruit against sunburn on Fuji and Honeycrisp apple cultivars (Schupp *et al.*, 2002) These positive results on Kaolin application was also confirmed with studies of Melgarejo, *et al.*, (2004), Abd El-Rhman, (2010) and Samra & shalan (2013) on pomegranate and Glenn *et al.*, 1999 on apple cultivars.

Fruit bagging is one of the most effective techniques to produce high-quality, pollution-free fruits and got more attentions to the fruit producers during the recent decades were obvious. The quality of fruit bagging has been getting better and better. The effect of bagging on appearance quality (brightness, color, size and weight of single fruit), the quality of fruit contents such as total soluble solids, titrable acids, vitamin C, become more apparent procedure. Also, the influence of bagging on fruit maturity period, storage property, protection of plant disease, insect pests, sunburn and prevention from residual effects of pesticides have also been described (Jing, 2011).

Hence, the objective of this work was to study the effect of some spray treatments with GA<sub>3</sub>, CaCl<sub>2</sub>, kaolin and bagging on fruit cracking, sunburn and quality of Manfaloty and Wonderful pomegranate cultivars.

## MATERIALS AND METHODS

This study was carried out during the two successive seasons of 2012 and 2013 on 5-years old Manfaloty trees and 3-years old Wonderful pomegranate trees ,spaced at 3x4 m. under drip irrigation system grown in sandy soil in a private orchard located at El-Khatatba region, Menofia Governorate, Egypt. The trees were subjected to cultural practices which usually done in this orchard. The experiment was designed as a completely randomized block design within 8 treatments included 3 replicates, each replicate included two trees from each cultivar.

**The applied treatments were arranged as follows:**

- 1-Control (sprayed with water only)
- 2-Fruit bagging
- 3-Spraying of GA<sub>3</sub> at 50 ppm
- 4- Spraying of GA<sub>3</sub> at 100 ppm
- 5- Spraying of CaCl<sub>2</sub> at 2%
- 6- Spraying of CaCl<sub>2</sub> at 4%
- 7-Spraying of kaolin at 2.5%
- 8- Spraying of kaolin at 5%

Fruit bagging using paper bags 35x30cm, GA<sub>3</sub> and CaCl<sub>2</sub> were sprayed at the second week of June, while kaolin was sprayed at three times one at the second week of June, July and August in both seasons.

At harvest time when fruits become fully colored (the first week of October for Manfaloty cv and third week of October for Wonderfull cv) in both seasons fruits per tree in each treatment was counted and fruit yield (kg) per tree was calculated. Also percentage of fruit cracking, sunburn per tree and Marketable fruits were recorded as follow:

$$\text{Fruit cracking\%} = \frac{\text{No.of cracked fruits}}{\text{Total NO.of fruits}} \times 100$$

$$\text{Sunburn \%} = \frac{\text{No.of sunburn fruits}}{\text{Total No.of fruits}} \times 100$$

-Marketable fruits%=Total N. of fruits – (No. of cracked+sunburn fruits) x 100.

Fifteen normal fruits were taken from each treatment arise and transported to the laboratory of. Sakha Horticulture Research Station, Kafr El-Sheikh Governorate for quality determination as follows.

- 1.Fruit weight (g)
- 2.Arill weight (g) and percentage.
- 3.Peel weight (g) and percentage.
- 4.Fruit length and diameter (cm)
- 5.Soluble solids content (SSC) percentage in fruit juice was determined by using hand refractometer.
- 6.Total acidity % was determined according to A.O.A.C.(1995)
- 7.SSC/acid ratio in fruit juice
- 8.Vitamin C was determined according to A.O.A.C.(1995)

9. Total anthocyanin in peel and juice of fruit was determined according to Ranganna (1979).

The obtained data were statistically analyzed using the analysis of variance (Snedecor & Cochran, 1980), Treatment means were compared according to Duncan Multiple Range Test at 0.5 level of probability

## RESULTS AND DISCUSSION

**The obtained results are discussed under the following:**

### **Yield and its components**

Regarding to Manfaloty pomegranate cv, data presented in Table (1) reveal that the highest fruits number /tree are obtained by spraying  $\text{CaCl}_2$  4% and  $\text{GA}_3$  at 100 ppm in the first season and second season respectively compared to the lowest one by control in both seasons. Trees sprayed with  $\text{GA}_3$  at 50 ppm tended to increase fruit weight compared to the other treatments in both seasons. The trees treated with  $\text{GA}_3$  at 50 ppm or 100 ppm,  $\text{CaCl}_2$  at 2% or 4% and Kaolin 5% gave the highest yield / tree without non-significant differences among them in the first season, meanwhile in the second one the  $\text{CaCl}_2$  4% treatment resulted the highest yield compared to the lowest yield obtained by control.

As for the effect of treatments on Wonderful pomegranate cv the same table presented that the highest number of fruit /tree was obtained by  $\text{GA}_3$  50 ppm,  $\text{CaCl}_2$  2% and kaolin 5% treatments without non-significant differences among them compared to the lowest one obtained by control in the first season while the highest fruit number / tree obtained by bagging treatment in the second season.  $\text{GA}_3$  at 50 or 100 ppm,  $\text{CaCl}_2$  4%, kaolin 2.5 or 5% and bagging treatment increased average fruit weight without non-significant differences among them over control in the first season. While the trees sprayed with 50 ppm  $\text{GA}_3$  gave the highest average fruit weight in the second season. Spraying the trees with 50 ppm  $\text{GA}_3$  tended to increase the yield over the other treatments in both seasons. The obtained results are in accordance with those of El-Khawaga (2003), Singh *et al.* (2003), Mohamed (2004) on Manfaloty pomegranate cv. In addition Talaat *et al.* (2009) found that spraying  $\text{GA}_3$  at 100 ppm increased fruit number and yield. Furthermore, Melgarejo *et al.* (2004), Abd El-Rhman (2010) and Samra & Shalan (2013) mentioned that bagging or kaolin spraying increased fruit weight and yield (kg) / tree. Generally, increasing fruit yield and its component with spraying  $\text{GA}_3$  and  $\text{CaCl}_2$  may be due to the role of  $\text{GA}_3$  and Ca on fruit formation, abscission, cell elongation and fruit retention percentage (Aboutalebi & Beharoznam, 2006). Also,  $\text{GA}_3$  may be due to increased concentration of photosynthesis in the shoot (Zoffoli *et al.*, 2009).

From these results it is clear that, increasing the yield of Manfaloty trees than Wonderful due to the different in trees age. Also, Manfaloty trees reached to fruiting age compared to Wonderful trees which were still at the beginning of fruiting period.

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**Fruit cracking and sunburn percentage:**

Data in Table (2) indicate that the differences among the treatments were highly significant as for the effect of treatments for two pomegranate cvs in both seasons the lowest percentage of fruit creaking obtained from bagging treatment followed by spraying with  $\text{CaCl}_2$  and  $\text{GA}_3$  treatment compared to the control. On the other hand, the control treatment gave the highest percentage of sunburnt fruits compared to the lowest percentages resulted by bagging treatment followed by kaolin 5 % as for the tow pomegranate cvs in both seasons. In this respect Al- Hmadawi *et al.* (2011), Lal *et al.* (2012) and Abubakar *et al.* (2013) reported that spraying  $\text{GA}_3$  reduced fruit cracking in pomegranate fruits .Furthermore Melgarejo *et al.* (2004), Palitha *et al.* (2010) ,Ergun (2012), Hoda & Hoda, (2013) and Samra & Shalan (2013) reveal that bagging or kaolin application significantly reduced the severity of sunburn damage on pomegranate fruits. Generally, decreasing fruit cracking by bagging may be due to the effect of bagging on heat stress of fruit and water content of peel which decrease the transpiration from fruit surface ( Glenn & Puterka 2007). In addition,  $\text{GA}_3$  influence on fruit cracking indirectly by influencing of permeability or elasticity of the fruit cuticle (Sekse, 2005). Moreover Ca attributed to stabilization of membrane systems and the formation of calcium pectates and cell wall which increase rigidity of the middle portion and cell wall of the fruit (Jackman & Stanly 1995). As for reducing sunburn damage by bagging and kaolin may be attributed to role of these treatments of reflecting radiation, especially UV wavelengths which reaching the surface of fruits (Ergun, 2012).

**Table (2): Effect of  $\text{GA}_3$ ,  $\text{CaCl}_2$ , kaolin and bagging treatments on percentage of fruit cracking and sunburn of Manfaloty and Wonderful pomegranate cultivars.**

| Treatments               | Manfaloty        |       |                   |       | Wonderfull       |      |                   |       |
|--------------------------|------------------|-------|-------------------|-------|------------------|------|-------------------|-------|
|                          | Cracked fruits % |       | Sunburned fruit % |       | Cracked fruits % |      | Sunburned fruit % |       |
|                          | 2012             | 2013  | 2012              | 2013  | 2012             | 2013 | 2012              | 2013  |
| Control                  | 16.0a            | 11.9a | 32.6a             | 35.9a | 5.5a             | 4.2a | 53.7a             | 36.3a |
| Bagging                  | 2.9c             | 1.7c  | 0.0f              | 0.0f  | 0.7c             | 0.4b | 0.0f              | 0.0g  |
| $\text{GA}_3$ at 50 ppm  | 4.0bc            | 2.6bc | 18.7b             | 17.5c | 1.4c             | 2.6a | 26.2b             | 13.5d |
| $\text{GA}_3$ at 100 ppm | 2.6c             | 2.9bc | 19.1b             | 26.5b | 3.7b             | 3.3a | 25.2bc            | 16.5c |
| $\text{CaCl}_2$ at 2%    | 3.2bc            | 2.4bc | 18.8b             | 15.2d | 1.7c             | 2.7a | 24.1c             | 18.1b |
| $\text{CaCl}_2$ at 4%    | 3.2bc            | 2.2bc | 14.0c             | 17.7c | 2.3bc            | 3.2a | 21.4d             | 17.9b |
| Kaolin 2.5%              | 4.9b             | 2.8bc | 11.9d             | 14.4d | 2.2bc            | 3.8a | 17.2e             | 8.9e  |
| Kaolin 5%                | 4.2bc            | 3.5b  | 8.6e              | 10.8e | 1.8c             | 2.8a | 16.6be            | 6.2f  |
| F . test at 0.05         | **               | **    | **                | **    | **               | **   | **                | **    |

Values within each column having different letters showed statistically significant differences ( $p < 0.05$ )

**Marketable fruits percentage:**

Data in Table (3) demonstrate that, all treatments caused a highly significant increase in marketable fruits % compared with the untreated trees (control) for the two cultivars. Furthermore bagging treatment gave the highest marketable percentage since it ranged about (97.09, 98.22 and

99.22, 99.55) compared with the lowest percentage with obtained from the control ( 48.71, 47.88 and 40.72, 59.38) of Manfaloty and Wonderfull cvs respectively as 2012, 2013 seasons. These findings are agree with those reported by Wen Shuai (2009), Jing *et al.* (2009) ,Xiang *et al.* (2011) and Samra & shalan (2013) on pomegranate fruits. Marketable fruits percentage increased as a result of decreasing fruit disorders (cracking and sunburn) percentages which were affected by all treatments compared with control.

**Table (3): Effect of GA<sub>3</sub>,CaCl<sub>2</sub>, kaolin and bagging treatments on percentage of marketable and unmarketable fruits of Manfaloty and Wonderfull pomegranate cultivars.**

| Treatments                       | Manfaloty           |       |                       |       | Wonderfull          |        |                       |       |
|----------------------------------|---------------------|-------|-----------------------|-------|---------------------|--------|-----------------------|-------|
|                                  | Marketable fruits % |       | Unmarketable fruits % |       | Marketable fruits % |        | Unmarketable fruits % |       |
|                                  | 2012                | 2013  | 2012                  | 2013  | 2012                | 2013   | 2012                  | 2013  |
| <b>Control</b>                   | 51.2e               | 52.1f | 48.7a                 | 47.8a | 40.7f               | 59.3f  | 59.2a                 | 40.6a |
| <b>Bagging</b>                   | 97.0a               | 98.2a | 2.9e                  | 1.7f  | 99.2a               | 99.5a  | 0.7f                  | 0.4f  |
| <b>GA<sub>3</sub> at 50 ppm</b>  | 77.2d               | 79.8d | 22.7b                 | 20.1c | 72.3e               | 83.8d  | 27.6b                 | 16.1c |
| <b>GA<sub>3</sub> at 100 ppm</b> | 78.1d               | 70.5e | 21.8b                 | 29.4b | 70.9e               | 80.1be | 29.0b                 | 19.8b |
| <b>CaCl<sub>2</sub> at 2%</b>    | 77.9d               | 82.3c | 22.0b                 | 17.6d | 74.1d               | 79.0e  | 25.8c                 | 20.9b |
| <b>CaCl<sub>2</sub> at 4%</b>    | 82.6c               | 80.0d | 17.3bc                | 19.9c | 76.2c               | 78.7e  | 23.7d                 | 21.2b |
| <b>Kaolin 2.5%</b>               | 83.1c               | 82.7c | 16.9bc                | 17.2d | 80.4b               | 87.2c  | 19.5e                 | 12.7d |
| <b>Kaolin 5%</b>                 | 87.1b               | 85.b  | 12.8d                 | 14.4e | 81.5b               | 90.9b  | 18.4e                 | 9.1e  |
| <b>F . test at 0.05</b>          | **                  | **    | **                    | **    | **                  | **     | **                    | **    |

Values within each column having different letters showed statistically significant differences (p< 0.05)

**Fruit length and diameter:**

Regarding to Manfaloty pomegranate cv data in Table (4) show that, there were non-significant differences among treatments as for fruit diameter in both seasons and for fruit length in the first season. Therefore the highest fruit length was obtained by CaCl<sub>2</sub> 4% treatment followed by Kaolin 2.5% and CaCl<sub>2</sub> 2% treatment without non-significant differences among them in the second season. In regard to Wonderfull cv the highest fruit length obtained by bagging and GA<sub>3</sub> 50 ppm compared to the lowest values recorded by control in both seasons respectively. Meanwhile bagging and CaCl<sub>2</sub> 4 % treatment gave the highest fruit diameter compared to control regarding with Wonderfull pomegranate cv. Also, Talaat *et al.* (2009), samra & shalan (2013) on pomegranate and Abo El- Enien (2012) on Navel orange found that spraying CaCl<sub>2</sub> or GA<sub>3</sub> improvement fruit length and diameter. This can be attributed to GA<sub>3</sub> which stimulate cell elongation and membrane permeability to water uptake (Chaudhary *et al.* 2006) .Gibberellins are involved in cell division and cell elongation. They are known to influence fruit size (Zhang &Whiting 2011) Gibberellic acid is also reported to promote growth by increasing plasticity of the cell wall followed by the hydrolysis of starch into sugars which reduces the cell water potential, resulting in the entry of water into the cell and causing elongation (Richard, 2006) . Furthermore, Melgarejio *et al.* (2004) mentioned that kaolin based an effective sunscreen while it gave non-significant differences for fruit diameter compared with untreated ones.

**Table (4): Effect of GA<sub>3</sub>, CaCl<sub>2</sub>, kaolin and bagging treatments on fruit length and fruit diameter of Manfaloty and Wonderfull pomegranate cultivars.**

| Treatments                 | Manfaloty         |       |                     |      | Wonderfull        |       |                     |      |
|----------------------------|-------------------|-------|---------------------|------|-------------------|-------|---------------------|------|
|                            | Fruit length (cm) |       | Fruit diameter (cm) |      | Fruit length (cm) |       | Fruit diameter (cm) |      |
|                            | 2012              | 2013  | 2012                | 2013 | 2012              | 2013  | 2012                | 2013 |
| Control                    | 7.2               | 7.6c  | 8.2                 | 9.1  | 7.3c              | 8.1c  | 8.5c                | 9.3  |
| Bagging                    | 7.7               | 8.4ab | 8.8                 | 9.9  | 8.0a              | 8.1bc | 9.2a                | 9.7  |
| GA <sub>3</sub> at 50 ppm  | 7.8               | 8.4ab | 9.0                 | 10.1 | 8.0a              | 8.9a  | 8.6bc               | 10.0 |
| GA <sub>3</sub> at 100 ppm | 7.5               | 8.3b  | 8.7                 | 9.6  | 8.0a              | 8.5ab | 8.9ab               | 10.1 |
| CaCl <sub>2</sub> at 2%    | 7.8               | 8.6ab | 8.7                 | 10.2 | 7.7b              | 8.5ab | 8.1d                | 9.9  |
| CaCl <sub>2</sub> at 4%    | 7.6               | 8.8a  | 8.7                 | 10.0 | 7.8ab             | 8.2bc | 9.2a                | 9.7  |
| Kaolin 2.5%                | 7.4               | 8.7ab | 8.4                 | 10.1 | 7.8ab             | 8.1bc | 8.9ab               | 9.7  |
| Kaolin 5%                  | 7.3               | 8.3b  | 8.5                 | 9.9  | 8.0a              | 8.1bc | 8.9ab               | 9.7  |
| F . test at 0.05           | Ns                | **    | Ns                  | Ns   | **                | **    | **                  | Ns   |

Values within each column having different letters showed statistically significant differences ( $p < 0.05$ )

### SSC %, total acidity and SSC/acid ratio.

It is clear from Table (5) that Manfaloty pomegranate trees sprayed with 50 ppm GA<sub>3</sub> gave the highest parentage of SSC in the fruit juice followed by bagging treatment compared to the other treatments in both seasons. As for acidity and SSC /acid ratio there were no significant differences among treatments in the second season. Trees sprayed with GA<sub>3</sub> at 100 ppm gave the highest acidity followed by kaolin 2.5 or 5 %. Meanwhile the highest SSC/ acid ratio was obtained by CaCl<sub>2</sub> 2% or 4 % compared to the lowest percentage obtained by GA<sub>3</sub> 100ppm treatment.

With regard to Wonderfull pomegranate cv data in the same table reveal that kaolin 2.5 or 5 % treatments increased SSC % over all treatments in the first seasons followed by bagging and spraying by GA<sub>3</sub> 50 ppm. Besides, the GA<sub>3</sub> 50 ppm, CaCl<sub>2</sub> 2 % and control treatments gave the highest values in this respect compared to other treatments in the second season. All treatments increased acidity without non-significant differences among them compared to CaCl<sub>2</sub> 2 % treatment which gave the second rank in this respect in the first season. Meanwhile, bagging treatment gave the highest acidity compared to the lowest values obtained by CaCl<sub>2</sub> 2 % treatment in the second season. On the other hand CaCl<sub>2</sub> 2 % treatment increased SSC / acid ratio over the other treatments in both seasons. These results are in agreement with those reported by Talaat *et al.* (2009) and Abd El-Rhman (2010) on pomegranate mentioned that spraying GA<sub>3</sub> and kaolin significantly increased soluble solids content (SSC). Furthermore, samra & shalan (2013) and Xiang *et al.* (2011) stated that, bagging application increasing SSC and total acidity. Also, Ramezani *et al.* (2009) revealed that, SSC increased by preharvest calcium sprays, but it was a slight difference between CaCl<sub>2</sub> 2% and 4%. The increase in total SSC in fruits with Ca or GA<sub>3</sub> may be due to the effect of them in improving trees growth which include leaf area, total chlorophyll of the leaves, absorption of water, nutrition and increasing in food synthesized that translocated to fruits Al- Hmadawi *et al.*(2011).





### Total anthocyanin contents:

Concerning anthocyanin (Juice and peel) data in Table (6) show that, for Manfaloty non-significant differences in juice anthocyanin content in the first season, while the differences were significant in the second one. The highest anthocyanin in Juice was obtained by bagging treatment compared to the lowest one produced by GA<sub>3</sub> at 100 ppm treatment. Other treatments gave intermediate values. The bagging treatment gave the highest anthocyanin in peel compared to the lowest values obtained by control and CaCl<sub>2</sub> 4 % in the first season, meanwhile in the second one all treatments increased anthocyanin content in peel without non-significant differences among them compared to control. With regard to Wonderfull pomegranate cv, bagging treatment gave the highest juice and peel anthocyanin contents compared to the other treatments. In this respect Arakawa (1991), Jing *et al.* (2009), Xiang *et al.* (2011) and Samra & shalan (2013) mentioned that the bagging pomegranate fruits with paper bags produced higher levels of anthocyanin. Generally, increasing anthocyanin contents by using bagging and kaolin may be due to the role of them for decrease the heat stress of fruit. In addition, Tora *et al.* (2008) presented that light exposure temperature is an important environmental factor that influences anthocyanin synthesis. Low temperature such as 25°C favors the anthocyanin biosynthesis, whereas high temperatures such as 35°C are associated with anthocyanin degradation and inhibition for anthocyanin accumulation. On the other hand, GA<sub>3</sub> at 100 ppm decreased anthocyanin content may be due to the role of GA<sub>3</sub> on delaying the maturation and senescence of fruits (Yilmaz & Özgüven, 2009).

From these results it is noticed that there were marked differences between two cultivars under study when compared to the results of the control, especially in the susceptibility to fruit cracking which was less percentage in Wonderfull cv compared with high percentage produced in Manfaloty. As well as acidity, anthocyanin content and coloring percentage of aril and peel. These differences may be due to genetic traits of the variety. The cracking may occur due to varietal characters and susceptibility (Kumar *et al.* 2009). In India, Malhotra *et al.* (1983) observed the least fruit splitting in Bedana and Dkolkha pomegranate cvs. The varietal differences in cracking were attributed to skin structure and epidermal cell size. Yamamura & Nation (1985) stated that, the more cracking resistance cultivars had significantly thicker cell wall and larger cells in subepidermal region than the other cultivars. On the other hand, the sunburn damage percentage of Wonderfull cv was higher in the first season as a result of the fact that the fruits were from young trees (3 years old) where the canopy was not fully developed exposing a high proportion of the fruit to full sun and high daily temperatures.

From this study, it is clear that bagging and spraying with GA<sub>3</sub>, CaCl<sub>2</sub> and kaolin treatments increased Marketable fruits percentages, improved fruit quality, reduced fruit cracking and sunburn percentages of Manfaloty and Wonderfull pomegranate cultivars. Also, the best results were obtained by bagging, spraying with GA<sub>3</sub> at 50 ppm and kaolin at 5% in both cultivars with fruit yield and quality. Therefore, these treatments could be recommended for improving Manfaloty and Wonderfull pomegranate cvs performance under similar conditions.

**Table (6): Effect of GA<sub>3</sub>, CaCl<sub>2</sub>, kaolin and bagging treatments on ascorbic acid and acidity anthocyanin in juice and peel of Manfaloty and Wonderfull pomegranate cultivars.**

| Treatments                 | Manfaloty            |        |        |       | Wonderfull           |        |        |       |
|----------------------------|----------------------|--------|--------|-------|----------------------|--------|--------|-------|
|                            | Anthocyanin mg/100ml |        |        |       | Anthocyanin mg/100ml |        |        |       |
|                            | Juice                |        | Peel   |       | Juice                |        | Peel   |       |
|                            | 2012                 | 2013   | 2012   | 2013  | 2012                 | 2013   | 2012   | 2013  |
| Control                    | 18.4                 | 16.0c  | 14.8c  | 15.4b | 17.4                 | 17.9c  | 17.2ab | 18.6a |
| Bagging                    | 19.0                 | 20.2a  | 18.0a  | 18.7a | 17.8                 | 20.8a  | 17.9a  | 19.3a |
| GA <sub>3</sub> at 50 ppm  | 18.8                 | 19.6ab | 16.7ab | 18.4a | 17.9                 | 19.0ab | 16.9b  | 18.6a |
| GA <sub>3</sub> at 100 ppm | 18.5                 | 11.2d  | 16.1bc | 17.5a | 16.2                 | 18.6bc | 17.3ab | 16.4c |
| CaCl <sub>2</sub> at 2%    | 18.6                 | 19.8ab | 16.9ab | 17.3a | 17.3                 | 19.3ab | 17.0b  | 18.6a |
| CaCl <sub>2</sub> at 4%    | 18.6                 | 16.9bc | 16.1bc | 17.3a | 16.7                 | 19.8ab | 16.0c  | 17.5b |
| Kaolin 2.5%                | 18.9                 | 18.7bc | 16.5ab | 18.5a | 17.9                 | 19.2ab | 17.3ab | 19.0a |
| Kaolin 5%                  | 18.8                 | 17.4ab | 16.7ab | 18.7a | 17.5                 | 17.8c  | 17.4ab | 19.3a |
| F. test at 0.05            | Ns                   | **     | *      | **    | Ns                   | *      | **     | **    |

Values within each column having different letters showed statistically significant differences (p< 0.05).

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**تحسين جودة الثمار في صنف الرمان المنفلوطي والوندر فول باستخدام التكييس و بعض معاملات الرش بالجبريللين وكلوريد الكالسيوم والكاولين.**  
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أجريت هذه الدراسة خلال الموسمين ٢٠١٢م، ٢٠١٣م على صنف الرمان المنفلوطي عمر خمس سنوات والوندر فول عمر ثلاث سنوات والمنزوعة على مسافات 4x3 في ارض رملية بمنطقة الخطاطبة محافظة المنوفية بهدف دراسة تأثير بعض معاملات التكييس والرش بكل من الجبريللين وكلوريد الكالسيوم والكاولين على المحصول وجودة الثمار لصنف الرمان تحت الدراسة ويمكن تلخيص اهم النتائج المتحصل عليها كالتالى:-

ادت جميع المعاملات الى زيادة عدد الثمار /شجرة وكذلك كمية المحصول الكلي / شجرة، كما ادت جميع المعاملات الى خفض كل من نسبة تشقق الثمار وكذلك نسبة الاصابة بلفحة الشمس في كلا الصنفين تحت الدراسة ، حيث اعطت معاملة التكييس بالاكياس الورقية و الرش بحمض الجبريللين بتركيز ٥٠ او ١٠٠ جزء في المليون اقل نسبة تشقق في الثمار والاصابة بلفحة الشمس ثم معاملات الرش بكلوريد الكالسيوم ٢ او ٤ % ثم معاملة الكاولين ٥% بالمقارنة بالكنترول، كما ادت. ادت جميع المعاملات الى زيادة معنوية في نسبة الثمار الصالحة للتسويق في كلا الصنفين تحت الدراسة ، حيث اعطت معاملة التكييس اعلى نسبة للثمار الصالحة للتسويق في كلا الموسمين بالمقارنة بالكنترول وباقي المعاملات. كما اعطت معاملات الرش بحمض الجبريللين ٥٠ و ١٠٠ جزء في المليون وكلوريد الكالسيوم ٢ و ٤% اعلى قيم في طول وقطر الثمرة. كما ادت معاملات التكييس والرش بالجبريللين والكاولين الى زياده معنوية في نسبة المواد الصلبة الذائبة و الحموضه ونسبة المواد الصلبة الذائبة للحموضه . كذلك اعطت معاملات الرش بالجبريللين ٥٠ جزء في المليون والكاولين ٢.٥ و ٥ % اعلى نسبة لحمض الاسكوربيك في كلا الصنفين. من ناحية اخرى اعطت معاملة التكييس اعلى نسبة في محتوى كل من العصير وقشرة الثمره من صبغة الانثوسيانين ثم معاملة الرش بالكاولين بتركيز ٥ % في كلا الصنفين وذلك خلال موسمي الدراسة. من هذه النتائج يتضح اهمية استخدام هذه المعاملات في تحسين خواص الثمار والمحصول في كل من صنف الرمان المنفلوطي والوندر فول وذلك عند زراعتها في المناطق التي تتشابه ظروفها المناخية مع ظروف المنطقة التي تم اجراء الدراسة بها.

**Table (1): Effect of GA<sub>3</sub>, CaCl<sub>2</sub>, kaolin and bagging treatments on number of fruit /tree, average of fruit weight of Manfaloty and Wonderfull pomegranate cultivars.**

| Treatments                 | Manfaloty         |       |                         |         |                 |        | Wonderfull        |       |                         |         |                 |        |
|----------------------------|-------------------|-------|-------------------------|---------|-----------------|--------|-------------------|-------|-------------------------|---------|-----------------|--------|
|                            | No .of fruit/tree |       | Average fruit weight(g) |         | Yield (kg)/tree |        | No .of fruit/tree |       | Average fruit weight(g) |         | Yield (kg)/tree |        |
|                            | 2012              | 2013  | 2012                    | 2013    | 2012            | 2013   | 2012              | 2013  | 2012                    | 2013    | 2012            | 2013   |
| Control                    | 51.1h             | 40.8f | 269.4b                  | 365.0d  | 13.7c           | 14.9d  | 25.0d             | 31.5e | 304.5b                  | 376.0c  | 7.6c            | 11.8c  |
| Bagging                    | 61.1g             | 44.3e | 329.4ab                 | 476.0b  | 20.2b           | 20.9c  | 32.8ab            | 44.0a | 355.2a                  | 420.4bc | 11.7ab          | 18.4a  |
| GA <sub>3</sub> at 50 ppm  | 66.8d             | 44.5e | 372.8a                  | 488.00a | 21.6a           | 21.7bc | 38.8a             | 31.5e | 348.6a                  | 496.0a  | 13.5a           | 15.6a  |
| GA <sub>3</sub> at 100 ppm | 65.8a             | 53.1a | 332.0ab                 | 442.5c  | 21.9a           | 23.5ab | 31.3c             | 34.0d | 354.5a                  | 464.0ab | 11.2b           | 15.8b  |
| CaCl <sub>2</sub> at 2%    | 65.0e             | 50.0c | 328.7ab                 | 479.8ab | 21.4a           | 20.6c  | 38.5a             | 36.6c | 306.6b                  | 438.3ab | 11.8ab          | 16.0ab |
| CaCl <sub>2</sub> at 4%    | 72.8b             | 44.8e | 314.2ab                 | 482.0ab | 22.6a           | 24.0a  | 32.3bc            | 37.6c | 356.6a                  | 413.6bc | 11.5ab          | 15.3b  |
| Kaolin 2.5%                | 61.6f             | 46.5d | 283.9b                  | 473.0b  | 17.5b           | 21.2c  | 37.5a             | 41.8b | 352.5a                  | 392.5bc | 12.9ab          | 16.4ab |
| Kaolin 5%                  | 70.6c             | 51.5b | 306.8b                  | 444.3c  | 21.6a           | 20.6c  | 37.8a             | 41.0b | 343.0a                  | 420.2bc | 13.3ab          | 17.2ab |
| F . test at 0.05           | **                | **    | **                      | **      | **              | **     | **                | **    | *                       | *       | **              | **     |

Values within each column having different letters showed statistically significant differences (p< 0.05)

**Table (5): Effect of GA<sub>3</sub>, CaCl<sub>2</sub>, kaolin and bagging treatments on SSC%, acidity and SSC/ acid ratio of Manfaloty and Wonderfull pomegranate cultivars.**

| Treatments                 | Manfaloty |        |           |      |                  |      | Wonderfull |        |           |        |                 |        |
|----------------------------|-----------|--------|-----------|------|------------------|------|------------|--------|-----------|--------|-----------------|--------|
|                            | SSC %     |        | Acidity % |      | SSC / Acid ratio |      | SSC %      |        | Acidity % |        | SSC/ Acid ratio |        |
|                            | 2012      | 2013   | 2012      | 2013 | 2012             | 2013 | 2012       | 2013   | 2012      | 2013   | 2012            | 2013   |
| Control                    | 15.7      | 14.9c  | 1.08b     | 1.10 | 15.0ab           | 14.2 | 14.9b      | 16.5a  | 1.30a     | 1.17b  | 11.4bc          | 14.1b  |
| Bagging                    | 16.3      | 16.3ab | 1.09b     | 0.96 | 14.8ab           | 17.4 | 15.8ab     | 15.7ab | 1.43a     | 1.48a  | 11.0c           | 10.6c  |
| GA <sub>3</sub> at 50 ppm  | 16.0      | 16.9a  | 1.06b     | 0.89 | 15.1ab           | 19.6 | 15.8ab     | 16.7a  | 1.30a     | 1.21ab | 12.1bc          | 14.0b  |
| GA <sub>3</sub> at 100 ppm | 15.9      | 15.2c  | 1.41a     | 1.09 | 10.9c            | 14.0 | 15.6ab     | 14.7b  | 1.44a     | 1.11bc | 10.8c           | 13.1bc |
| CaCl <sub>2</sub> at 2%    | 15.7      | 15.3bc | 0.97b     | 0.74 | 16.4a            | 20.8 | 15.1b      | 16.6a  | 0.70b     | 0.88c  | 19.2a           | 19.1a  |
| CaCl <sub>2</sub> at 4%    | 16.5      | 14.6c  | 0.98b     | 1.17 | 16.9a            | 12.5 | 15.6ab     | 15.6ab | 1.18a     | 1.34ab | 13.8bc          | 11.9bc |
| Kaolin 2.5%                | 16.3      | 14.6c  | 1.26ab    | 0.91 | 12.9bc           | 16.1 | 16.7a      | 15.6ab | 1.35a     | 1.10bc | 12.4bc          | 14.2b  |
| Kaolin 5%                  | 15.1      | 15.0c  | 1.16ab    | 0.82 | 13.5ab           | 19.1 | 16.5a      | 15.7ab | 1.11a     | 1.14bc | 15.4ab          | 14.0b  |
| F . test at 0.05           | Ns        | **     | *         | Ns   | *                | Ns   | *          | *      | *         | *      | *               | **     |

Values within each column having different letters showed statistically significant differences (p< 0.05)