

STUDIES ON THINNING, BAGGING AND ALUMINUM SILICATE SPRAYING ON YIELD AND QUALITY OF WANDERFULL POMEGRANATE

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ABSTRACT

This investigation was carried out to study the effect of hand thinning, bagging and spraying with aluminum silicate on yield and fruit quality of Wanderfull pomegranate cv.

The obtained results revealed that hand thinning alone or with bagging significantly reduced the number of fruits/tree than bagging only or spraying with aluminum silicate. Yet, the effect of these treatments was on yield/tree pronounced. Since, hand thinning alone or with bagging significantly increased both fruit weight and size than the control.

The data also revealed that, bagging the fruit or spraying with aluminum silicate significantly reduced the percent of sunburn damages than hand thinning or the control. Bagging the fruits gave zero percent of sunburn. Furthermore, hand thinning with bagging or spraying the trees with aluminum silicate increased the values of soluble solids % and anthocyanin content in the skin of the fruits and in juice than hand thinning or the control. For protecting fruits of Wanderfull pomegranate from sunburn damage and improving fruit quality it is advised to use hand thinning with bagging.

INTRODUCTION

Pomegranate (*Punica granatum* L.) is one of the oldest fruit crops grown in Egypt and the Mediterranean. The cultivated area considered as a minor crop, since it ranked the 13th among fruit crops in Egypt. Nowadays, acreage is rapidly increasing especially with Wanderfull cultivar under the new reclaimed lands.

The total cultivated area is about 13521 feddans with total production about 64574 tons according to the Ministry of Agriculture statistics (2011).

The fruit growers prefer to produce an optimum fruit number per tree. In this respect, fruit thinning is an important factor to improve fruit quality of pomegranate (Hussien *et al.*, 1994 a,b and El-Sese and Mohamed, 2005). Commercial fruits of Manfalouty pomegranate cultivar were produced from the first three weeks of fruit set. The early fruit set produced larger with good fruit quality and earlier harvest. Whereas, the later ones gave non-commercial fruits with poor quality because they are not able to ripen in autumn (El-Sese, 1988 and Mohamed, 2004).

Pomegranates are grown in Mediterranean climates often with very warm summers. The high temperature causes sunburn damage outside the skin of the fruit making them unmarketable. Pomegranate fruits are especially sensitive to sun because they are terminal bearing with generally thin branches that bend with the increase in fruit weight as the season progresses. Pomegranates are picked in late summer to early autumn, therefore the fruits are exposed to high temperatures throughout the summer. As a result, the incidence of sunburn damage can be high causing great

losses that may exceed 30 % of harvested fruits. An improved fertilization and irrigation program could increase vegetative development and improve protection of fruits from direct sun light (Malgarejo *et al.*, 2004).

Controlling irrigation, bagging and spraying pomegranate with Kaolin reduced the percent of fruit cracking (Abd EL-Rhman, 2010).

Kaolin mineral particle, a hydrated alumino-silicate are used to reduce severity of sunburn damage in pomegranate fruit (Weerakkody *et al.*, 2010).

Kaolin has emerged as the most important film resource, mainly used for reflecting radiation, especially UV wavelengths, reaching the surfaces of leaves and fruits (Glenn *et al.*, 2002). Therefore, Kaolin sunscreen treatments can significantly reduce sunburn damage (Palitha *et al.*, 2010). Also, Glenn *et al.* (2002) presented that using white-coat on entire pomegranate tree reduced sunburn damage.

The present study evaluates the effects of hand thinning, bagging and spraying with aluminum silicate (Kaolin) on sunburn damage, yield and fruit quality of Wanderfull pomegranate cultivar.

MATERIALS AND METHODS

This study was carried out in a private orchard at desert road from Cairo Alex, Egypt during the seasons of 2011-2012 on 4-years-old Wanderfull pomegranate trees grown in sandy soil. The trees were planted at 3x4 m under drip irrigation system.

Thirty trees almost uniform in shape and size, received the same horticultural management in the orchard. This experiment was designed as a completely randomized block design with three replicates, each replicate was represented by two trees.

The applied treatments were the following :

- 1- Control.
- 2- Hand thinning.
- 3- Fruit bagging.
- 4- Hand thinning + Fruit bagging.
- 5- Spraying of aluminum silicate at 1.0 %.

Hand thinning of fruits was carried out at the last week of May by leaving one or two fruits on each thin branch. Also, fruit bagging was applied to all fruits on the tree one week after hand thinning using paper bags 25 x 30 cm. Trees were sprayed with CMM* which composition from [Minerals- 97.4 % hydrous Kaolin (aluminum silicate) – 2.6 % inerts] at 1.0 % three times one at the first week of June and every month till July. At harvest time fruits per each tree were counted and weighed to estimate yield/tree per each treatment using average fruit weight. Also, the number of sunburn fruit per each tree was recorded to estimate the sunburn percentage as follow :

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

*CMM= Crop microclimate management Inc, USA Apex, North Carolina, USA.

When fruits from each treatment become fully colored at 15 October at the first year and at 29 October at the second one, five fruits from each replicate were taken and transported to the laboratory of Pomology Dept., Fac. of Agric., Mansoura Univ., for determining the following parameters :

- 1- Average fruit weight (g).
- 2- Average fruit size (ml).
- 3- Average fruit length and diameter (cm).
- 4- Soluble solids content (SSC) percentage in fruit juice using a hand refractometer.
- 5- Total acidity % in fruit juice, expressed as citric acid according to A.O.A.C. (1985).
- 6- SSC/acid ratio in fruit juice.
- 7- Total anthocyanine in both skin and juice of fruit was determined by using the method of Mazumadar and Majumder (2003).

The obtained data were statistically analyzed, and the differences between treatments were tested by analysis of variance (ANOVA) according to Snedecor and Cochran (1980). Means of treatments were compared using L.S.D value at 5 % level of probability.

RESULTS AND DISCUSSION

This investigation was undertaken to study the effect of hand thinning, bagging and aluminum silicate spraying on yield and fruit quality of Wanderfull pomegranate cv. In this respect, the obtained results are presented as follow :

1- Number of fruits and yield / tree :

Data from Table (1) reveal that hand thinning alone or with bagging significantly reduced the number of fruits/tree during both seasons of study. The reduction attributed to these treatments was about 23 % than the control. Whereas, both bagging or spraying the trees gave non-significant effect on number of fruits/tree. Since, these treatments were applied after fruit set.

With regard to the effect on yield/tree, the data showed that all treatments gave insignificant effect on yield/tree during the two seasons. Yet, spraying the trees with aluminum silicate showed a somewhat increment in yield/tree than hand thinning each alone or with bagging. The increment in yield/tree due this treatment was about 12.3 % than the control as a mean of the two seasons under the study.

Table (1) : Effect of thinning, bagging and aluminum silicate treatments on No. of fruits and yield/tree of Wanderfull pomegranate.

Treatment	No. of fruits /tree			Yield/tree (kg)		
	Season 2011	Season 2012	Mean	Season 2011	Season 2012	Mean
Control	33,66	60,66	47,16	11,69	20,39	16,04
Thinning	20,00	47,00	33,00	11,09	21,31	16,40
Bagging	30,00	58,33	44,17	11,90	22,60	17,25
Thinning + Bagging	26,33	47,33	36,83	12,72	22,41	17,56
Aluminum silicate 1.0%	31,33	61,00	46,17	12,33	23,71	18,02
L.S.D at 5 %	4,30	9,27	----	N.S	N.S	----

From this data it is also clear that in spite of hand thinning alone or with bagging gave a lower number of fruits/tree but the yield was not affected, this is may be due to that these treatments increased average fruit weight than the other treatments or the control.

Likewise, Hussein *et al.* (1994a) mentioned that thinning decreased the number of fruits/tree of Manfalouty pomegranate, while the total yield (kg/tree) was not affected comparing to the control. Also, EL-Sese and Mohamed (2005) found that such increment in percentage of yield weight can be attributed to the high increase of average fruit weight resulted from thinning treatment. Similar results were obtained by Talaat *et al.* (2009).

2- Sunburn damage :

From Table (2) it is clear that bagging each alone or with hand thinning presented no fruits per trees were affected with sunburn, since these treatments gave zero percent of sunburn during both seasons of study. Also, spraying the trees with aluminum silicate significantly reduced the number of sunburn / tree than hand thinning or the control. The percent of sunburn fruits was about 18.8 %, whereas it was about 35.0 and 38.0 % for the other treatment and the control, respectively. Also, spraying the trees with aluminum silicate reduced the number of sunburn by about 48.0 % than the control.

Table (1) : Effect of thinning, bagging and aluminum silicate treatments on No. of sunburn and % sunburn of Wanderfull pomegranate.

Treatment	No. of sunburn			Sunburn %		
	Season 2011	Season 2012	Mean	Season 2011	Season 2012	Mean
Control	13,33	19,33	16,33	39,09	31,73	35,41
Thinning	9,66	17,66	13,66	38,73	37,60	38,17
Bagging	0,00	0,00	0,00	0,00	0,00	0,00
Thinning + Bagging	0,00	0,00	0,00	0,00	0,00	0,00
Aluminum silicate 1.0%	6,33	10,66	8,49	20,23	17,43	18,83
L.S.D at 5 %	1,40	3,04	----	2,97	2,71	----

In this respect, Glenn & Puterka (2007) presented that Kaolin reduces heat stress on leaves and increases carbon assimilation, which results in higher fruit yield and better coloration.

Furthermore, Palitha *et al.* (2010) reported that Kaolin spraying significantly reduced sunburn damage of pomegranate fruit from 21.9 % in the untreated fruits to 9.4 % for treated ones. So, Kaolin based a sunscreen significantly reduced the severity of sunburn damage on pomegranate fruit. Also, Ergun (2012) mentioned that kaolin has emerged as the most important film resource for plants. This non-toxic film resource, has been used for reflecting radiation, especially UV wavelengths, reaching the surface of leaves and fruits.

3- Fruit weight and size :

It is obvious from Table (3) that hand thinning alone or with bagging significantly increased both average fruit weight and size of Wanderfull pomegranate during both seasons of study.

Table (3) : Effect of thinning, bagging and aluminum silicate treatments on fruit weight and size of Wanderfull pomegranate.

Treatment	Fruit weight (g)			Fruit size (ml)		
	Season 2011	Season 2012	Mean	Season 2011	Season 2012	Mean
Control	٣٤٧,٣٦	٣٣٦,٢٠	٣٤١,٧٨	٣٣٦,٢٠	٣٤٧,٠٦	٣٤١,٦٣
Thinning	٤٦٣,٧٠	٤٥٣,٤٣	٤٥٨,٥٧	٤٥٣,٤٣	٤٤٢,٠٠	٤٤٧,٧٢
Bagging	٣٩٨,٦٣	٣٨٨,٤٠	٣٩٣,٥٢	٣٨٨,٤٠	٣٤٨,٥٣	٣٦٨,٤٧
Thinning + Bagging	٤٨٣,٣٦	٤٧٣,٦٦	٤٧٨,٥١	٤٧٣,٦٦	٤٥٧,٤٠	٤٦٥,٥٣
Aluminum silicate 1.0%	٣٩٣,٧٦	٣٨٨,٨٣	٣٩١,٢٩	٣٨٨,٩٣	٣٧٥,٧٣	٣٨٢,٣٣
L.S.D at 5 %	٣٢,٤٦	٣٢,٩٩	----	٣٣,٠٣	٣٤,٧٥	----

The increment of fruit weight due these treatments were about 34.2 and 40.0 % over control as a mean of the two seasons, respectively. Furthermore, spraying the trees with aluminum silicate at 1.0 % also significantly increased both fruit weight and size than the control. This treatment increased average fruit weight by about 14.5 % over the control. Moreover, bagging fruit with paper bags also increased average fruit weight and size than the control, but the increment due this treatment was lower than the other treatments used. The increment due this treatment was about 15.1 % over the control as mean of the two seasons.

Our data are agree with those reported by Hussein *et al.* (1994b) & EL-Sese and Mohamed (2005) since, they mentioned that fruit thinning of Manfalouty pomegranate significantly increased average fruit weight comparing to the control.

Also, Solomakin & Blanke (2010) mentioned that mechanical thinning produced larger fruit size of apple than the control. Whereas, Palitha *et al.* (2010) showed that sunscreens presented no difference in average fruit diameter of Wanderfull pomegranate than the untreated ones.

4- Fruit length and diameter :

The effect of hand thinning, bagging and aluminum silicate treatments on both average fruit length and diameter of Wanderfull pomegranate are presented in Table (4). From this Table it is clear that similar effect from these treatments on average fruit length and diameter to those obtained on average fruit weight and size. Since, the effects are pronounced on average fruit diameter. It also showed that all treatments significantly increased average fruit diameter than the control. Also, hand thinning alone or with bagging gave a higher significant values than the other treatments or the control. Also, Melgarejo *et al.* (2004) presented that kaolin based sunscreen gave no difference effect in average fruit diameter than the untreated.

Table (4) : Effect of thinning, bagging and aluminum silicate treatments on fruit length and diameter of Wanderfull pomegranate.

Treatment	Fruit length (cm)			Fruit diameter (cm)		
	Season 2011	Season 2012	Mean	Season 2011	Season 2012	Mean
Control	9,48	9,13	9,31	8,00	8,70	8,35
Thinning	9,41	9,77	9,59	9,70	9,41	9,56
Bagging	9,38	9,10	9,24	9,20	9,01	9,11
Thinning + Bagging	9,83	9,53	9,68	9,77	9,30	9,54
Aluminum silicate 1.0 %	9,47	9,30	9,39	8,91	9,00	8,96
L.S.D at 5 %	N.S	0,388	----	0,242	0,268	----

5- SSC, total acidity and SSC/acid ratio :

It is clear from Table (5) that hand thinning with bagging gave higher values of SSC in fruit juice than the other treatments used. Also, bagging fruits or spraying with aluminum silicate showed higher values of SSC than those obtained from hand thinning only or the control.

With regard to the effect on total acidity in fruit juice, data from the same table reveal that all treatments used had no significant effect in this respect.

Table (5) : Effect of thinning, bagging and aluminum silicate treatments on SSC, total acidity and SSC/acid ratio in fruit juice of Wanderfull pomegranate.

Treatment	SSC %		Acidity %		SSC/acid ratio	
	Season 2011	Season 2012	Season 2011	Season 2012	Season 2011	Season 2012
Control	16,06	16,70	1,16	1,10	13,80	14,46
Thinning	16,70	16,70	1,14	1,11	14,01	10,00
Bagging	17,00	17,77	1,16	1,10	14,77	10,37
Thinning + Bagging	17,06	17,70	1,14	1,12	14,97	10,77
Aluminum silicate 1.0%	16,77	17,33	1,04	1,10	10,97	10,08
L.S.D at 5 %	0,740	0,707	N.S	N.S	0,787	1,290

Concerning to the effect on SSC/acid ratio in fruit juice, the data presented that all treatment gave higher values of SSC/acid ratio than the control. The increment of these values may be due to that these treatments increased the percent of soluble solids content and reduced the values of total acidity in fruit juice. In this respect, EL-Sese and Mohamed (2005) reveal that flower thinning significantly increased SSC %, but decreased the total acidity compared to the control.

6- Total anthocyanin content :

Data from Table (6) reveal the effect of hand thinning, bagging and spraying with aluminum silicate on the content of total anthocyanin in fruit skin and seed juice. From this Table, it is clear that all treatments used significantly increased anthocyanin content in fruit skin than the control. Furthermore, sprayed trees with aluminum silicate at 1.0 % gave a higher significant effect in this respect.

Concerning the effect on anthocyanin content in seed juice, data showed that bagging alone or with hand thinning or spraying aluminum silicate gave a higher significant value of anthocyanin than hand thinning only

or the control. Also, the effect of these treatments were more pronounced on the values of total anthocyanin in the skin of Wanderfull fruits than those obtained on juice. This could be due the effect of bagging on reducing sunlight that leading anthocyanin catabolism in the skin and seed.

Table (6) : Effect of thinning, bagging and aluminum silicate treatments on anthocyanin content of Wanderfull pomegranate.

Treatment	Anthocyanin (Skin) mg/100gm F.W			Anthocyanin (Seed) mg/100ml juice		
	Season 2011	Season 2012	Mean	Season 2011	Season 2012	Mean
Control	11,24	11,98	11,61	11,62	12,00	12,09
Thinning	16,03	17,12	16,83	11,72	12,62	12,17
Bagging	19,41	20,94	20,18	13,67	10,26	14,47
Thinning + Bagging	19,74	22,38	21,06	14,08	10,02	14,80
Aluminum silicate 1.0 %	20,64	22,32	21,48	14,37	10,10	14,76
L.S.D at 5 %	1,009	1,100	----	0,969	0,717	----

In this respect, Arakawa (1991) mentioned that bagging apple fruit with paper bags, one month after flowering produced higher levels of anthocyanin at immature and mature stages than did shaded apples. Furthermore, Kulkarni & Aradhya (2005) reported that the phenolic compounds in pomegranate juice are used up in the biosynthesis of flavylum ring during anthocyanin pigment formation. Also, Solomakhin and Blanke (2010) found that mechanical thinning produced more anthocyanin of Gala apples than the control.

Generally, 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.

From this study, it is clear that hand thinning with bagging Wanderfull pomegranate fruit reduced the number of fruit/tree but produced a higher fruits with good colour and quality. Also, sprayed pomegranate trees with Aluminum silicate at 1.0 % reduced the percent of sunburn but increased both SSC and total anthocyanin content than the control. So, bagging fruits of Wanderfull pomegranate prevent the sunburn damage completely and enhanced anthocyanin contents in skin and seed.

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دراسات على الخف والتكيس والرش بسليكات الألمونيوم على المحصول وصفات الجودة في الرمان صنف الوندرفل

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أجرى هذا البحث لدراسة تأثير الخف اليدوي وتكيس الثمار وكذا رش الأشجار بسليكات الألمونيوم على المحصول وصفات الجودة لثمار الرمان صنف الوندرفل. أوضحت النتائج المتحصل عليها أن الخف اليدوي سواء منفرداً أو مع تكيس الثمار أدى إلى تقليل عدد الثمار على الأشجار مقارنة بتكيس الثمار أو الرش بمادة سليكات الألمونيوم. وكانت لتلك المعاملات أثر واضح على محصول الشجرة حيث أدى الخف اليدوي بمفرده أو مع تكيس الثمار إلى زيادة معنوية في كل من متوسط وزن وحجم الثمار مقارنة بالكنترول. كما أظهرت الدراسة أيضاً أن تكيس الثمار أو الرش بسليكات الألمونيوم أدت إلى تقليل نسبة الثمار المصابة بلفحة الشمس مقارنة بالخف اليدوي أو الكنترول حيث أن تكيس الثمار لم يظهر عليها أية إصابة بلفحة الشمس بالإضافة إلى أن إجراء الخف اليدوي مع تكيس الثمار أو الرش بسليكات الألمونيوم أدى إلى تحسين خواص العصير وذلك لزيادة نسبة المواد الصلبة الذائبة الكلية وكذا محتوى قشرة الثمار والبذور من صبغة الأنثوسيانين مقارنة بالخف اليدوي أو الكنترول. لذا ينصح لحماية ثمار الرمان الوندرفل من ضرر ضربة الشمس وتحسين جودة الثمار فإنه يجب إجراء الخف اليدوي مع تكيس الثمار.

قام بتحكيم البحث

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